



Circulation Research

Manuscript Submission and Peer Review System

Disclaimer: The manuscript and its contents are confidential, intended for journal review purposes only, and not to be further disclosed.

URL: <https://circres-submit.aha-journals.org>

Manuscript Number: CIRCRES/2018/313854DR1

Title: ATF6 regulates cardiac hypertrophy by transcriptional induction of the mTORC1 activator, Rheb

Authors:

Christopher Glembotski
Erik Blackwood
Christoph Hofmann
Michelle Santo Domingo
Alina Bilal
Winston Stauffer
Donna Thuerauf
Fred Kolkhorst
Oliver Müller
Tobias Jakobi
Christoph Dieterich
Hugo Katus
Shirin Doroudgar
Anup Sarakki
Adrian Arrieta

For C

Circulation Research Online Submission: <https://circres-submit.aha-journals.org>

Circulation Research Homepage: <http://circres.ahajournals.org>

Circulation Research Editorial Office

3355 Keswick Rd, Main Bldg 103

Baltimore, MD 21211

CircRes@circresearch.org

Telephone: 410-327-5005

1
2 CIRCRES/2018/313233D-A
3

4 ATF6 regulates cardiac hypertrophy by transcriptional induction of the mTORC1
5 activator, Rheb
6

7 Erik A. Blackwood, B.S.¹, Christoph Hofmann^{1,2,3}, Michelle Santo Domingo, B.S.
8 ¹, Alina S. Bilal, B.A.¹, Anup Sarakki, B.S.¹, Winston Stauffer, B.S.¹, Adrian
9 Arrieta, M.S.¹, Donna J. Thuerauf, M.S.¹, Fred W. Kolkhorst, Ph.D.¹,
10 Oliver J. Müller^{2,3,4}, M.D., Tobias Jakobi^{3,5}, Ph.D.,
11 Christoph Dieterich^{3,5}, Ph.D., Hugo A. Katus, M.D.^{2,3}, Shirin Doroudgar, Ph.D.^{2,3}
12 and Christopher C. Glembotski, Ph.D.^{1*}
13
14

15 ¹San Diego State University Heart Institute and the Department of Biology, San
16 Diego State University, San Diego, CA 92182

17 ²Department of Cardiology, Angiology, and Pneumology, University Hospital
18 Heidelberg, Innere Medizin III, Im Neuenheimer Feld 669,
19 69120 Heidelberg, Germany.

20 ³DZHK (German Centre for Cardiovascular Research), Partner Site
21 Heidelberg/Mannheim, 69120 Heidelberg, Germany.

22 ⁴ Department of Internal Medicine III,
23 University of Kiel, Arnold-Heller-Str.3, Kiel, Germany

24 ⁵Section of Bioinformatics and Systems Cardiology, Department of Internal
25 Medicine III, Klaus Tschira Institute for Integrative Computational Cardiology,
26 University Hospital Heidelberg, Heidelberg, Germany
27
28

29 **Short Title:** ATF6 regulates cardiac growth

30 ***Corresponding Author:** Christopher C. Glembotski, the SDSU Heart Institute and
31 Department of Biology, San Diego State University, 5500 Campanile Drive, San Diego,
32 CA 92182, USA. Tel.: (619) 594-2959; FAX: (619) 594-5676; E-mail:
33 cglembotski@mail.sdsu.edu
34
35
36

1 **ABSTRACT:**

2 **Rationale:** ER stress dysregulates ER proteostasis, which activates the transcription
3 factor, ATF6, an inducer of genes that enhance protein folding and restore proteostasis.
4 Due to increased protein synthesis, it is possible that protein folding and, thus, ER
5 proteostasis are challenged during cardiac myocyte growth. However, it is not known
6 whether ATF6 is activated, and if so, what its function is during hypertrophic growth of
7 cardiac myocytes.

8 **Objective:** To examine the activity and function of ATF6 during cardiac hypertrophy.

9 **Methods and Results:** We found that ATF6 was activated and ATF6-target genes were
10 induced in mice subjected to an acute model of trans-aortic constriction (TAC), or to
11 free-wheel exercise, which promote adaptive cardiac myocyte hypertrophy with
12 preserved cardiac function. Cardiac myocyte-specific deletion of *Atf6* (ATF6 cKO)
13 blunted TAC- and exercise-induced cardiac myocyte hypertrophy and impaired cardiac
14 function, demonstrating a role for ATF6 in compensatory myocyte growth. Transcript
15 profiling and chromatin immunoprecipitation identified *RHEB* as an ATF6-target gene in
16 the heart. RHEB is an activator of mTORC1, a major inducer of protein synthesis and
17 subsequent cell growth. Both TAC and exercise upregulated *RHEB*, activated mTORC1,
18 and induced cardiac hypertrophy in WT mouse hearts, but not in ATF6 cKO hearts.
19 Mechanistically, knockdown of ATF6 in neonatal rat ventricular myocytes blocked
20 phenylephrine (PE)-, and insulin-like growth factor 1 (IGF1)-mediated *Rheb* induction,
21 mTORC1 activation, and myocyte growth, all of which were restored by ectopic RHEB
22 expression. Moreover, AAV9-*RHEB* restored cardiac growth to ATF6 cKO mice
23 subjected to TAC. Finally, ATF6 induced *RHEB* in response to growth factors, but not in
24 response to other activators of ATF6 that do not induce growth, indicating that ATF6
25 target gene induction is stress-specific.

26 **Conclusions:** Compensatory cardiac hypertrophy activates ATF6, which induces *Rheb*
27 and activates mTORC1. Thus, ATF6 is a previously unrecognized link between growth
28 stimuli and mTORC1-mediated cardiac growth.

29

30 **Key Words:**

31 Myocytes, cardiac protein folding, proteostasis, cardiac hypertrophy, ATF6, Rheb,
32 mTORC1

33

1 **Non-standard Abbreviations and Acronyms**

2

3	AAV	adeno-associated virus
4	AdV	adenovirus
5	ANOVA	analysis of variance
6	ATF6	activating transcription factor 6 alpha
7	ATF6 cKO	ATF6 alpha conditional knockout
8	Cat	Catalase
9	ER	endoplasmic reticulum
10	Grp78	78 kilodalton glucose-regulated protein, Hpa5
11	HR	heart rate
12	HW	heart weight
13	ICF	immunocytofluorescence
14	LV	left ventricle
15	LVEDV	left ventricular end diastolic volume
16	LVESV	left ventricular end systolic volume
17	LVIDD	left ventricular inner diameter in diastole
18	LVIDS	left ventricular inner diameter in systole
19	PWTD	left ventricular posterior wall thickness in diastole
20	PWTS	left ventricular posterior wall thickness in systole
21	Rheb	Ras homologue enriched in brain
22	SR	sarcoplasmic reticulum
23	TAC	transverse aortic constriction
24	TL	tibia length
25	TM	tunicamycin
26	UPR	unfolded protein response
27		
28		

1 INTRODUCTION:

2
3 Protein homeostasis, or proteostasis involves the coordination of protein synthesis
4 and folding to ensure proteome integrity and vital cell function¹. In cardiac myocytes the
5 endoplasmic reticulum (ER) is a major site of synthesis of proteins that are critical for
6 proper function of the heart, including many calcium-handling proteins, receptors, and
7 secreted proteins, such as hormones, stem cell homing factors, and growth factors^{2,3}.
8 Therefore, ER proteostasis maintains the integrity of the cardiac myocyte proteome and,
9 thus, cardiac contractility. Increased protein synthesis in growing cardiac myocytes must
10 be balanced by increased protein-folding to avoid the accumulation of toxic misfolded
11 proteins; thus growth poses a potential challenge to cardiac myocyte proteostasis⁴.
12 However, the molecular mechanisms underlying the maintenance of ER proteostasis
13 during cardiac myocyte growth are not well understood.

14 ER proteostasis is controlled in all mammalian cells by several ER-transmembrane
15 sensors of protein misfolding, including the adaptive transcription factor, ATF6⁵. When
16 protein synthesis surpasses the capacity of the protein-folding machinery, increases in
17 misfolded proteins cause the translocation of the ER-transmembrane, 670-amino acid,
18 90 kD form of ATF6, to the Golgi, where it is clipped, liberating an N-terminal fragment
19 that serves as a transcription factor. This 50 kD active form of ATF6 regulates a gene
20 program that is responsible for the expression of numerous proteins that enhance ER
21 protein folding, which adaptively restores the balance between protein synthesis and
22 folding^{6,7}. Thus, nodal proteostasis regulators, such as ATF6, that sense and maintain
23 this balance could play important roles in optimizing cardiac myocyte growth; however,
24 neither the activation nor the function of ATF6 in the setting of hypertrophic cardiac
25 growth has been examined. Accordingly, here we studied the effects of *Atf6* deletion in
26 mouse hearts and in cultured cardiac myocytes during physiologically-relevant
27 maneuvers known to promote compensatory cardiac hypertrophy in either a concentric
28 (pressure overload)⁸ or eccentric (exercise)⁹ manner, positing that the absence of ATF6
29 would imbalance proteostasis, which would be maladaptive.

30 Both growth maneuvers activated ATF6, and *Atf6* deletion was maladaptive, as
31 evidenced by impaired cardiac function. However, surprisingly, cardiac myocyte growth
32 was also impaired upon *Atf6* deletion. This was unexpected, since *Atf6* is not known to
33 be required for cardiac myocyte growth. Further mechanistic studies showed that ATF6
34 is activated as a result of the increased demands placed on the ER protein folding
35 machinery during growth-related increases in protein synthesis. Moreover we found that
36 *Atf6* serves a previously unrecognized role as a molecular link between growth stimuli
37 and activation of mammalian/mechanistic target of rapamycin complex 1 (mTORC1), a
38 major promoter of protein synthesis and consequent growth of cardiac myocytes¹⁰⁻¹⁵.
39 Two conditions need to be met for mTORC1 to be activated; 1) in response to a growth
40 stimulus, mTORC1 needs to translocate to organelles, such as lysosomes¹⁶, where it
41 encounters the small GTPase activator of mTORC1, Rheb¹⁷, and 2) Rheb must be
42 active and present in sufficient quantities¹⁸. In terms of Rheb activation, it is known that
43 growth stimuli lead to the phosphorylation and, thus, inhibition of the Rheb GTPase-
44 activating protein (GAP), TSC1/TSC2¹⁹, which increases the GTP-loading state and,
45 thus, the activity of Rheb. However, the molecular mechanisms underlying the *Rheb*
46 gene expression are less well understood. Here, we showed, for the first time, that ATF6
47 is an inducer of *Rheb*, and in this way, ATF6 coordinates protein synthesis and protein
48 folding, ensuring the adaptive maintenance of proteostasis in growing cardiac myocytes.
49 Thus, ATF6 is a newly identified and essential member of mTORC1 growth signaling in
50 cardiac myocytes in the heart.

1 **Methods:**

2 Further details on the Methods can be found in the Online Supplement.

3 *Laboratory Animals:* The research reported in this paper has been reviewed and
4 approved by the SDSU Institutional Animal Care and Use Committee and it conforms to
5 the Guide for the Care and Use of Laboratory Animals published by the National
6 Research Council.

7 *ATF6 Floxed Mice:* *Atf6*^{fl/fl} mice used in this study were generated by Dr. Gokhan S.
8 Hotamisligil²⁰. All of the mice used in this study were 10 week-old males.

9 *Statistics:* Unless otherwise stated, values shown are mean ± SEM and statistical
10 treatments are either a t-test or a one-way ANOVA followed by Newman-Keuls *post hoc*
11 analysis.

12

For Circulation Research Peer Review. Do not
distribute. Destroy after use.

1 RESULTS:

- 2 • ATF6 is required for cardiac myocyte hypertrophy in response to pressure overload

3 To examine the role of *Atf6* in cardiac myocytes on heart growth, we generated an
4 *Atf6* conditional knockout mouse (ATF6 cKO) by injecting *Atf6^{fl/fl}* mice with a recombinant
5 AAV9 that encodes *Cre* under the control of the *cardiac troponin T* promoter (**Fig. 1A**).
6 Compared to *Atf6^{fl/fl}* injected with AAV9-Con, injection with AAV9-CRE effectively
7 reduced *Atf6* mRNA from cardiac myocytes isolated from *Atf6^{fl/fl}* mice, but not non-
8 cardiac myocytes, or liver (**Fig. 1B**). *Atf6^{fl/fl}* mice injected with AAV9-Con (Con) or AAV9-
9 CRE (ATF6 cKO), were subjected to TAC and examined 7d later, when hypertrophic
10 growth is maximal²¹ and structural remodeling is compensatory^{22, 23}. TAC activated ATF6
11 in Con mouse hearts, as evidenced by increased levels of the active, 50 kD form of
12 ATF6 (**Fig. 1C**). This was unexpected, since ATF6 is not known to be activated in
13 cardiac myocytes by any growth stimulus. Coordinate with ATF6 activation, TAC
14 increased expression of numerous canonical ATF6 target genes (**Fig. 1C-D; Online Fig.**
15 **IA**). As expected, ATF6 was undetectable in ATF6 cKO mouse hearts (**Fig. 1C-D**). TAC
16 increased Con mouse heart weights, but, surprisingly, this growth effect was significantly
17 blunted in ATF6 cKO mouse hearts (**Fig. 1E**). TAC increased *Nppa* and *Nppb*
18 expression to similar extents in both Con and ATF6 cKO mice, while the induction of
19 *Myh7* and *Col1a1* was slightly greater in the ATF6 cKO mice (**Fig. 1F**). This, coupled
20 with the decrease in *Atp2a2* i.e. *SERCA2a* in ATF6 cKO mice, suggests a blunted
21 compensatory response in the absence of ATF6. In Con mouse hearts, cardiac function,
22 including fractional shortening was preserved, while chamber dimensions were
23 unchanged after TAC (**Fig. 1G; Online Table I**) and cardiac myocyte size was increased
24 (**Fig. 1H**), consistent with the compensatory nature of cardiac hypertrophy in mice at this
25 time after pressure overload²⁴. However, in contrast to Con, in ATF6 cKO mice
26 subjected to TAC myocyte size was decreased compared to Con (**Fig. 1H**) and fractional
27 shortening was impaired (**Fig. 1G**) with increased chamber dimensions, such as LVEDV
28 and LVESV, despite high frequency Doppler measurements between right and left
29 carotid arteries demonstrating consistent and identical pressure overload in TAC-
30 operated Con and ATF6 cKO mice (**Online Table I**). Along with increased plasma levels
31 of cTnl (**Online Fig. IB**), these results are consistent with the initial stages of chamber
32 dilation, as well as myocardial damage and decompensation in the ATF6 cKO mice.
33 Thus, ATF6 is activated by pressure overload and is required for hypertrophy.

- 35 • ATF6 is required for cardiac myocyte hypertrophy in response to exercise

36 To assess the breadth of the impact of ATF6 on heart growth, we examined the
37 effects of cardiac myocyte-specific ATF6 deletion in mice subjected to free-wheel
38 exercise^{25, 26} (**Fig. 2A**). Similar to TAC, exercise surprisingly activated ATF6 and
39 induced ATF6 target genes in Con, but not in ATF6 cKO mice (**Fig. 2B-C**). As expected,
40 compared to Con sedentary mice, Con mice subjected to exercise exhibited increased
41 heart weights and LV wall thickness, as well as myocyte size (**Fig. 2D, 2F; Online Table**
42 **II**). While *Nppa* and *Nppb* were mildly increased, *Atp2a2* was robustly increased by
43 exercise in Con mouse hearts, and there was no change in *Myh7* or *Col1a1* (**Fig. 2E**);
44 this gene profile is typical of adaptive cardiac hypertrophy in exercising mice^{24, 27}. In
45 contrast to Con, in ATF6 cKO mice subjected to exercise there was no change in heart
46 weights or LV wall thickness (**Fig. 2D; Online Table II**), reduced increases in myocyte
47 size (**Fig. 2F**), and reduced induction of ATF6 target genes (**Fig. 2C**). Compared to
48 exercised Con mice, exercised ATF6 cKO mice showed no increase in *Nppa*, and

1 neither Con nor ATF6 cKO mice showed significant changes in *Nppb* or *Myh7*.
2 Importantly, while Con mice exhibited decreased *Col1a1* and increased *Atp2a2* after
3 exercise, which are beneficial genetic changes typical of this regime, the ATF6 cKO
4 mice failed to adapt and had increased *Col1a1* and no change in *Atp2a2* (**Fig. 2E**).
5 Thus, ATF6 is activated by exercise and is required for compensatory hypertrophy in this
6 exercise model.
7

8 • Rheb is an ATF6-inducible gene in the heart

9 Since there are no known *Atf6*-inducible genes that are required for cardiac myocyte
10 growth, we turned to transcript profiling for clues to the identities of such genes. RNA
11 sequencing of the hearts of our previously published transgenic mice that express
12 activated ATF6²⁸ (**Online Table III**) revealed that ATF6 induced 51 genes in the gene
13 ontology category, small GTPase mediated signal transduction; this category includes
14 the ras-related small GTPase, Ras homologue enriched in brain (*RHEB*) (**Fig. 3A**;
15 **Online Fig. IIA**). Rheb is required for activation of mTORC1, however, only in the
16 presence of a growth stimulus. Accordingly, we focused on *Rheb* as a candidate gene
17 through which ATF6 might contribute to cardiac hypertrophy, pursuing the hypothesis
18 that increased *Rheb* gene expression and subsequent mTORC1 activation under growth
19 conditions are *Atf6*-dependent. The upregulation of *RHEB* by ATF6 in mouse hearts
20 observed by RNA sequencing was confirmed by qRT-PCR (**Online Fig. IIB**). Consistent
21 with ATF6 as a possible transcriptional inducer of *Rheb* was our finding that the *Rheb*
22 promoter has two potential ATF6 binding sites, which we call ER stress response
23 elements (ERSEs)-1 and -2 (**Fig. 3B**). Chromatin immunoprecipitation (ChIP) showed
24 that ATF6 binds to both sites in the *RHEB* gene in neonatal rat ventricular myocytes
25 (NRVM) (**Fig. 3C**). The progressive decline in *RHEB* promoter activity in plasmids that
26 encode 5'-truncation deletions of the rat *RHEB* promoter driving luciferase demonstrated
27 the importance of these putative ERSEs in ATF6-mediated *RHEB* promoter activation
28 (**Online Fig. IIC**). To mechanistically investigate the functional involvement of these
29 ERSEs further, we mutated either or both ERSE (**Fig. 3D**). Mutating either ERSE
30 decreased ATF6 *RHEB* promoter activation by ATF6, however, the promoter-proximal
31 site, i.e. ERSE-1 appeared to have the largest effect (**Fig. 3E**). To determine whether
32 ATF6 is sufficient to induce *Rheb* in the heart, *in vivo*, mice were injected with a
33 recombinant AAV9 that encodes activated ATF6, i.e. ATF6(1-373). qRT-PCR and
34 immunoblotting demonstrated that activated ATF6 increased *RHEB* mRNA and protein
35 in the heart (**Online Fig. IID-F**). These results are the first demonstration in any cell type
36 that ATF6 induces *RHEB*, implicating ATF6 as a critical link between growth stimuli and
37 mTORC1 activation.
38

39 • RHEB induction during pressure-overload and exercise requires ATF6

40 We found that *RHEB* was strongly induced in Con mice after either TAC or exercise,
41 but not in ATF6 cKO mouse hearts (**Fig. 3F-K**). Thus, ATF6 is necessary for the
42 upregulation of RHEB in these models of cardiac hypertrophy, *in vivo*. Since RHEB is
43 required for mTORC1 activation in response to a growth stimulus, we assessed
44 mTORC1 pathway activation. As expected, pressure-overload and exercise both
45 activated mTORC1, as shown by increased phosphorylation of mTORC1 (Ser2448), p70
46 ribosomal S6 kinase (S6K; Thr389), and eukaryotic translation initiation factor 4E-
47 binding protein 1 (4E-BP1; Thr37/46); however, mTORC1 activation was blunted in
48 ATF6 cKO mouse hearts (**Fig. 3G, J**), consistent with the key role for ATF6 in mTORC1
49 activation by growth stimuli. To examine whether ATF6 might affect other signaling

1 pathways leading to mTORC1 activation, we assessed the phosphorylation of Akt on
2 Ser308 and the phosphorylation of TSC2, both of which lie upstream of Rheb in the
3 mTORC1 signaling pathway. We found that pressure overload increased
4 phosphorylation of Akt (Thr308) and TSC2 (Thr1462), as expected; however, in contrast
5 to Rheb expression, neither of these phosphorylation events were affected by *ATF6*
6 deletion (**Online Fig. IIIA**). Thus, the deficit in mTORC1 activation in *ATF6* cKO mice
7 must reside downstream of Akt and TSC2, i.e. Rheb. We also examined whether *ATF6*
8 deletion affected other well known canonical hypertrophy signaling pathways, but found
9 that neither phosphorylation of Akt on Ser473, Erk phosphorylation (**Online Fig. IIIA**) or
10 calcineurin activation (**Online Fig. IIIB**) were affected by *ATF6* deletion. These results
11 pinpoint the growth deficit in the *ATF6* cKO mouse hearts to the inability to upregulate
12 Rheb.
13

14 • RHEB is required for PE- and IGF1-induced cardiac myocyte growth

15 To explore the mechanistic relationship between *ATF6* and *RHEB* we used *RHEB*
16 and *ATF6* loss-of-function approaches in NRVM treated with the α_1 -adrenergic
17 receptor agonist, phenylephrine (PE) or insulin-like growth factor 1 (IGF1), which
18 recapitulate much of the intracellular signaling during pressure-overload or exercise-
19 induced hypertrophy, respectively²⁹. Knocking down either *ATF6* or *RHEB* abrogated the
20 effects of PE or IGF1 on cardiac myocyte hypertrophy, fetal gene induction, *ATF6* target
21 gene induction and mTORC1 signaling (**Fig. 4A-E; Online Fig. IVA, IVC; Fig. 5A-E;**
22 **Online Fig. IVB**), but had no effect on mTORC2 signaling, as assessed by
23 phosphorylation of Akt on Ser-473 (**Online Fig. IVD-E**). To further substantiate the
24 results with *Rheb* siRNA, we used a different Rheb loss-of-function approach involving
25 the Rheb inhibitor, Lonafarnib³⁰. Lonafarnib mimicked the effects of *Rheb* siRNA on PE-
26 and IGF1-mediated *ATF6* activation, mTORC1 signaling, *ATF6* gene induction and
27 growth in NRVM (**Online Fig. V**).

28 To complement *ATF6* loss-of-function approach, we used a gain-of-function
29 approach, examining the effects of ectopic expression of *ATF6* and *RHEB*. In the
30 absence of a growth stimulus, ectopic expression of *ATF6* did not increase myocyte
31 growth, as expected, due to the absence of mTORC1 activation under these conditions
32 (**Online Fig. VIA Con**). Either PE or IGF1 increased myocyte growth, which was
33 completely blocked by the mTORC1 inhibitor, rapamycin, as expected (**Online Fig. VIA,**
34 **PE and IGF1, red vs blue**). Ectopic *ATF6* augmented the growth-promoting effects of
35 PE and IGF1, which were also completely blocked by rapamycin (**Online Fig. VIA, PE**
36 **and IGF1, black and green**). Moreover, ectopic *ATF6* slightly augmented PE- and
37 IGF1-stimulated NRVM growth, however, it was not able to restore growth in cells
38 treated with either *RHEB* siRNA or Lonafarnib (**Online Fig. VIB-C**). As expected, ectopic
39 expression of *RHEB* had no effect in the absence of a growth stimulus; however, upon a
40 growth stimulus, the loss of growth and mTORC1 activation seen with *ATF6* siRNA were
41 completely restored by ectopically expressed *RHEB* (**Fig. 4F-H; Fig. 5F-H**).

42 • Mechanistic Relationship between Growth Signaling and the UPR

43 The unfolded protein response (UPR), which in addition to *ATF6*, is mediated by
44 PERK and IRE1⁵, is activated by the misfolding of proteins induced by a variety of
45 chemical and pathophysiological treatments, most of these do not promote growth. In
46 fact, the UPR is not widely considered to be growth-promoting. Accordingly, since we
47 found here that *ATF6* can be activated during growth, we assessed how growth affected
48 the other arms of the UPR. We found that PE and IGF1 activated all three arms of the

1 UPR in a rapamycin-sensitive manner (**Online Fig. VIIA**), indicating that mTORC1
2 activation is required for UPR activation during growth. We then individually knocked
3 down *ATF6*, *PERK* and *IRE1*, and found that only ATF6 knockdown blunted growth
4 (**Online Fig. VIIB-C**). To ensure that the effects of ATF6 on growth are dependent on
5 the transcriptional effects of ATF6, we showed that NRVM infected with AdV-ATF6(1-
6 373) [active] exhibited increased growth in response to PE, especially when endogenous
7 ATF6 was knocked down, however AdV-ATF6(94-373) [transcriptionally inactive] did not
8 (**Online Fig. VIID**).

9 Next, we examined the effect on mTORC1 signaling of other UPR stimulators that do
10 not affect growth, such as tunicamycin (TM), which increases ER protein misfolding by
11 inhibiting protein glycosylation in the ER. In contrast to PE, activation of ATF6 by TM
12 was not dependent on *RHEB* (**Fig. 6A-B**). Additionally, while *RHEB* knockdown blocked
13 PE- and IGF1-mediated induction of ATF6 target genes, (**Fig. 4E, 5E**), it had no effect
14 on TM-mediated induction of ATF6 target genes (**Fig. 6C**). Thus, there are
15 RHEB/growth-dependent and RHEB/growth-independent pathways that lead to ATF6
16 activation and induction of ATF6 target genes.

17 • Stimulus-dependent Differential Induction of ATF6 Target Genes

18 We dived deeper into the mechanism of RHEB/growth-dependent and RHEB/growth-
19 independent pathways of ATF6 activation. We previously showed that ATF6 induces
20 some proteins targeted to the ER, where they enhance protein folding (e.g.
21 *HSPA5/GRP78*), and others located outside the ER, where they serve other functions.
22 One example of the latter is our finding that I/R activates ATF6-dependent induction of
23 *catalase* (*CAT*), which resides in peroxisomes and neutralizes damaging ROS. Here, we
24 provide an additional example of an ATF6-inducible gene, *RHEB*, that encodes a protein
25 that resides outside the ER. Because of the differences in the locations and functions of
26 *Hspa5*, *Cat*, and *Rheb*, we posited that they might be differentially induced by treatments
27 that cause ER protein misfolding (TM), or oxidative stress (I/R) but do not induce growth,
28 or to a treatment that induces growth (PE). While, for the most part, the mRNA levels for
29 all three genes were increased by all the treatments, the quantitative nature of induction
30 differed depending on the treatments, such that TM, sI/R, and PE had the greatest
31 effects on induction of *Hspa5*, *Cat*, and *Rheb*, respectively (**Fig. 6D**). Notably, *CAT*
32 induction was highly selective, showing an approximate 6-fold induction by sI/R, and
33 much less induction by either TM or PE (**Fig. 6D, Cat**). Remarkably, *RHEB* induction
34 was also highly selective, showing the least induction by TM or sI/R, while being induced
35 by over 5-fold by PE (**Fig. 6D, Rheb**). Importantly, all of these effects depended on
36 ATF6 (**Fig. 6E**).

37
38 To dissect this stimulus-dependent differential gene induction further, we showed
39 that promoter/luciferase reporter constructs for *Hspa5*, *Cat*, and *Rheb* (**Fig. 6F**) were
40 also differentially induced by TM, sI/R and PE, mimicking mRNA induction (**Fig. 6G**).
41 Importantly, as with the mRNA, all of these effects depended upon ATF6 (**Fig. 6H**).

42
43 These stimulus-specific effects of ATF6 on *Hspa5*, *Cat*, and *Rheb* could be due to
44 the stimulus-dependent binding of ATF6 to the ERSEs in these genes. To test this, we
45 developed a new method for measuring ATF6 binding to the *HSPA5*, *CAT*, and *RHEB*
46 promoters in cells treated with TM, sI/R or PE. To this end we generated a recombinant
47 AdV FLAG full-length p90 ATF6, i.e. ATF6(1-670), which remains in the ER in the
48 absence of ER stress, and, therefore, can not bind to ERSEs. NRVM expressing FLAG-
49 ATF6(1-670) were treated with TM, sI/R or PE, each of which induce the formation of the

1 FLAG-tagged N-terminal, active p50 form of ATF6, so it can bind to ERSEs. ChIP
2 demonstrated that the binding of ATF6 to these genes differed, depending on the
3 stimulus, mimicking the mRNA induction and promoter activation (**Fig. 6I**). These effects
4 were not seen with AdV encoding only FLAG, verifying ATF6-specificity (**Fig. 6J**). This
5 shows, for the first time in any cell type, that ATF6 can be activated by a broad spectrum
6 of conditions that affect proteostasis in a variety of ways, yet the relative induction of
7 ATF6 targets differs in a condition-dependent manner.

9 • Ectopic Expression of RHEB Restores Cardiac Growth to ATF6 cKO Mouse Hearts

10 Next, we assessed the effects of ectopic expression of *RHEB* in the heart, *in vivo*
11 using a new recombinant AAV9-RHEB (**Fig. 7A**). In ATF6 cKO mice, AAV9-RHEB
12 effectively restored the loss of mTORC1 signaling, hypertrophic growth and cardiac
13 function, as well as the hypertrophic and ATF6 gene programs in response to TAC (**Fig.**
14 **7B-F; Online Table IV**). Thus, it is by increasing RHEB that ATF6 influences mTORC1
15 signaling and subsequent cardiac myocyte growth, fetal gene expression and ATF6-
16 target gene expression.

18 • ATF6 Activation in Response to Growth Requires mTORC1 Activation, Protein
19 Synthesis and Protein Misfolding

20 To this point, mTORC1 and ATF6 activation were shown to be dependent on each
21 other under the growth conditions examined. To account for this interdependence, we
22 posited a temporal sequence of events, wherein the initial event is mTORC1 activation,
23 which depends on basal levels of Rheb (**Fig. 8A, Step 1**). This initial mTORC1 activation
24 precedes, but drives initial increases in protein synthesis that place demands on the
25 protein-folding machinery (**Fig. 8A, Step 2**), which activates ATF6. Then, ATF6 serves
26 canonical- and non-canonical roles (**Fig. 8A, Steps 3, 4**), the latter of which includes
27 *RHEB* induction (**Fig. 8A, Step 5**), which is necessary to sustain mTORC1 activation
28 (**Fig. 8A, Step 6**) and the continued increases in protein synthesis that required for
29 growth and cardiac myocyte hypertrophy (**Fig. 8A, Step 7**). To examine this hypothesis,
30 a TAC time course was carried out. At 3h of TAC, a time when mTORC1 is activated,
31 but protein synthesis has not yet increased, mTORC1 signaling was activated, but ATF6
32 was not activated and *RHEB* was not induced (**Fig. 8B, 3h**). However, at both 2 and 7d
33 of TAC, when protein synthesis is increased, mTORC1 signaling and ATF6 were
34 activated, and *RHEB* was induced (**Fig. 8B, 2d and 7d**). As expected, heart weights
35 increased as a function of TAC time from 3h to 7d (**Fig. 8C; Online Table V**). Thus,
36 mTORC1 activation occurred soon after TAC and preceded ATF6 activation. Further
37 supporting our hypothesis that initially, mTORC1 activation precedes ATF6 activation
38 were results of a 3h TAC experiment in ATF6 cKO mice, where, in contrast to longer
39 times of TAC (*i.e.* 7d - **Fig. 3G**), the deletion of ATF6 did not affect mTORC1 activation
40 (**Fig. 8D**). As expected, heart weights did not change under these conditions (**Fig. 8E;**
41 **Online Table VI**).

43 Consistent with these results, when examining the effect of PE and IGF1 at the
44 earliest time points, just prior to when protein synthesis is greatest in NRVM, knocking
45 down *ATF6* did not affect mTORC1 activation (**Online Fig. VIIIA**), but again, ATF6
46 activation was rapamycin-dependent (**Online Fig. VIIIB**). Moreover, inhibiting protein
47 synthesis with cycloheximide had no effect on mTORC1 activation at these short times
48 of PE or IGF1 treatment, but impaired ATF6 activation and *RHEB* induction, indicating
49 that protein synthesis is required for ATF6 activation and subsequent *RHEB* induction

1 **(Online Fig. VIIC)**. Finally, in NRVM treated with the chemical chaperone, 4PBA, PE
2 and IGF1 activated mTORC1 however, ATF6 was not activated and *RHEB* was not
3 induced **(Online Fig. VIID)**, indicating the increase in protein folding demand driven by
4 increases in protein synthesis are responsible for activating ATF6.
5
6

For Circulation Research Peer Review. Do not
distribute. Destroy after use.

1 DISCUSSION:

2 • ATF6 is Required for Growth of the Heart

3 While previous studies reported increased expression of a few ER stress genes in
4 mouse models of pressure overload, implicating ER protein misfolding³¹⁻³⁴, prior to our
5 study here, neither the activation nor the roles for ATF6 in cardiac myocytes during
6 cardiac growth had been examined. Here, we showed, for the first time that ATF6, a
7 major mediator of the UPR, is activated by diverse growth stimuli and that ATF6 is
8 required for growth of the heart in response to these stimuli. We determined that the
9 mechanism of this effect involves ATF6-mediated induction of *RHEB* (Fig. 8A). It was
10 surprising to find that ATF6 is required for heart growth, considering the UPR is not
11 widely known to be involved in growth processes. However, this non-canonical role for
12 ATF6 complements its canonical role as a sensor of misfolded proteins in the ER and,
13 as such, a sensor of increases in protein folding demand, which occur during growth.
14 Thus, ATF6 maintains proteostasis and proteome integrity when the heart is stimulated
15 to grow in a compensatory manner.

16
17 We also found that, depending on the stimulus, ATF6 target genes are differentially
18 expressed due to the unique effects that the stresses have on ATF6 binding to, and
19 thus, transcriptional activation of ATF6 target genes. Such differential ATF6 target gene
20 induction by treatments that all activate ATF6 suggests that there are yet-to-be-
21 described regulatory layers that fine-tune the ATF6 gene program to best adapt to the
22 conditions. Some possible mechanisms that could contribute to this differential
23 expression are beginning to emerge, as it has been shown that ATF6 can interact with
24 other transcription factors, such as Nrf1, PGC1 α and β , and ERR γ ,³⁵⁻³⁷ which changes
25 the transcriptional programming in ways that fine-tune ATF6 target gene induction.

26

27 • Rheb in the Heart

28 Rheb was originally documented as an mTORC1 activator in the brain³⁸, this role has
29 been demonstrated in numerous other tissues and organs^{17, 39, 40}. Global deletion of
30 *Rheb* is embryonic lethal, in part due to cardiac defects⁴¹, demonstrating the importance
31 of Rheb-mediated mTORC1 activation in heart growth and development. The growth-
32 promoting effect of *Rheb* gain-of-function was demonstrated in adult rat ventricular
33 myocytes transfected with adenovirus encoding *Rheb*⁴². However, overexpression of
34 *Rheb* in transgenic mice increased infarct size, in part because Rheb inappropriately
35 decreased autophagy, which is adaptive in this disease setting⁴³. Pharmacological
36 inhibition of Rheb in mice subjected to TAC for three weeks was cardioprotective¹⁴.
37 These findings differ from our study, perhaps because different times after TAC were
38 studied, or different approaches to decreasing Rheb. It is also possible that Rheb
39 induction and mTORC1 activation have different roles in a severe afterload-induced
40 hypertrophy model, such that acute activation works in a compensatory manner, but
41 chronic activation drives decompensation. The α MHC-CRE-dependent conditional
42 deletion of *Rheb* from mouse cardiac myocytes resulted in atrophic hearts, heart failure,
43 and death within 1-2 weeks after birth, a timeframe that aligns with the time of α MHC
44 expression after birth^{12, 44}. Although there have been no studies prior to ours
45 mechanistically connecting *Atf6* with *Rheb* induction, one study in tumor cells⁴⁵, and
46 another in the setting of Huntington's disease⁴⁶, have implicated such a connection and,
47 therefore, support the findings reported here.

1 • Feedback Regulation of ATF6-mediated Growth

2 Our study describes a mechanism whereby ATF6 matches protein synthesis with
3 folding in times of increased growth; since this constitutes a positive feedback
4 mechanism, we reason that there must also be mechanisms that interrupt this feedback,
5 thereby limiting the rate of growth driven by the ATF6-Rheb-mTORC1 axis. One such
6 mechanism might involve Rheb itself, which has been shown to activate PERK⁴⁷.
7 Mechanisms such as this underscore the complexities of proteostasis, raising questions
8 about how Rheb switches from protein synthesis activator to inhibitor.

9 • Conclusions

10 The results of our study firmly place ATF6 in a critical position as a determinant of
11 cardiac growth (**Fig. 8A**). Moreover, since ATF6 is ubiquitously expressed, our findings
12 underscore the widespread importance of the ATF6-Rheb-mTORC1-growth signaling
13 axis described here in non-cardiac cells and tissues in addition to the heart.

For Circulation Research Peer Review
not
distribute. Destroy after use.

1 **ACKNOWLEDGMENTS**

2 We thank Dr. Gokhan S. Hotamisligil (Harvard T.H. Chan School of Public Health,
3 Boston, MA) for the ATF6 $\alpha^{fl/fl}$ mice.

4 **SOURCES OF FUNDING**

5 EAB American Heart Association (17PRE33670796), the Rees-Stealy Research
6 Foundation and SDSU Heart Institute, the Inamori Foundation, and the ARCS
7 Foundation, Inc., San Diego Chapter.

8 CH Boehringer Ingelheim Fonds Travel Grant, the DZHK Mobilitätsprogramm and the
9 Deutsche Herzstiftung

10 OJM the DZHK and by the BMBF (German Ministry of Education and Research)

11 SD was supported by an Excellence Grant from the German Centre for Cardiovascular
12 Research (DZHK) and Department of Cardiology, Angiology, and Pneumology,
13 University Hospital Heidelberg.

14 CCG by (NIH) grants R01 HL75573, R01 HL104535, and P01 HL085577.

15

16 **DISCLOSURES**

17 NONE

18

19

20

For Circulation Research Peer Review. Do not
distribute. Destroy after use.

1 **Figure Legends:**

2
3 **Figure 1. Effect of cardiac myocyte-specific ATF6 gene deletion in hearts of**
4 **mice subjected to TAC.**

5
6 **A**, Protocol for AAV9 administration to ATF6^{fl/fl} mice and TAC. **B**, ATF6 mRNA
7 levels determined by qRT-PCR on isolated cardiac myocytes (CM), non-cardiac
8 myocytes (NCM), and liver extracts from ATF6^{fl/fl} mice injected with AAV9-Con
9 (Con) or AAV9-CRE (i.e. ATF6 cKO). **C**, Immunoblot of LV extracts from Con or
10 ATF6 cKO mice. **D**, mRNA for ATF6 target genes determined by qRT-PCR. **E**,
11 Heart weight/tibia lengths (HW/TL). **F**, mRNA levels for fetal genes determined
12 by qRT-PCR. *Nppa*, natriuretic peptide A; *Nppb*, natriuretic peptide B; *Myh7*, β -
13 myosin heavy chain; *Col1a1*, Collagen 1A1; *Atp2a2*, Serca2a. **G**, Fractional
14 shortening (%), determined by echocardiography, see Online Table I. **H**,
15 Confocal immunocytofluorescence microscopy (ICF) analysis of mouse heart
16 sections for laminin (green). Data are mean \pm SEM. * $P \leq 0.05$, ** $P \leq 0.01$, # $P \leq 0.001$
17 different from Con Sham, or from the value shown by the bar.

18
19 **Figure 2. Effect of cardiac myocyte-specific ATF6 gene deletion in hearts of**
20 **mice subjected to free wheel exercise.**

21
22 **A**, Protocol for AAV9 administration to ATF6^{fl/fl} mice and free wheel exercise. **B**,
23 Immunoblot of LV extracts from Con or ATF6 cKO mice. **C**, mRNA levels for
24 ATF6 target genes determined by qRT-PCR. **D**, Heart weights/tibia lengths
25 (HW/TL). **E**, mRNA levels for fetal genes determined by qRT-PCR. **F**, ICF
26 analysis of mouse heart sections for laminin (green). Data are mean \pm SEM.
27 * $P \leq 0.05$, ** $P \leq 0.01$, # $P \leq 0.001$. Echocardiography details are in Online Table II.

28
29 **Figure 3. Regulation of Rheb Expression by ATF6.**

30
31 **A**, Heat map of transcript profiling showing z-score-transformed RPKM values
32 (Reads Per Kilobase per Million mapped reads) with hierarchical clustering of
33 transcripts of control and ATF6 transgenic mouse hearts. Differentially expressed
34 genes with p values and FDR ≤ 0.05 and a subset of genes annotated with term
35 GO:0007264 are shown. All the genes increased or decreased by ATF6 are in
36 Online Table III. **B**, Locations of consensus ATF6-binding motifs, i.e. ER stress
37 response elements 1 and 2 (ERSE-1 and 2) and their sequences in the *RHEB*
38 gene 5'-flanking region. Nucleotide differences from canonical ERSE elements
39 are bold. **C**, Neonatal rat ventricular myocytes (NRVM) were infected with AdV
40 encoding control or FLAG-ATF6(1-373) [active form], and then ATF6 binding to
41 endogenous ERSE-1 or ERSE-2, as well as to the endogenous *PDIA6* ERSE,
42 used here as a positive control, and the negative control targets heme
43 oxygenase 1 (*ho-1*) and *gapdh* were examined by chromatin immunoprecipitation
44 (ChIP). **D**, Locations of ERSE-1 and 2 in the *RHEB* 5'-flanking region, their
45 sequences (lower case), and the mutations that were made (bold and upper
46 case). **E**, NRVM were transfected with rat-*rheb*(-1067/+123)-Luc WT, M2, M1 or

1 M1/M2 then infected with AdV FLAG-ATF6(1-373),. Then, 48h later, luciferase
2 activity was measured in extracts. **F-H**, mRNA for *RHEB* determined by qRT-
3 PCR (**F**) and Rheb protein and mTOR pathway components measured by
4 immunoblots (**G**) and quantified by densitometry (**H**) from Con or ATF6 cKO
5 mouse heart extracts after 7 days of Sham or TAC. **I-K**, mRNA for *RHEB*
6 determined by qRT-PCR (**I**) and Rheb protein and mTOR pathway components
7 immunoblots (**J**) and quantified by densitometry (**K**) from Con or ATF6 cKO
8 mouse heart extracts after 4 weeks of sedentary or free wheel exercise (Run).
9 Data are mean \pm SEM. * $P \leq 0.05$, ** $P \leq 0.01$, # $P \leq 0.001$.

10
11 **Figure 4. Effects of ATF6- and RHEB knockdown and ectopic Rheb**
12 **expression on phenylephrine-induced hypertrophy in cultured cardiac**
13 **myocytes.**

14
15 **A-E**, NRVM were transfected with a nontargeted siRNA (siCon) or with siRNAs
16 targeted to either rat *ATF6* (siAtf6) or *RHEB* (siRheb), and then treated \pm
17 phenylephrine (PE; 50 μ M) for 48 hours. **A**, Cell surface area was determined by
18 photomicroscopy and morphometry. **B**, ICF of NRVM for α -actinin (blue) and
19 TOPRO-3 (red). Bar = 50 μ m. **C**, qRT-PCR examination of *Nppa* and *Nppb*.
20 Values are expressed as fold-of-control cardiac myocytes in the absence of PE.
21 **D**, Immunoblot of NRVM. **E**, mRNA for ATF6 target genes determined by qRT-
22 PCR. Values are expressed as fold-of-control myocytes in the absence of PE. **F-**
23 **H**, NRVM were transfected with a control plasmid or a plasmid encoding Flag-
24 Rheb and either siCon or siAtf6, followed by treatment \pm PE for 48 hours. Cell
25 surface area (**F**) was determined by morphometry after ICF (**G**). NRVM were
26 stained for FLAG (green; isolated channel displayed in inset), α -actinin (blue),
27 and TOPRO-3 (red). Bar = 50 μ m. Only FLAG-positive cells were used for cell
28 surface area analysis. **H**, Immunoblot of NRVM. Data are mean \pm SEM. * $P \leq 0.05$,
29 ** $P \leq 0.01$, # $P \leq 0.001$.

30
31 **Figure 5. Effects of ATF6- and RHEB knockdown and ectopic Rheb**
32 **expression on insulin like growth factor 1-induced hypertrophy in cultured**
33 **cardiac myocytes.**

34
35 **A-E**, NRVM were transfected with siCon, siAtf6 or siRheb, then treated \pm IGF1
36 (100ng/ml) for 48 hours. **A**, Cell surface area was determined by was determined
37 by morphometry after ICF. **B**, ICF of NRVM for α -actinin (blue) and TOPRO-3
38 (red). Bar = 50 μ m. **C**, qRT-PCR for *Nppa* and *Nppb*. Values are fold-of-control
39 myocytes in the absence of IGF1. **D**, Immunoblot of NRVM. **E**, mRNA levels of
40 ATF6 target genes determined by qRT-PCR. Values are fold-of-control myocytes
41 in the absence of IGF1. **F-H**, NRVM were transfected with a control plasmid or a
42 plasmid encoding Flag-Rheb and then either siCon or siAtf6, followed by
43 treatment \pm IGF1 for 48 hours. Cell surface area (**F**) was determined by
44 morphometry after ICF (**G**). NRVM were stained for FLAG (green; isolated
45 channel displayed in inset), α -actinin (blue) and TOPRO-3 (red). Bar = 50 μ m.

1 Only FLAG-positive cells were used for cell surface area analysis. **H**, Immunoblot
2 of NRVM. Data are mean \pm SEM. * $P \leq 0.05$, ** $P \leq 0.01$, # $P \leq 0.001$.

3
4 **Figure 6. Examination of Rheb Requirement for Growth-dependent but not**
5 **Growth-independent Activation of the ATF6.**

6
7 **A-B**, NRVM were transfected with siCon, siAtf6 or siRheb then treated \pm
8 tunicamycin (TM; 10 μ g/mL) (**A**) or PE (50 μ M) (**B**) for 24 hours, then analyzed for
9 ATF6 activation by immunoblotting. **C**, mRNA levels for ATF6 target genes
10 determined by qRT-PCR. Values are fold-of-control, i.e. not treated with TM. **D**,
11 **E**, NRVM were transfected with siCon (**D**) or siAtf6 (**E**), then treated \pm TM
12 (10 μ g/mL), or PE (50 μ M) for 24 hours, or subjected to simulated
13 ischemia/reperfusion (si/R; 8 hours of si, followed by 24 hours of reperfusion)
14 and mRNA for ATF6 target genes determined by qRT-PCR. **F**, Diagram of
15 constructs that encode luciferase driven by the *grp78*, *catalase*, and *rheb* 5'-
16 flanking region. **G, H**, NRVM were transfected with human-*grp78*(-284/+221)-Luc
17 WT, rat-*catalase*(-1161/+131)-Luc WT, or rat-*rheb*(-1067/+123)-Luc WT and then
18 transfected with siCon (**G**) or siAtf6 (**H**), then treated \pm TM (10 μ g/mL), or PE
19 (50 μ M) for 24 hours, or subjected to si/R and luciferase activity measured in
20 extracts. **I, J**, NRVM infected with AdV FLAG-ATF6(1-670) (**I**) or control (**J**), and
21 then ATF6 binding to the endogenous *grp78*, *catalase*, or *rheb* genes, as well as
22 to the negative control gene, *gapdh*, examined by ChIP under the same
23 experimental conditions described above. Data are mean \pm SEM. * $P \leq 0.05$,
24 ** $P \leq 0.01$, # $P \leq 0.001$.

25
26 **Figure 7. Effect of cardiac myocyte-specific ectopic Rheb expression in**
27 **ATF6 gene deleted mouse hearts subjected to TAC.**

28
29 **A**, Experimental protocol for AAV9 administration to ATF6^{fl/fl} mice and TAC. **B**,
30 Heart weights/tibia lengths (HW/TL). **C**, Fractional shortening (%), as determined
31 by echocardiography, see Online Table IV. **D**, mRNA for fetal genes determined
32 by qRT-PCR. **E**, mRNA for ATF6 target genes determined by qRT-PCR. **F**,
33 Immunoblots of LV extracts. Data are mean \pm SEM. * $P \leq 0.05$, ** $P \leq 0.01$,
34 # $P \leq 0.001$.

35
36
37 **Figure 8. Mechanism whereby ATF6 acts as a nodal regulator of both**
38 **protein synthesis and protein folding during cardiac hypertrophy.**

39
40 **A**, Shown are the temporal sequence of steps involved in mediating the initial
41 (Steps 1-4) and sustained (Steps 5-7) aspects of growth and the interdependent
42 roles of mTORC1 and ATF6. **B, C**, Immunoblot of LV extracts (**B**) and heart
43 weights/tibia lengths (HW/TL) (**C**) from WT mice subjected to TAC for 3 hours, 2
44 days, or 7 days. Echocardiography details in Online Table V. **D, E**, Immunoblot of
45 LV extracts (**D**) and heart weights/tibia lengths (HW/TL) (**E**) from Con or ATF6

1 cKO mice subjected to 3 hours of TAC. Echocardiography details in Online Table
2 VI. Data are mean \pm SEM. * $P \leq 0.05$, # $P \leq 0.001$.
3
4

For Circulation Research Peer Review. Do not
distribute. Destroy after use.

1 **References:**

- 2
- 3 1. Balch WE, Morimoto RI, Dillin A and Kelly JW. Adapting proteostasis for disease
4 intervention. *Science*. 2008;319:916-9.
- 5 2. Glembotski CC. Roles for the sarco-/endoplasmic reticulum in cardiac myocyte
6 contraction, protein synthesis, and protein quality control. *Physiology (Bethesda)*.
7 2012;27:343-50.
- 8 3. Gidalevitz T, Stevens F and Argon Y. Orchestration of secretory protein folding
9 by ER chaperones. *Biochim Biophys Acta*. 2013;1833:2410-24.
- 10 4. Glembotski CC. Roles for ATF6 and the sarco/endoplasmic reticulum protein
11 quality control system in the heart. *Journal of Molecular and Cellular Cardiology*.
12 2014;71:11-15.
- 13 5. Arrieta A, Blackwood EA and Glembotski CC. ER Protein Quality Control and the
14 Unfolded Protein Response in the Heart. *Curr Top Microbiol Immunol*. 2017.
- 15 6. Zhu C, Johansen FE and Prywes R. Interaction of ATF6 and serum response
16 factor. *Mol Cell Biol*. 1997;17:4957-66.
- 17 7. Haze K, Yoshida H, Yanagi H, Yura T and Mori K. Mammalian transcription
18 factor ATF6 is synthesized as a transmembrane protein and activated by proteolysis in
19 response to endoplasmic reticulum stress. *Mol Biol Cell*. 1999;10:3787-99.
- 20 8. Luckey SW, Walker LA, Smyth T, Mansoori J, Messmer-Kratzsch A, Rosenzweig
21 A, Olson EN and Leinwand LA. The role of Akt/GSK-3beta signaling in familial
22 hypertrophic cardiomyopathy. *J Mol Cell Cardiol*. 2009;46:739-47.
- 23 9. Bernardo BC and McMullen JR. Molecular Aspects of Exercise-induced Cardiac
24 Remodeling. *Cardiol Clin*. 2016;34:515-530.
- 25 10. Zhang D, Contu R, Latronico MV, Zhang J, Rizzi R, Catalucci D, Miyamoto S,
26 Huang K, Ceci M, Gu Y, Dalton ND, Peterson KL, Guan KL, Brown JH, Chen J,
27 Sonenberg N and Condorelli G. mTORC1 regulates cardiac function and myocyte
28 survival through 4E-BP1 inhibition in mice. *J Clin Invest*. 2010;120:2805-16.
- 29 11. Shende P, Plaisance I, Morandi C, Pellieux C, Berthonneche C, Zorzato F,
30 Krishnan J, Lerch R, Hall MN, Ruegg MA, Pedrazzini T and Brink M. Cardiac raptor
31 ablation impairs adaptive hypertrophy, alters metabolic gene expression, and causes
32 heart failure in mice. *Circulation*. 2011;123:1073-82.
- 33 12. Tamai T, Yamaguchi O, Hikoso S, Takeda T, Taneike M, Oka T, Oyabu J,
34 Murakawa T, Nakayama H, Uno Y, Horie K, Nishida K, Sonenberg N, Shah AM, Takeda
35 J, Komuro I and Otsu K. Rheb (Ras homologue enriched in brain)-dependent
36 mammalian target of rapamycin complex 1 (mTORC1) activation becomes indispensable
37 for cardiac hypertrophic growth after early postnatal period. *J Biol Chem*.
38 2013;288:10176-87.
- 39 13. Volkers M, Toko H, Doroudgar S, Din S, Quijada P, Joyo AY, Ornelas L, Joyo E,
40 Thuerauf DJ, Konstandin MH, Gude N, Glembotski CC and Sussman MA. Pathological
41 hypertrophy amelioration by PRAS40-mediated inhibition of mTORC1. *Proc Natl Acad
42 Sci U S A*. 2013;110:12661-6.
- 43 14. Wu X, Cao Y, Nie J, Liu H, Lu S, Hu X, Zhu J, Zhao X, Chen J, Chen X, Yang Z
44 and Li X. Genetic and pharmacological inhibition of Rheb1-mTORC1 signaling exerts
45 cardioprotection against adverse cardiac remodeling in mice. *Am J Pathol*.
46 2013;182:2005-14.
- 47 15. Sciarretta S, Forte M, Frati G and Sadoshima J. New Insights Into the Role of
48 mTOR Signaling in the Cardiovascular System. *Circ Res*. 2018;122:489-505.
- 49 16. Sancak Y, Peterson TR, Shaul YD, Lindquist RA, Thoreen CC, Bar-Peled L and
50 Sabatini DM. The Rag GTPases bind raptor and mediate amino acid signaling to
51 mTORC1. *Science*. 2008;320:1496-501.

- 1 17. Duran RV and Hall MN. Regulation of TOR by small GTPases. *EMBO Rep.*
2 2012;13:121-8.
- 3 18. Betz C and Hall MN. Where is mTOR and what is it doing there? *J Cell Biol.*
4 2013;203:563-74.
- 5 19. Tee AR, Manning BD, Roux PP, Cantley LC and Blenis J. Tuberous sclerosis
6 complex gene products, Tuberin and Hamartin, control mTOR signaling by acting as a
7 GTPase-activating protein complex toward Rheb. *Curr Biol.* 2003;13:1259-68.
- 8 20. Engin F, Yermalovich A, Nguyen T, Hummasti S, Fu W, Eizirik DL, Mathis D and
9 Hotamisligil GS. Restoration of the unfolded protein response in pancreatic beta cells
10 protects mice against type 1 diabetes. *Sci Transl Med.* 2013;5:211ra156.
- 11 21. Wang Y, Zhang Y, Ding G, May HI, Xu J, Gillette TG, Wang H and Wang ZV.
12 Temporal dynamics of cardiac hypertrophic growth in response to pressure overload.
13 *Am J Physiol Heart Circ Physiol.* 2017;313:H1119-H1129.
- 14 22. Nakamura A, Rokosh DG, Paccanaro M, Yee RR, Simpson PC, Grossman W
15 and Foster E. LV systolic performance improves with development of hypertrophy after
16 transverse aortic constriction in mice. *Am J Physiol Heart Circ Physiol.* 2001;281:H1104-
17 12.
- 18 23. Takaoka H, Esposito G, Mao L, Suga H and Rockman HA. Heart size-
19 independent analysis of myocardial function in murine pressure overload hypertrophy.
20 *Am J Physiol Heart Circ Physiol.* 2002;282:H2190-7.
- 21 24. Harvey PA and Leinwand LA. The cell biology of disease: cellular mechanisms of
22 cardiomyopathy. *J Cell Biol.* 2011;194:355-65.
- 23 25. Allen DL, Harrison BC, Maass A, Bell ML, Byrnes WC and Leinwand LA. Cardiac
24 and skeletal muscle adaptations to voluntary wheel running in the mouse. *J Appl Physiol*
25 *(1985).* 2001;90:1900-8.
- 26 26. Chung E, Heimiller J and Leinwand LA. Distinct cardiac transcriptional profiles
27 defining pregnancy and exercise. *PLoS One.* 2012;7:e42297.
- 28 27. Bernardo BC, Weeks KL, Pretorius L and McMullen JR. Molecular distinction
29 between physiological and pathological cardiac hypertrophy: experimental findings and
30 therapeutic strategies. *Pharmacol Ther.* 2010;128:191-227.
- 31 28. Martindale JJ, Fernandez R, Thuerauf D, Whittaker R, Gude N, Sussman MA
32 and Glembotski CC. Endoplasmic reticulum stress gene induction and protection from
33 ischemia/reperfusion injury in the hearts of transgenic mice with a tamoxifen-regulated
34 form of ATF6. *Circ Res.* 2006;98:1186-93.
- 35 29. Simpson P. Stimulation of hypertrophy of cultured neonatal rat heart cells
36 through an alpha 1-adrenergic receptor and induction of beating through an alpha 1- and
37 beta 1-adrenergic receptor interaction. Evidence for independent regulation of growth
38 and beating. *Circ Res.* 1985;56:884-94.
- 39 30. Basso AD, Mirza A, Liu G, Long BJ, Bishop WR and Kirschmeier P. The farnesyl
40 transferase inhibitor (FTI) SCH66336 (lonafarnib) inhibits Rheb farnesylation and mTOR
41 signaling. Role in FTI enhancement of taxane and tamoxifen anti-tumor activity. *J Biol*
42 *Chem.* 2005;280:31101-8.
- 43 31. Okada K, Minamoto T, Tsukamoto Y, Liao Y, Tsukamoto O, Takashima S, Hirata
44 A, Fujita M, Nagamachi Y, Nakatani T, Yutani C, Ozawa K, Ogawa S, Tomoike H, Hori
45 M and Kitakaze M. Prolonged endoplasmic reticulum stress in hypertrophic and failing
46 heart after aortic constriction: possible contribution of endoplasmic reticulum stress to
47 cardiac myocyte apoptosis. *Circulation.* 2004;110:705-12.
- 48 32. Sari FR, Widyantoro B, Thandavarayan RA, Harima M, Lakshmanan AP, Zhang
49 S, Muslin AJ, Suzuki K, Kodama M and Watanabe K. Attenuation of CHOP-mediated
50 myocardial apoptosis in pressure-overloaded dominant negative p38alpha mitogen-
51 activated protein kinase mice. *Cell Physiol Biochem.* 2011;27:487-96.

- 1 33. Park CS, Cha H, Kwon EJ, Sreenivasaiah PK and Kim DH. The chemical
2 chaperone 4-phenylbutyric acid attenuates pressure-overload cardiac hypertrophy by
3 alleviating endoplasmic reticulum stress. *Biochem Biophys Res Commun.*
4 2012;421:578-84.
- 5 34. Liu X, Kwak D, Lu Z, Xu X, Fassett J, Wang H, Wei Y, Cavener DR, Hu X, Hall J,
6 Bache RJ and Chen Y. Endoplasmic reticulum stress sensor protein kinase R-like
7 endoplasmic reticulum kinase (PERK) protects against pressure overload-induced heart
8 failure and lung remodeling. *Hypertension.* 2014;64:738-44.
- 9 35. Vekich JA, Belmont PJ, Thuerauf DJ and Glembotski CC. Protein disulfide
10 isomerase-associated 6 is an ATF6-inducible ER stress response protein that protects
11 cardiac myocytes from ischemia/reperfusion-mediated cell death. *J Mol Cell Cardiol.*
12 2012;53:259-67.
- 13 36. Wu J, Ruas JL, Estall JL, Rasbach KA, Choi JH, Ye L, Bostrom P, Tyra HM,
14 Crawford RW, Campbell KP, Rutkowski DT, Kaufman RJ and Spiegelman BM. The
15 unfolded protein response mediates adaptation to exercise in skeletal muscle through a
16 PGC-1alpha/ATF6alpha complex. *Cell Metab.* 2011;13:160-9.
- 17 37. Misra J, Kim DK, Choi W, Koo SH, Lee CH, Back SH, Kaufman RJ and Choi HS.
18 Transcriptional cross talk between orphan nuclear receptor ERRgamma and
19 transmembrane transcription factor ATF6alpha coordinates endoplasmic reticulum
20 stress response. *Nucleic Acids Res.* 2013;41:6960-74.
- 21 38. Yamagata K, Sanders LK, Kaufmann WE, Yee W, Barnes CA, Nathans D and
22 Worley PF. rheb, a growth factor- and synaptic activity-regulated gene, encodes a novel
23 Ras-related protein. *J Biol Chem.* 1994;269:16333-9.
- 24 39. Potharaveedu VN, Schopel M, Stoll R and Heumann R. Rheb in neuronal
25 degeneration, regeneration, and connectivity. *Biol Chem.* 2017;398:589-606.
- 26 40. Heard JJ, Fong V, Bathaie SZ and Tamanoi F. Recent progress in the study of
27 the Rheb family GTPases. *Cell Signal.* 2014;26:1950-7.
- 28 41. Goorden SM, Hoogeveen-Westerveld M, Cheng C, van Woerden GM, Mozaffari
29 M, Post L, Duckers HJ, Nellist M and Elgersma Y. Rheb is essential for murine
30 development. *Mol Cell Biol.* 2011;31:1672-8.
- 31 42. Wang Y, Huang BP, Luciani DS, Wang X, Johnson JD and Proud CG. Rheb
32 activates protein synthesis and growth in adult rat ventricular cardiomyocytes. *J Mol Cell*
33 *Cardiol.* 2008;45:812-20.
- 34 43. Sciarretta S, Zhai P, Shao D, Maejima Y, Robbins J, Volpe M, Condorelli G and
35 Sadoshima J. Rheb is a critical regulator of autophagy during myocardial ischemia:
36 pathophysiological implications in obesity and metabolic syndrome. *Circulation.*
37 2012;125:1134-46.
- 38 44. Cao Y, Tao L, Shen S, Xiao J, Wu H, Li B, Wu X, Luo W, Xiao Q, Hu X, Liu H,
39 Nie J, Lu S, Yuan B, Han Z, Xiao B, Yang Z and Li X. Cardiac ablation of Rheb1 induces
40 impaired heart growth, endoplasmic reticulum-associated apoptosis and heart failure in
41 infant mice. *Int J Mol Sci.* 2013;14:24380-98.
- 42 45. Schewe DM and Aguirre-Ghiso JA. ATF6alpha-Rheb-mTOR signaling promotes
43 survival of dormant tumor cells in vivo. *Proc Natl Acad Sci U S A.* 2008;105:10519-24.
- 44 46. Fernandez-Fernandez MR, Ferrer I and Lucas JJ. Impaired ATF6alpha
45 processing, decreased Rheb and neuronal cell cycle re-entry in Huntington's disease.
46 *Neurobiol Dis.* 2011;41:23-32.
- 47 47. Tyagi R, Shahani N, Gorgen L, Ferretti M, Pryor W, Chen PY, Swarnkar S,
48 Worley PF, Karbstein K, Snyder SH and Subramaniam S. Rheb Inhibits Protein
49 Synthesis by Activating the PERK-eIF2alpha Signaling Cascade. *Cell Rep.* 2015.
- 50

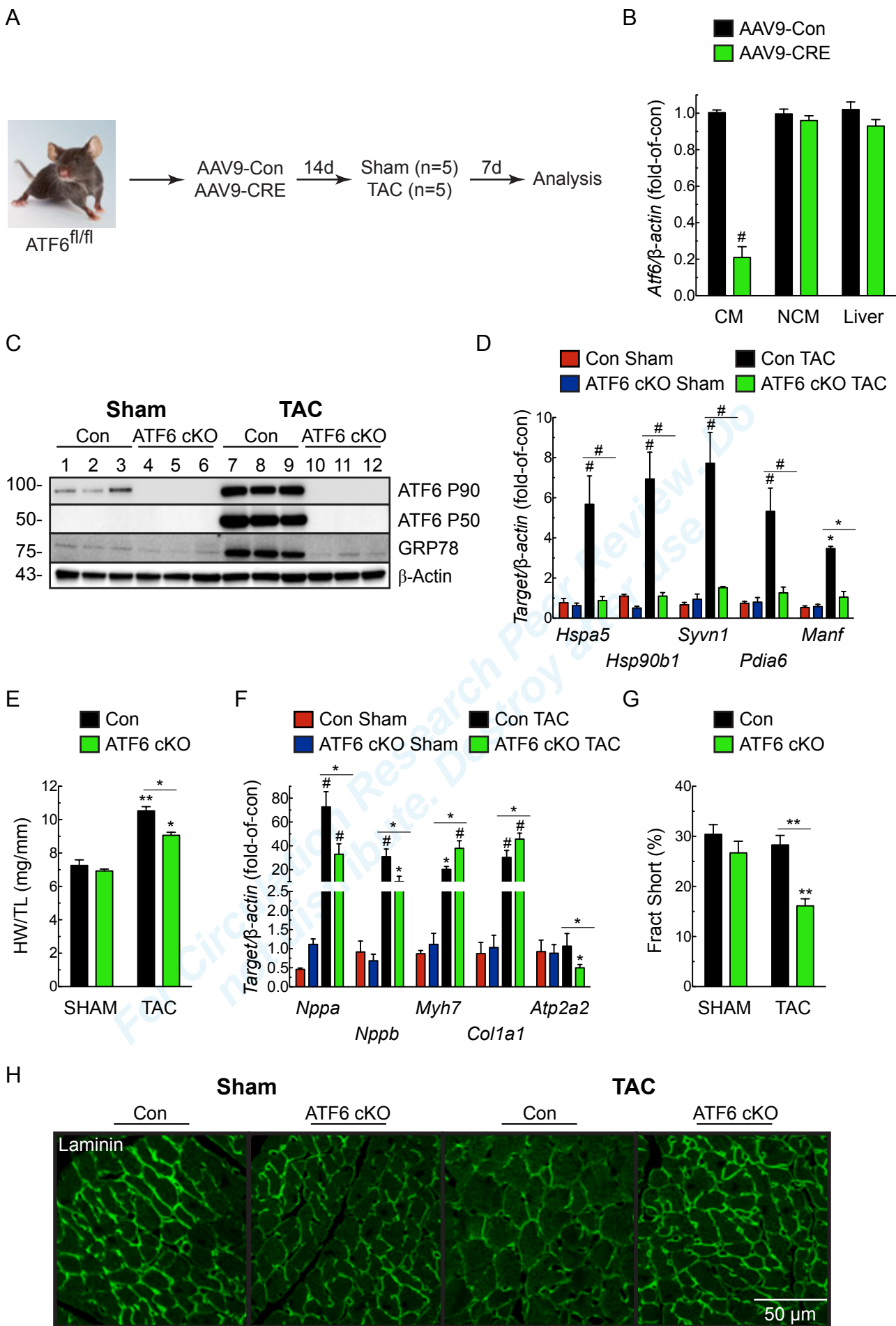


Figure 1

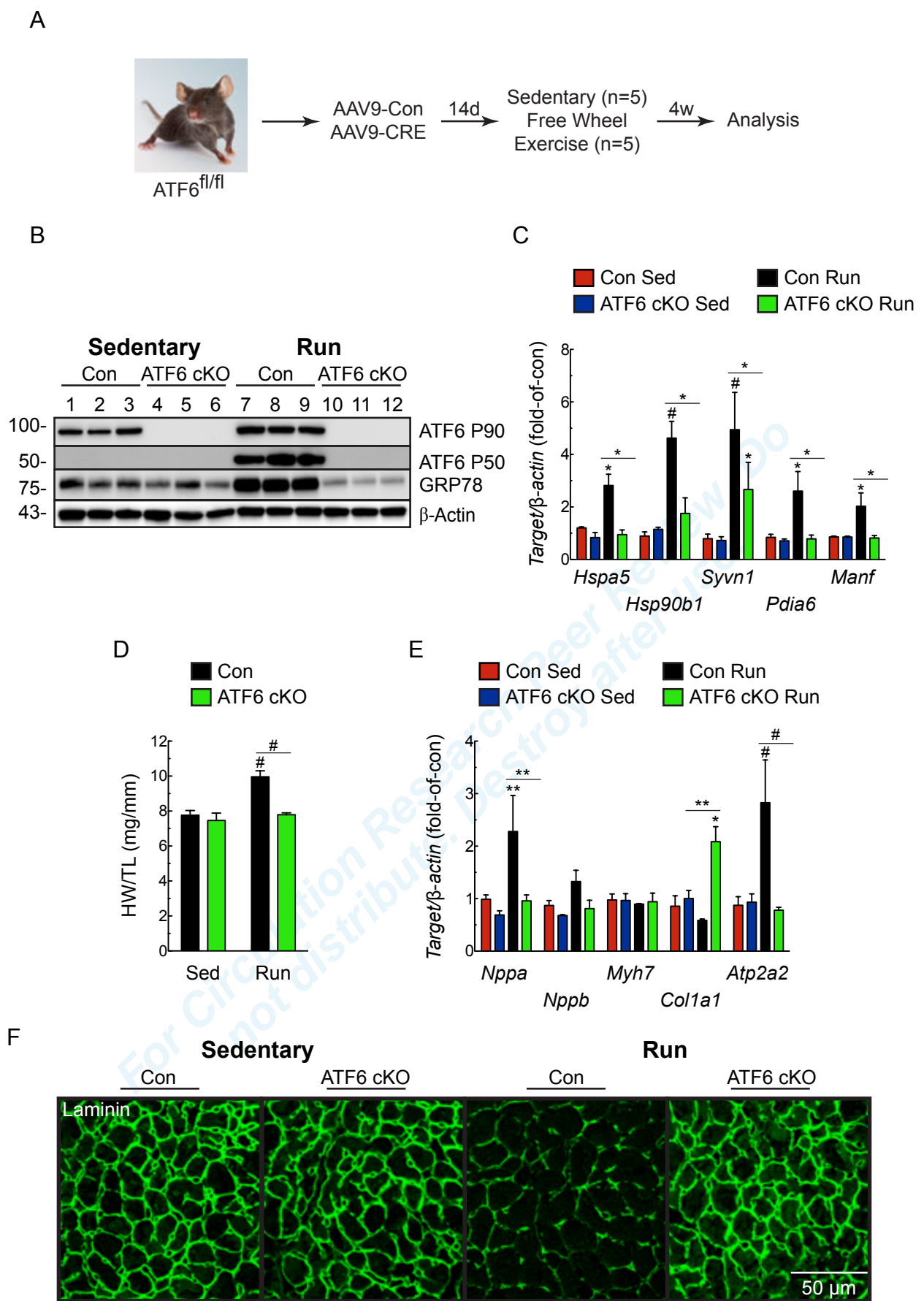


Figure 2

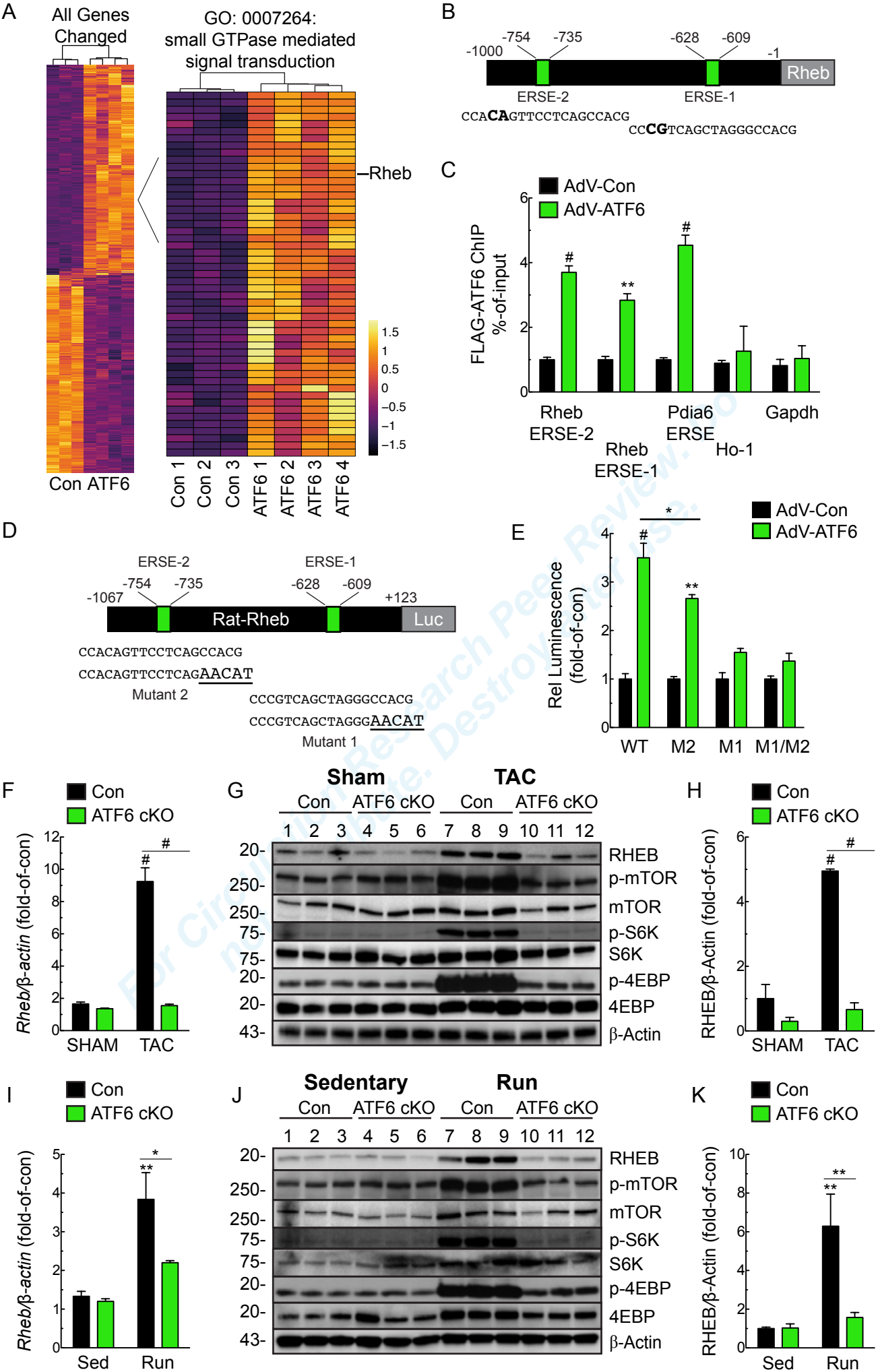


Figure 3

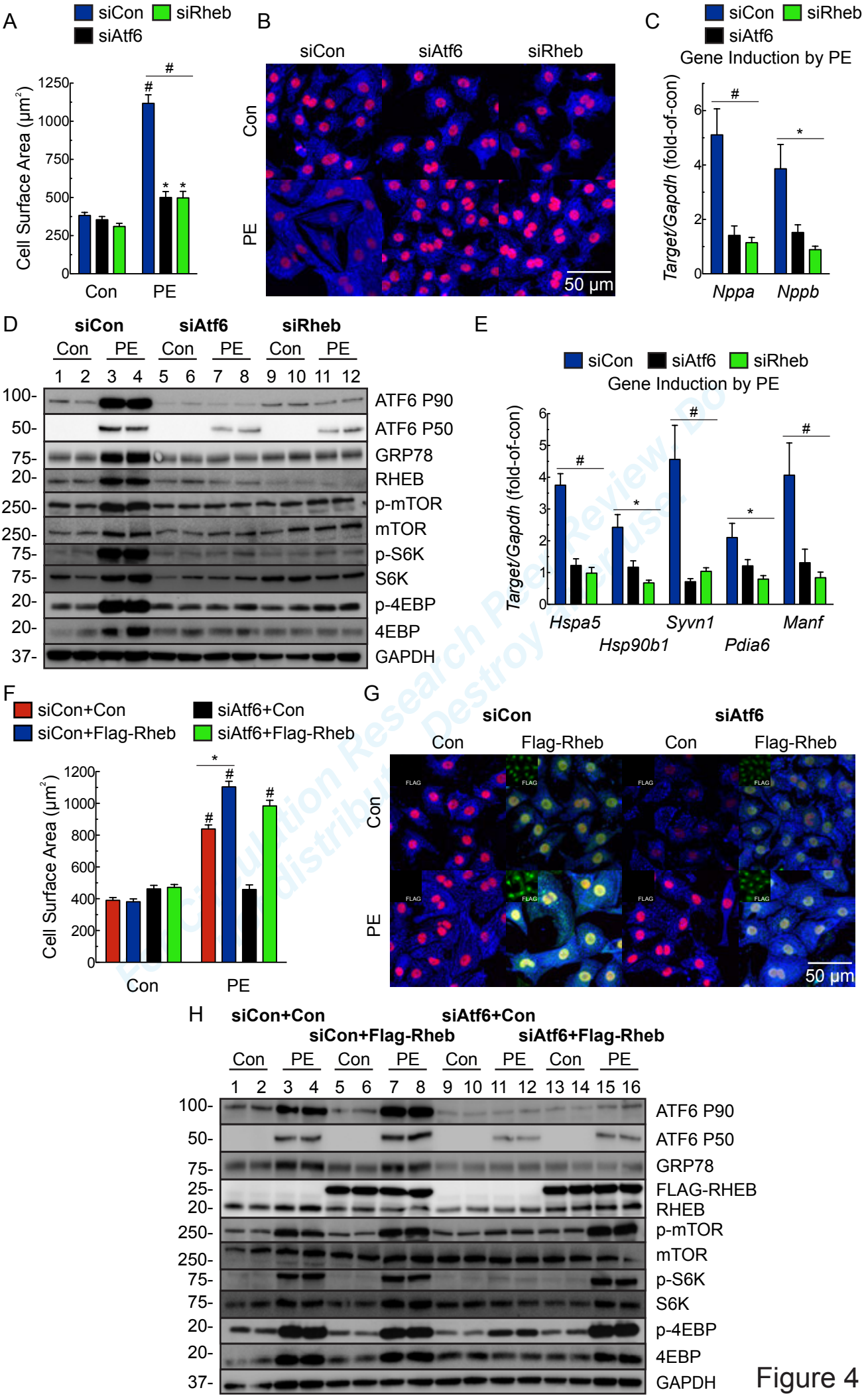


Figure 4

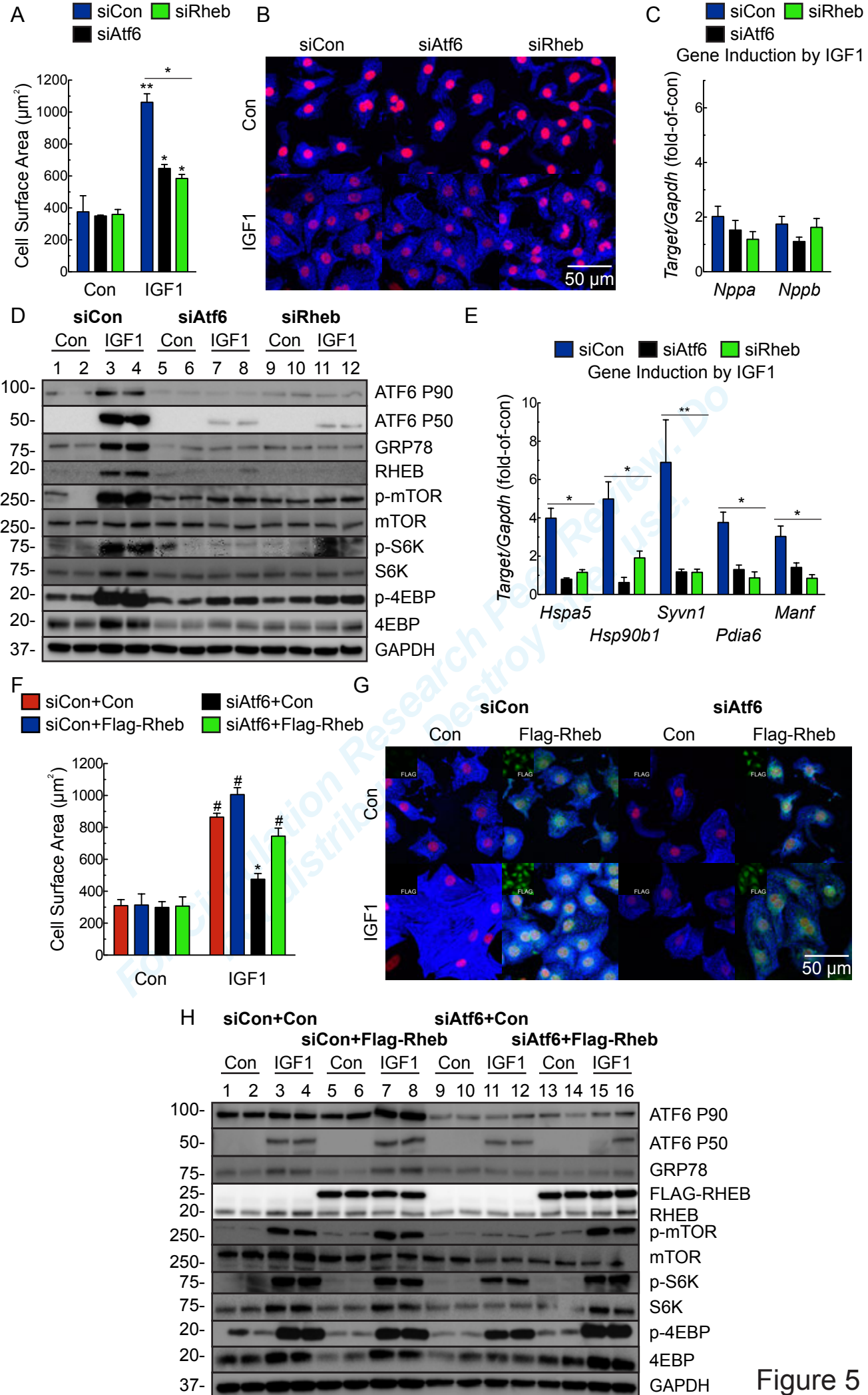


Figure 5

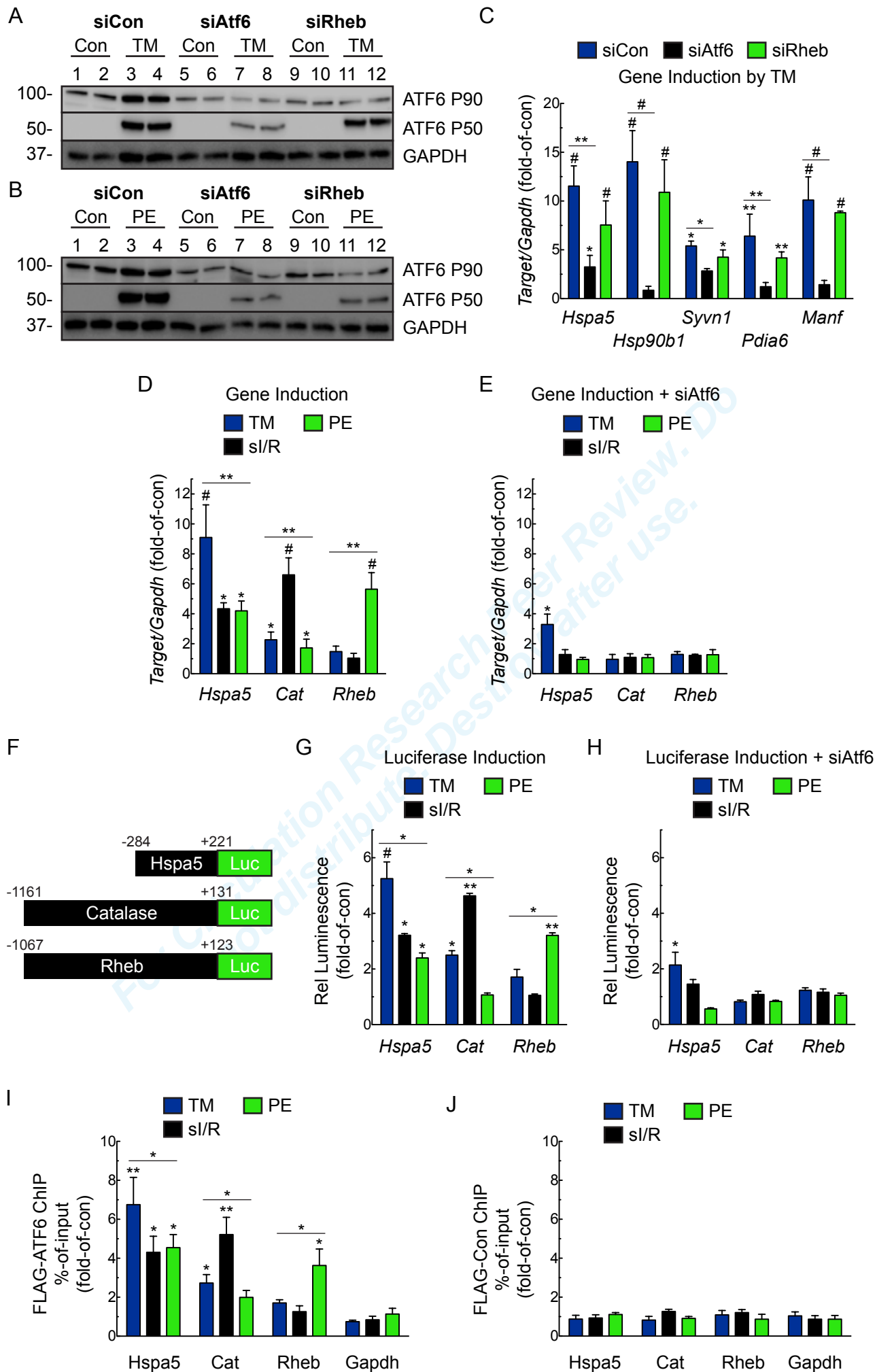


Figure 6

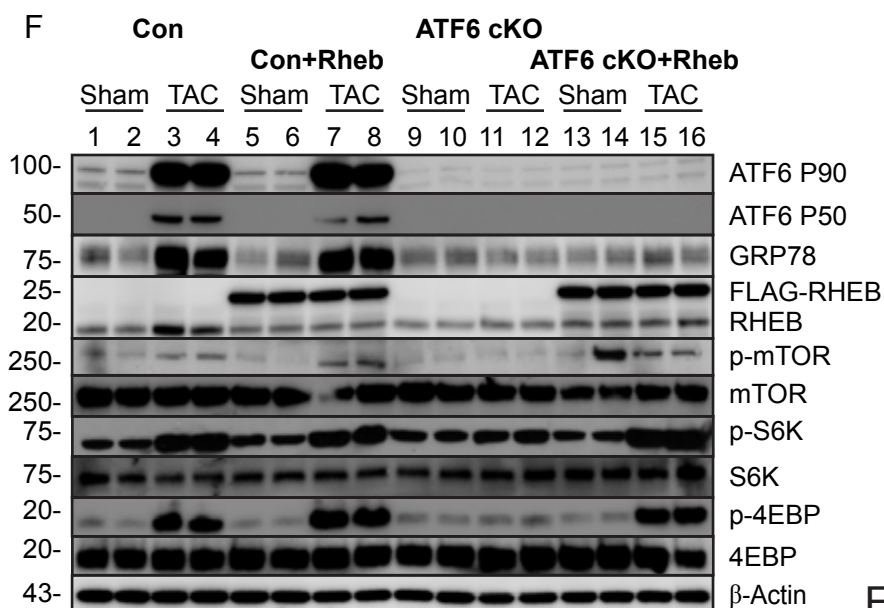
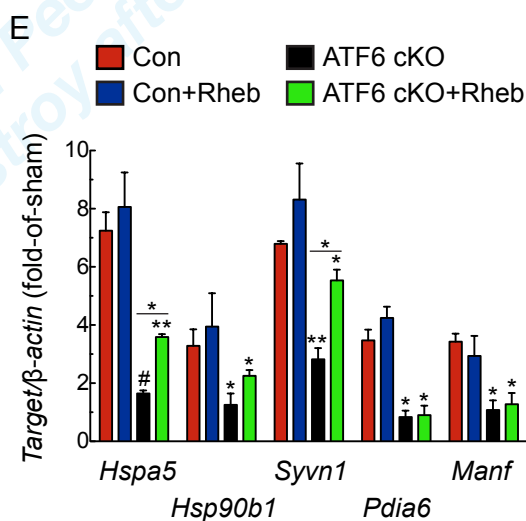
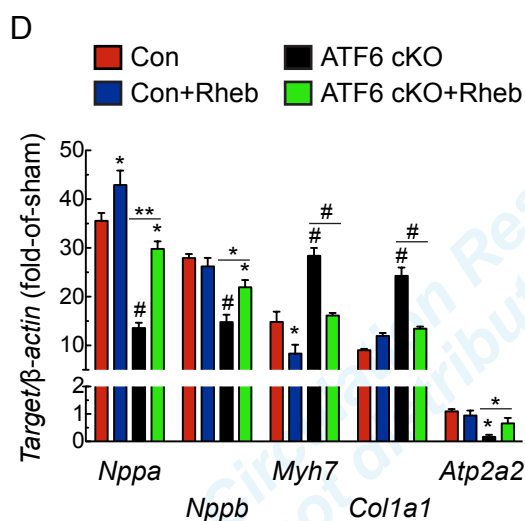
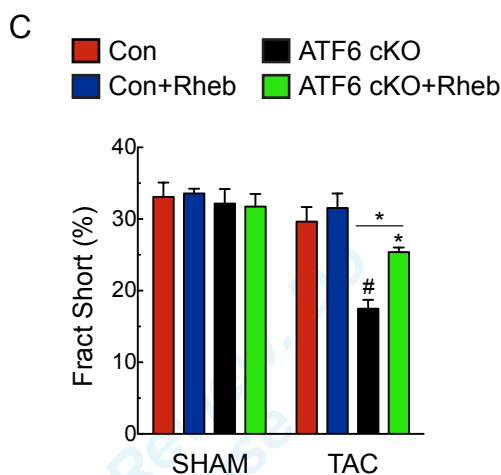
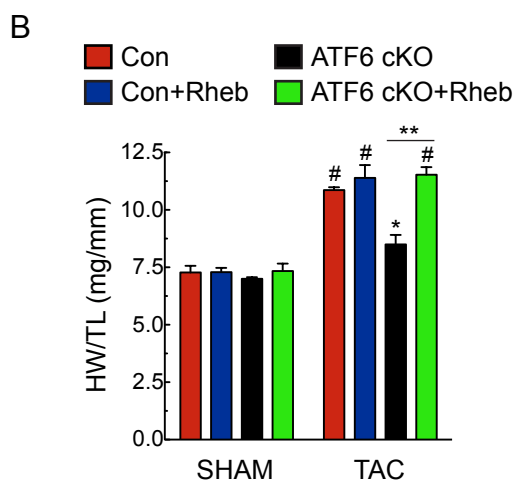
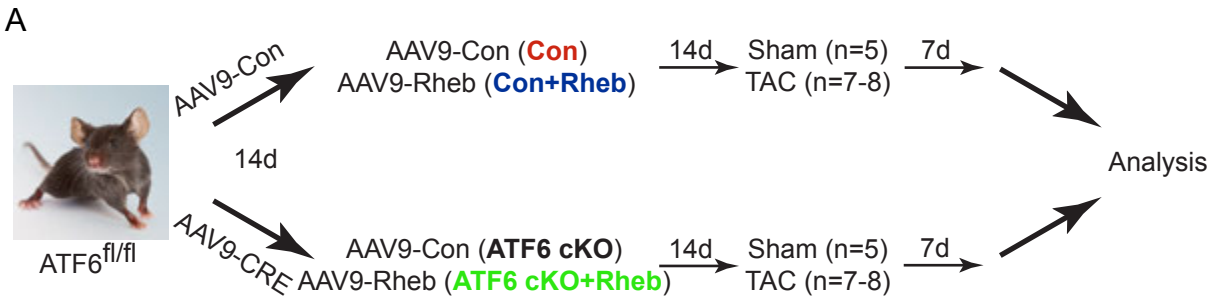
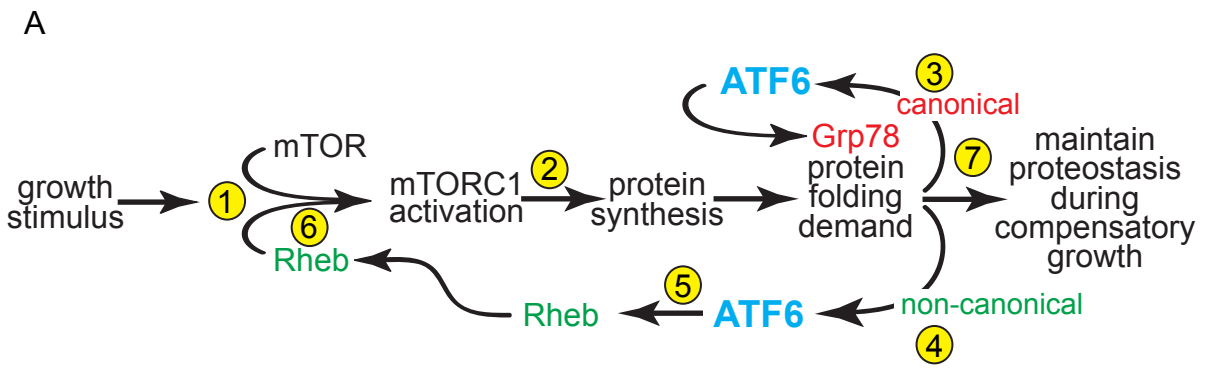
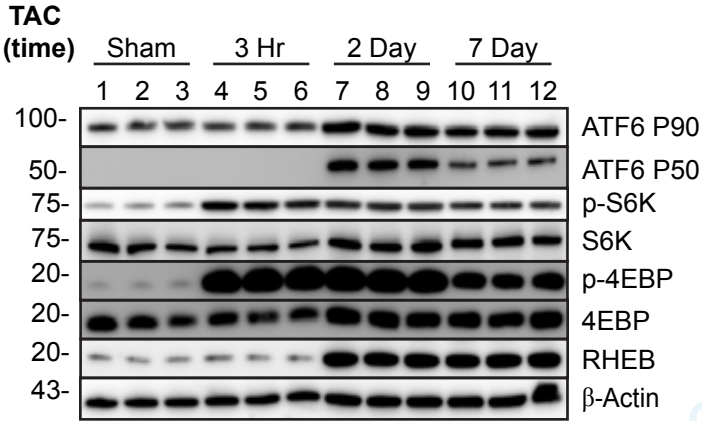


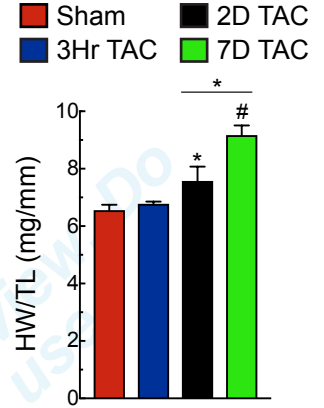
Figure 7



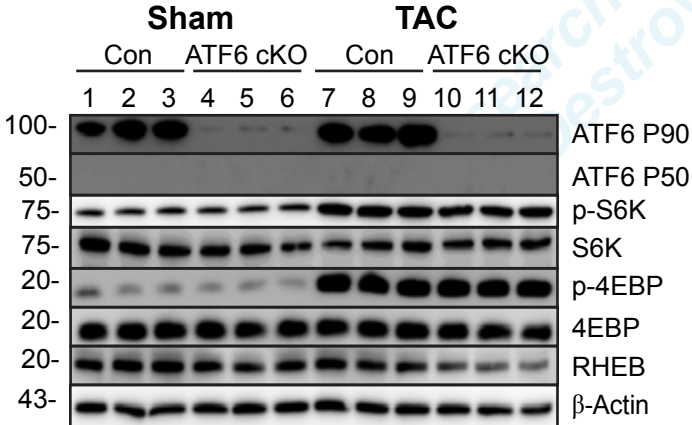
B WT TAC Timecourse



C



D 3Hr TAC



E

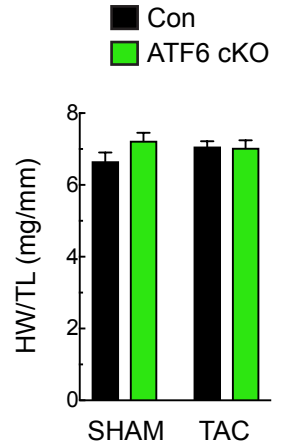


Figure 8

Supplemental Material

Detailed Methods

Laboratory animals

The research reported in this article has been reviewed and approved by the San Diego State University Institutional Animal Care and Use Committee (IACUC), and conforms to the Guide for the Care and Use of Laboratory Animals published by the National Research Council. ATF6-floxed (ATF6^{fl/fl}) mice were a generous gift from Dr. Gokhan S. Hotamisligil. Briefly, ATF6-floxed mice were generated with a targeting construct flanking exons 8 and 9 of ATF6 with LoxP sequences on a C57B/6J background, as previously described¹.

Animal numbers

A total of 184 mice were used for this study. ATF6^{fl/fl} C57BL/6J mice injected with AAV9-Con (Con) (n=81) and their ATF6^{fl/fl} littermates injected with AAV9-Cre (ATF6 cKO) (n=80); for certain experimental paradigms Con and ATF6 cKO mice were subsequently injected with either AAV9-Con (n=37), AAV9-Rheb (n=13) or AAV9-ATF6 (n=24); ATF6 TG C57BL/6J mice (n=4) and their non-transgenic littermates (n=3). Male wild-type C57BL/6J mice were purchased from Jackson Laboratories for the TAC time course experiment (n=16). All animals were fed *ad libitum* for all experimental purposes and kept on a traditional 12-hour light/dark cycle. All animal sacrifice and tissue harvest was consistently performed between the hours of 12pm-3pm when we have observed animals to be in a fasted and sedentary state.

Cultured cardiac myocytes (NRVM) and experimental design

Neonatal rat ventricular myocytes (NRVMs) were isolated via enzymatic digestion, purified by Percoll density gradient centrifugation, and maintained in Dulbecco's modified Eagle's medium (DMEM)/F12 supplemented with 10% fetal bovine serum (FBS) and antibiotics (100 units/ml penicillin and 100 µg/ml streptomycin) on plastic culture plates that had been pre-treated with 5 µg/ml fibronectin, as previously described². For all NRVM experiments, plating density was maintained at 2.5×10^5 cells/well on 12-well plates. Sixteen hours after plating, NRVM were subjected to respective treatments. For stimulated *in vitro* hypertrophy in NRVM, an initial period of serum starvation was implemented by replacing all culture media with 0.5 ml of glucose-free DMEM for 48 hours. NRVM culture media was then replaced with DMEM/F12 supplemented with BSA (1 mg/ml) containing either control, phenylephrine (50 µM) or IGF1 (100ng/ml) for an additional 48 hours. Experiments in which Lonafarnib (2 µM; Cayman Chemical, Cas#193275-84-2), rapamycin (20nM; Sigma-Aldrich), cyclohexamide

(100 µg/ml; Sigma-Aldrich, Cat#C1988) or 4-phenylbutyrate (100 µM; Sigma-Aldrich, Cat#SML0309) were administered was performed as previously described³⁻⁶, treatment was performed after serum starvation in conjunction with respective phenylephrine or IGF1 administration. Images were obtained with an IX70 fluorescence microscope (Olympus, Melville, NY). For *in vitro* chemical UPR activation, sixteen hours after plating NRVM and AMVM were treated with tunicamycin (10 µg/ml) for 24 hours in DMEM/F12 supplemented with bovine serum albumin (BSA) (1 mg/ml) for NRVM. For *in vitro* ischemia/reperfusion (I/R), ischemia was simulated by replacing all culture media with 0.5 ml of glucose-free DMEM containing 2% dialyzed FBS, then incubated at 0.1% O₂ in a hypoxia chamber with an oxygen controller (ProOx P110 oxygen controller, Biospherix, Parish, NY) for 8 hours or 3 hours for NRVM or AMVM, respectively, as previously described². Reperfusion was simulated by replacing culture media with DMEM/F12 supplemented with BSA (1 mg/ml) for NRVM or maintaining media for AMVM and incubating at 21% O₂ for an additional 24 hours.

Immunoblotting

NRVM were lysed and subjected to immunoblot analysis, as previously described². In brief, cultures were lysed with VC lysis buffer made from 20 mM Tris-HCl (pH 7.5), 150 mM NaCl, 0.1% SDS, 1% Triton X-100, protease inhibitor cocktail (Roche Diagnostics, Indianapolis, IN) and phosphatase inhibitor cocktail (Roche Diagnostics). Mouse heart tissues were homogenized in modified RIPA buffer with 2% SDS. Lysates were clarified by centrifugation at 15,000xg for 15 min at 4°C, and the protein concentration was determined using DC protein assay (Bio-Rad, Hercules, CA). Samples comprising 15 µg of protein were mixed with Laemmli sample buffer, boiled, then subjected to SDS-PAGE followed by transfer onto PVDF membranes for immunoblotting. Full-length Atf6 (p90) was detected with an antibody from SAB Signalway Antibody (1:1000, cat# 32008, College Park, MD), while active Atf6 (p50) was detected with an antibody from Proteintech (1:1000, cat# 24169-1-AP, Rosemont, IL). Other antibodies used include: anti-KDEL antibody (1:8,000, cat# ADI-SPA-827, Enzo Life Sciences, Farmingdale, NY), which was used to detect GRP78, anti-IRE1 (1:500, cat# sc-390960, Santa Cruz), anti-XBP1s (1:1000, cat# 619502, BioLegend, San Diego, CA), anti-phospho-PERK (1:1000, cat# 3179, Cell Signaling), anti-PERK (1:1000, cat# 3192, Cell Signaling), anti-Gapdh (1:25000, cat# G109a, Fitzgerald Industries International Inc.), anti-β-actin (1:1000, cat# sc-47778, Santa Cruz), and anti-FLAG (1:3,000, cat#F1804, Sigma-Aldrich, St. Louis, MO). The following antibodies were purchased from Cell Signaling (Danvers, MA): anti-RHEB (1:1,000, cat#13879s), anti-Phospho-mTOR (Ser2448, 1:1,000, cat#2971s), anti-mTOR (1:1,1000, cat#2972s), anti-Phospho-AKT (Ser473, 1:1,000, cat#9271s), anti-Phospho-ATK (Thr308, 1:1000, cat#13038s), anti-AKT (1:1,000, cat#9272s), anti-Phospho-S6K (1:1,000, cat#9205s), anti-S6K (1:1,000, cat#9202s), anti-Phospho-4EBP (1:1,000, cat#2855s), anti-4EBP (1:1,000, cat#9452s), anti-Phospho-TSC2 (Thr1462, 1:1000, 3617s), anti-TSC2 (1:1000, 3990s), anti-

Phospho-ERK1/2 (Thr202/Tyr204, 1:1000, 9101s), and anti-ERK1/2 (1:1000, 9102s).

Adenovirus

Recombinant adenoviruses (AdV) encoding 3XFLAG-tagged constitutively active ATF6, ATF6 α (1-373), 3XFLAG-tagged transcriptionally dead ATF6, ATF6 α (94-373), and 3XFLAG-tagged full-length inactive ATF6, ATF6 α (1-670) were generated using AdEasy system essentially as previously described⁷. Transduction of NRVM was performed by incubating cultures for 5 hours with the appropriate AdV at a multiplicity of infection of one.

Plasmid transfection

Transfection of plasmids into NRVM was achieved using electroporation as previously described⁸. Briefly, 1 million NRVM were suspended in 300 μ l DMEM/F12 supplemented with BSA (1 mg/ml) and mixed with 10 μ g of CMV-Flag-Rheb (AddGene plasmid #19996), or a Rheb promoter-luciferase construct of choice (see below), or an empty vector control plasmid. Subsequently, each mixture was then electroporated in a Bio-Rad gene pulser at 500 V, 25 microfarads, 100 Ω in a 0.2 cm gap cuvette. Transfected NRVM viability is approximately 50% and were then plated into four-chamber Lab Tek chamber slides at 0.75×10^5 NRVM per 2 cm² chamber.

Rheb promoter-luciferase constructs

The promoter region of the rat RHEB gene spanning nucleotides -1067 to +123 was amplified by PCR using ggatcgacgcgctcagtagcgcctgttcgagaaa as the forward primer, which introduced an MluI site (underlined) just 5' of rat RHEB -1067, and ggatcgctcgcgagcttgtagcCTgGTCAGC as the reverse primer, which introduced an XhoI site (underlined) just 3' of rat RHEB +123. Upper case nucleotides match those in the rat RHEB gene. The amplified product was then cloned into pGL2p to generate rat-RHEB(-1067/+123)-Luc. Truncated versions of rat-RHEB luciferase were cloned into pGL2p using a similar strategy and the same reverse primer coupled with the following forward primers: ggaacgcgacgcgtTCACCACCCACACTAAGC (-723), and ggaacgcgacgcgtGAACAGTGTCTCTCCTTGGC (-390) to generate rat-RHEB(-723/+123)-Luc and rat-RHEB(-390/+123)-Luc, respectively. Upper case nucleotides of these primers correspond to rat RHEB gene sequences. Informatics analyses identified putative ER stress response elements in the rat RHEB gene at nucleotide positions -754 to -736 and -628 to -610 in the rat RHEB gene, which we called ERSE-2 and ERSE-1, respectively. These elements in rat-RHEB(-1067/+123)-Luc were mutated by site-directed mutagenesis in ways

predicted to ablate ATF6 binding using RHEB-ERSE-2 mut sense primer, CCCACAGTTCCTCAGaacatAATAAAGCTTAGTCAC and RHEB-ERSE-2 mut antisense primer, GTGACTAAGCTTTATTatggttCTGAGGAACTGTGGG RHEB-ERSE-1 mut sense primer, GCCCGTCAGCTAGGGaacatCGCCTCACGCC, and RHEB-ERSE-1 mut antisense primer, GGCGTGAGGCGatggttCCCTAGCTGACGGGC.

PCR-based mutagenesis was performed using the QuikChange XL Site-Directed Mutagenesis Kit (Agilent Technologies, Santa Clara, CA). Lower case letters represent mutated nucleotides; upper case letters represent nucleotides that are identical to those in the rat RHEB gene. Plasmids were transfected into NRVM and luciferase activity was determined as previously described².

Luciferase reporter assay

Luciferase reporter assays were performed as previously described². Briefly, suspended NRVMs were co-transfected by electroporation with Rheb promoter-luciferase constructs described above, human-Hspa5(-284/+221), or rat-Catalase(-1161/+131) promoter-luciferase constructs previously described^{2, 9} along with pCH110 plasmids encoding SV40-beta-galactosidase and pGL2B, as described previously¹⁰. NRVMs were plated overnight and then infected with different forms of AdV-ATF6 or subjected to respective experimental paradigms. NRVMs were lysed after 48 h, and the activities of luciferase and beta-galactosidase were measured using an Optocompt II luminometer (MGM Instruments, Hamden, CT).

Small interfering RNA (siRNA) transfection

Transfection of siRNA into NRVM was achieved using HiPerfect Transfection Reagent (Qiagen, Valencia, CA) following the vendor's protocol as previously described². Briefly, NRVM culture medium was replaced with DMEM/F12 supplemented with 0.5% FBS without antibiotics, 120 nM siRNA, and 1.25 µl HiPerfect / 1 µl siRNA, then incubated for 16 hours, after which the culture medium was replaced with DMEM/F12 supplemented with BSA (1 mg/ml) for an additional 48 hours. The following targeting siRNAs were used: rat ATF6 (assay ID# RSS315363, Stealth siRNA, Thermo Fisher), rat RHEB (assay ID# RSS352522, Stealth siRNA, Thermo Fisher), rat PERK (assay ID# s132055, Silencer Select siRNA, Thermo Fisher), and rat IRE1 (assay ID# RSS363210, Stealth siRNA, Thermo Fisher). A non-targeting sequence (cat# 12935300, Thermo Fisher) was used as a control siRNA.

Immunocytofluorescence (ICF) and immunohistochemistry

NRVM were plated on fibronectin and laminin-coated glass chamber slides, respectively as previously described². Briefly, cells were fixed with 4% paraformaldehyde, followed by permeabilization with 0.5% Triton-X. Adult mouse hearts were paraffin-embedded after fixation in neutral buffered 10% formalin via abdominal aorta retroperfusion as previously described³. Primary antibodies used were anti- α -actinin (1:200, cat# A7811, Sigma-Aldrich), anti-tropomyosin (1:200, cat# T9283, Sigma-Aldrich), anti-RHEB (1:50, cat#13879s, Cell Signaling), and anti-laminin (1:30, cat# L9393, Sigma-Aldrich). Slides were incubated with appropriate fluorophore-conjugated secondary antibodies (1:100, Jackson ImmunoResearch Laboratories, West Grove, PA) followed by nuclei counter stain Topro-3 (1:1000, Thermo Fisher). Images were obtained using laser scanning confocal microscopy on an LSM 710 confocal laser scanning microscope (Carl Zeiss, Oberkochen, Germany).

Quantitative real-time PCR (qRT-PCR)

Total RNA was isolated from NRVM or mouse hearts as previously described³ using Quick-RNA MiniPrep kit (Zymo Research, Irvine, CA) or RNeasy Mini kit (Qiagen), respectively. cDNA synthesis was performed using SuperScript III First-Strand Synthesis System (Thermo Fisher). qRT-PCR was performed using Maxima SYBR Green/ROX qPCR Master Mix in a StepOnePlus RT-PCR System (Thermo Fisher). All qPCR probes were obtained from Integrated DNA Technologies, as previously described^{2, 6}. Rheb-specific qPCR primers are listed below:

Gene (rat)	Forward Primer	Reverse Primer
Rheb - 1	CAGCAGGGCAGGATGAATA	GCTTGCCGTGGATAACTTTAAT
Rheb - 2	AAGATGCCTCAGTCCAAGTC	GATCAGCTTGGTGAATGTGTTT
Gene (mouse)		
Rheb - 1	CCATGGCAAGTTGTTGGATATG	TCTTCATAGCTGATCACCCTTTC
Rheb - 2	ACGTCTGACTCTGTCCAATG	TGCCAACAGGAGGCAATAA

Adeno-Associated virus serotype 9 (AAV9)

The plasmid encoding the human cardiac troponin T promoter driving Cre-recombinase was provided as a gift from Dr. Oliver Muller⁹. AAV9 preparation was carried out as previously described². Non-anesthetized 8-week old ATF6^{fl/fl} mice were injected with 100 μ L of AAV9-control or AAV9-cTnT-Cre containing 1×10^{11} viral particles via the lateral tail vein using a 27-gauge syringe and housed for 2 weeks before either sacrifice or experimental initiation. To generate AAV9-FLAG-Rheb, a plasmid encoding FLAG-Rheb was obtained from Addgene (Addgene 19996). The region of this construct containing FLAG-Rheb was excised with EcoR1 and Xho1, then, after addition of an EcoR1/Nhe1 linker, it

was ligated into the Nhe1 and Xho1 sites of the AAV shuttle vector, pTRUF-CMVenhMLC800. AAV9 were then prepared and administered as previously described in accordance with the respective experimental paradigms².

Chromatin immunoprecipitation (ChIP)

ChIP assays were performed essentially as previously described^{2, 11}. Briefly, AdV-Con, AdV-FLAG-ATF6(1-373), or AdV-FLAG-ATF6(1-670) infected NRVM were treated with fixing buffer (50 mM HEPES-KOH, pH 7.5, 100 mM NaCl, 1 mM EDTA, 0.5 mM EGTA, and 1% formaldehyde) for 10 min, quenched with 125 mM glycine, and scraped into ice-cold PBS. Cells were centrifuged, resuspended in lysis buffer (50 mM HEPES, pH 7.9, 140 mM NaCl, 1 mM EDTA, 10% glycerol, 0.5% NP-40, 0.25% Triton X-100, and protease inhibitor cocktail), and incubated on ice for 10 min. After centrifugation at 1,800 x g for 10 min, the pellets were washed with buffer containing 10 mM Tris, pH 8.1, 200 mM NaCl, 1 mM EDTA, and 0.5 mM EGTA, resuspended in shearing buffer (0.1% SDS, 1 mM EDTA, and 10 mM Tris, pH 8.1), and then transferred to microTUBEs (Covaris, Woburn, MA). Chromatin was sheared by sonication for 15 min using an M220 focused ultrasonicator (Covaris). Triton X-100 and NaCl were added to the final concentration of 1% Triton and 150 mM NaCl followed by centrifugation at 16,000 x g for 10 min. Immunoprecipitation was performed by incubated 140 μ l of sheared chromatin with 5 μ g of anti-FLAG antibody (cat# F1804, Sigma-Aldrich) and 260 μ l of immunoprecipitation buffer (0.1% SDS, 1 mM EDTA, 10 mM Tris, pH 8.1, 1% Triton X-100, and 150 mM NaCl) at 4°C overnight. Protein A/G magnetic beads (5 μ l, BcMag, Bioclone, San Diego, CA) were added to the mixtures and incubated at 4°C for 1.5 h. Magnetic beads were sequentially washed with low salt wash buffer (0.1% SDS, 1% Triton X-100, 2 mM EDTA, 20 mM HEPES-KOH, pH7.9, and 150 mM NaCl), high salt wash buffer with 500 mM NaCl, LiCl wash buffer (100 mM Tris-HCl, pH 7.5, 0.5 M LiCl, 1% NP-40, and 1% deoxycholate acid), and TE buffer (10 mM Tris-HCl, pH 8.0 and 0.1 mM EDTA). Immune complexes were eluted by incubating beads with proteinase K digestion buffer (20 mM HEPES, pH 7.9, 1 mM EDTA, 0.5% SDS, and 0.4 mg/ml proteinase K) at 50°C for 15 min. Formaldehyde crosslinking was reversed by incubating with 0.3 M NaCl and 0.3 mg/ml RNase A at 65°C overnight. Samples were further incubated with 550 μ g/ml proteinase K at 50°C for 1h. DNA was purified using NucleoSpin Gel and PCR Clean-up Kit (Macherey-Nagel, Bethlehem, PA) and eluted by 30 μ l of water. Two μ l of DNA was used for qRT-PCR analysis with primers targeting rat Rheb ERSE-1 (5'-CTGCACAGATTCCATTCTTCCC-3' and 5'-TGTCTATACTTTAAATT-3'), rat Rheb ERSE-2 (5'-TGACAGCCAACCTACAGCC-3' and 5'-GAAGCGCGGTCATTGGTG-3'), rat Hspa5 (5'-GGTGGCATGAACCAACCAG-3' and 5'-GCTTATATATCCTCCCCGC-3'), rat Cat (5'-CTACCCACCAATTAGTACCAAATAA-3' and 5'-AGAAGGGACAGGATTGGAAG-3'), rat Pdia6 ERSE (5'-CACATGAGCGAAATCCACAGA-3' and 5'-ACTAGTCGAGCCATGCTGAT-3'),

rat HO-1 (5'-GGGCTACTCCCGTCTTCCTG-3' and 5'-CCTTTCCAGAACCCTCTACTCTACTC-3'), or rat Gapdh (5'-ATGCGGTTTCTAGGTTACAG-3' and 5'-ATGTTTTCTGGGGTGCAAAG-3'). Pdia6 served as a positive control for a known ATF6 target gene in cardiac myocytes while HO-1 and Gapdh served as negative controls. ChIP signals obtained from the qRT-PCR were normalized to the input DNA.

³H-Leucine incorporation and trichloroacetic acid precipitation of protein

NRVM ³H-Leucine incorporation was performed as previously described⁶. Briefly, NRVM were plated at a density of 2.5×10^5 cells/well on 12-well plastic culture plates. After 48 hours of serum starvation in DMEM/F-12, NRVM culture media was replaced with DMEM/F12 supplemented with BSA (1 mg/ml) containing either control, phenylephrine (50 μ M), IGF1 (100ng/ml), or Lonafarnib (2 μ M) for an additional 48 hours. To this media was added 1 μ Ci of ³H-Leucine (PerkinElmer NET460A001MC L-[3,4,5-³H(N)]-Leucine, 100 to 150 Ci/mmol). After 48 hours, the media was removed, cultures were washed 3 times with 1 ml DMEM/F-12 and cells were subsequently scraped from culture dishes with 0.5 ml of 25% trichloroacetic acid and transferred to 1.5 ml microcentrifuge tubes. Protein precipitation was induced using 50 μ l of a 10mg/ml solution of BSA and samples were allowed to freeze overnight. Upon thawing, precipitates were collected by centrifugation at 4°C at $\sim 20,000$ xg for 20 minutes. Supernatants were removed by manual aspiration and precipitated protein dissolved in 200 μ l of base buffer (1% Triton X-100, 1M NaOH) at 37°C for two hours. Radioactivity in solubilized material was quantified by scintillation counting in glass scintillation vials using 180 μ l of solubilized protein into 10 ml of Ecoscint scintillation fluid. Each vial was counted for a minimum of 2 minutes with at least six separate myocyte cultures per treatment.

Cultured cardiac myocyte area

NRVM (minimum of n=3 cultures per treatment) were visualized by phase-contrast microscopy and images were obtained with an IX70 fluorescence microscope (Olympus, Melville, NY) as previously described⁶. Cell surface area was determined using NIH Image J software from a minimum of 100 cells per image using three separate fields from each cell culture.

Transverse aortic constriction

Transverse aortic constriction (TAC) was performed as previously described⁶. Briefly, adult male mice were anesthetized using a 2% isoflurane/O₂ mixture and intubated. Mice were treated with buprenorphine (0.1 mg/kg IP) and a partial trans-sternal thoracotomy performed using aseptic technique. An approximately

1.5 cm vertical left parasternal skin incision was made, underlying pectoralis muscle retracted, and the chest cavity entered through the fourth intercostal space. Using hooked retractors, adjacent ribs were retracted to expose the heart and aortic arch. The aorta was isolated from annexed tissue, and the artery partially ligated between the innominate and left common carotid arteries with 6-0 silk. The calibrated constriction of the aorta was performed by placing a dull 27-gauge needle to the side of the artery, the ligature tied firmly to both the needle and the artery, and, subsequently, the needle was removed leaving a calibrated stenosis of the aorta. Sham operated mice were exposed to the same procedure, except that the aorta was not constricted. The thoracic cavity was closed and the animals were allowed to recover. Animals were injected once with buprenorphine (0.1 mg/kg IP) about 12 h after recovery in order to reduce any post-operative discomfort. In case any animals displayed signs of pain or distress after this period, additional doses of buprenorphine were administered as needed. Immediately prior to sacrifice, animals were anesthetized and constriction levels were quantified by measuring alterations in Doppler velocities of the innominate and left carotid arteries 7 days post-TAC, as previously described¹². Mean carotid peak blood flow velocities were determined using a 20 MHz Doppler probe (Indus Instruments, Houston, TX) and ratios of innominate (RC) to left carotid (LC) were determined to evaluate consistency across animals in both SHAM and TAC groups. Just prior to sacrifice, post-TAC, animals were anesthetized and 0.5 mL of arterial blood were obtained via inferior vena cava puncture. Blood was placed in heparin- and EDTA-coated vacutainer (BD Vacutainer) and centrifuged at 3000 rpm for 10 minutes and plasma samples were analyzed for cardiac troponin I with a Mouse cTnI High-Sensitivity ELISA kit (Life Diagnostics, Inc.). A calcineurin phosphatase activity assay was performed using a calcineurin tissue extract assay kit (cat#BML-AK816-0001, Enzo Life Sciences) according to the manufacturer's protocol. Briefly, free phosphate was removed from LV tissue extracts by passing through a desalting column and calcineurin phosphatase activity was measured spectrophotometrically by detecting free phosphate released from the synthetic RII phosphopeptide.

Free-wheel exercise protocol

Free-wheel exercise protocol was performed as previously described¹³. Briefly, adult male mice were housed individually in cages containing rodent exercise wheels of a 5.356 in diameter (Model InnoWheel, BioServe) and provided with food and water *ad libitum*. The wheels were equipped with a digital magnetic counter to record revolutions of the wheel during bouts of exercise. Sedentary mice were maximally housed and provided with food and water *ad libitum* in cages not equipped with exercise wheels.

Transthoracic echocardiography

Transthoracic echocardiography was performed using an ultrasound imaging system (Vevo 2100 System, Fujifilm VisualSonics, Toronto, Ontario, Canada) as described².

Transcript profiling and bioinformatics

ATF6 TG and non-transgenic littermates were treated with tamoxifen (10 mg/kg IP) daily for 5 days as previously described¹⁴. Total RNA was isolated from mouse left ventricular extracts and RNA sequencing was carried out on Illumina Nextseq at CellNetworks Deep Sequencing Core Facility at Heidelberg University. Sequencing adapter residues and low quality bases were removed from raw sequencing reads prior to all other analysis steps using Flexbar version 3.0.3¹⁵. Subsequently, reads mapping to known ribosomal RNA species were excluded from further analyses using Bowtie2 version 2.3.0 with a custom rRNA-index and only keeping non-aligning reads¹⁶. Principal read mapping against the mouse reference genome (mm10, ENSEMBL build 85) was performed with the STAR aligner, version 2.5.3a¹⁷. The read-to-transcript assignment was carried out using the R package Rsubread version 1.24.2¹⁸ and the ENSEMBL gene annotation mm10/build85. The resulting count table was further processed with the edgeR R package¹⁹ to construct the list of differentially expressed genes. The final heatmap was generated using the pheatmap R package version 1.0.10²⁰.

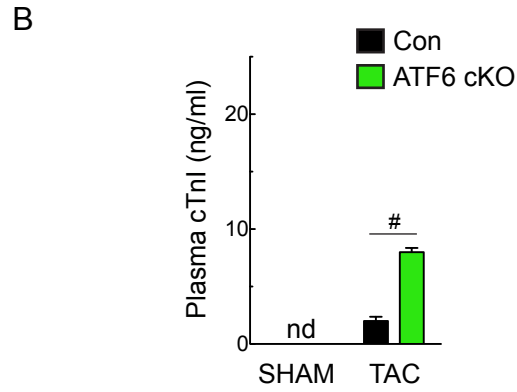
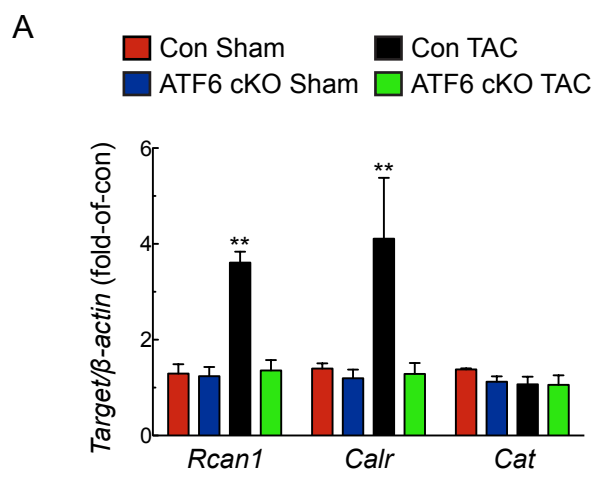
Statistics

For studies involving induction of myocardial hypertrophy, either through surgical TAC or isoproterenol infusion, cohort sizes were based on a predictive power analysis to achieve 5% error and 80% power. Cell culture experiments were performed with at least three cultures for each treatment. Two-group comparisons were performed using Student's two-tailed t-test, and all multiple group comparisons were performed using a one-way ANOVA with a Newman-Keuls post-hoc analysis. Data are represented as mean with all error bars indicating \pm SEM. * $P < 0.05$, ** $P < 0.01$, # $P < 0.001$.

REFERENCES:

1. Engin F, Yermalovich A, Nguyen T, Hummasti S, Fu W, Eizirik DL, Mathis D and Hotamisligil GS. Restoration of the unfolded protein response in pancreatic beta cells protects mice against type 1 diabetes. *Sci Transl Med*. 2013;5:211ra156.
2. Jin JK, Blackwood EA, Azizi K, Thuerauf DJ, Fahem AG, Hofmann C, Kaufman RJ, Doroudgar S and Glembotski CC. ATF6 Decreases Myocardial Ischemia/Reperfusion Damage and Links ER Stress and Oxidative Stress Signaling Pathways in the Heart. *Circ Res*. 2017;120:862-875.
3. Niessner H, Beck D, Sinnberg T, Lasithiotakis K, Maczey E, Gogel J, Venturelli S, Berger A, Mauthe M, Toulany M, Flaherty K, Schaller M, Schadendorf D, Proikas-Cezanne T, Schittek B, Garbe C, Kulms D and Meier F. The farnesyl transferase inhibitor lonafarnib inhibits mTOR signaling and enforces sorafenib-induced apoptosis in melanoma cells. *J Invest Dermatol*. 2011;131:468-79.
4. Volkers M, Toko H, Doroudgar S, Din S, Quijada P, Joyo AY, Ornelas L, Joyo E, Thuerauf DJ, Konstandin MH, Gude N, Glembotski CC and Sussman MA. Pathological hypertrophy amelioration by PRAS40-mediated inhibition of mTORC1. *Proc Natl Acad Sci U S A*. 2013;110:12661-6.
5. Park CS, Cha H, Kwon EJ, Sreenivasiah PK and Kim DH. The chemical chaperone 4-phenylbutyric acid attenuates pressure-overload cardiac hypertrophy by alleviating endoplasmic reticulum stress. *Biochem Biophys Res Commun*. 2012;421:578-84.
6. Doroudgar S, Volkers M, Thuerauf DJ, Khan M, Mohsin S, Respress JL, Wang W, Gude N, Muller OJ, Wehrens XH, Sussman MA and Glembotski CC. Hrd1 and ER-Associated Protein Degradation, ERAD, are Critical Elements of the Adaptive ER Stress Response in Cardiac Myocytes. *Circ Res*. 2015;117:536-46.
7. Thuerauf DJ, Hoover H, Meller J, Hernandez J, Su L, Andrews C, Dillmann WH, McDonough PM and Glembotski CC. Sarco/endoplasmic reticulum calcium ATPase-2 expression is regulated by ATF6 during the endoplasmic reticulum stress response: intracellular signaling of calcium stress in a cardiac myocyte model system. *J Biol Chem*. 2001;276:48309-17.
8. Zechner D, Craig R, Hanford DS, McDonough PM, Sabbadini RA and Glembotski CC. MKK6 activates myocardial cell NF-kappa B and inhibits apoptosis in a p38 mitogen-activated protein kinase-dependent manner. *Journal of Biological Chemistry*. 1998;273:8232-8239.
9. Doroudgar S, Thuerauf DJ, Marcinko MC, Belmont PJ and Glembotski CC. Ischemia activates the ATF6 branch of the endoplasmic reticulum stress response. *J Biol Chem*. 2009;284:29735-45.
10. Thuerauf DJ, Hoover H, Meller J, Hernandez J, Su L, Andrews C, Dillmann WH, McDonough PM and Glembotski CC. Sarco/endoplasmic reticulum calcium ATPase-2 expression is regulated by ATF6 during the endoplasmic reticulum stress response - Intracellular signaling of calcium stress in a cardiac myocyte model system. *Journal of Biological Chemistry*. 2001;276:48309-48317.

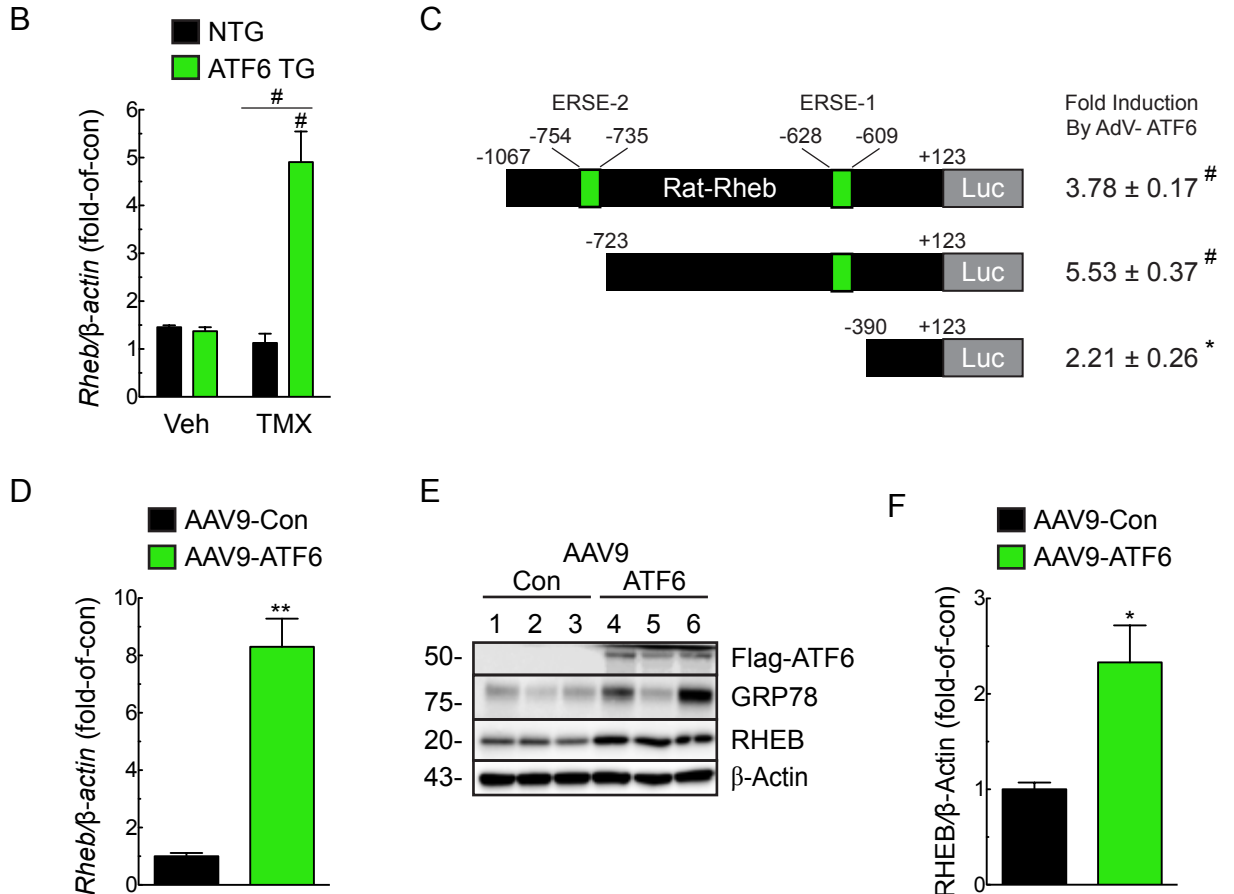
11. Vekich JA, Belmont PJ, Thuerlauf DJ and Glembotski CC. Protein disulfide isomerase-associated 6 is an ATF6-inducible ER stress response protein that protects cardiac myocytes from ischemia/reperfusion-mediated cell death. *J Mol Cell Cardiol.* 2012;53:259-67.
12. Reynolds JO, Quick AP, Wang Q, Beavers DL, Philippen LE, Showell J, Barreto-Torres G, Thuerlauf DJ, Doroudgar S, Glembotski CC and Wehrens XH. Junctophilin-2 gene therapy rescues heart failure by normalizing RyR2-mediated Ca²⁺ release. *Int J Cardiol.* 2016;225:371-380.
13. Volkers M, Toko H, Doroudgar S, Din S, Quijada P, Joyo AY, Ornelas L, Joyo E, Thuerlauf DJ, Konstandin MH, Gude N, Glembotski CC and Sussman MA. Pathological hypertrophy amelioration by PRAS40-mediated inhibition of mTORC1. *Proc Natl Acad Sci U S A.* 110:12661-6.
14. Martindale JJ, Fernandez R, Thuerlauf D, Whittaker R, Gude N, Sussman MA and Glembotski CC. Endoplasmic reticulum stress gene induction and protection from ischemia/reperfusion injury in the hearts of transgenic mice with a tamoxifen-regulated form of ATF6. *Circ Res.* 2006;98:1186-93.
15. Roehr JT, Dieterich C and Reinert K. Flexbar 3.0 - SIMD and multicore parallelization. *Bioinformatics.* 2017;33:2941-2942.
16. Langmead B and Salzberg SL. Fast gapped-read alignment with Bowtie 2. *Nat Methods.* 2012;9:357-9.
17. Dobin A, Davis CA, Schlesinger F, Drenkow J, Zaleski C, Jha S, Batut P, Chaisson M and Gingeras TR. STAR: ultrafast universal RNA-seq aligner. *Bioinformatics.* 2013;29:15-21.
18. Liao Y, Smyth GK and Shi W. The Subread aligner: fast, accurate and scalable read mapping by seed-and-vote. *Nucleic Acids Res.* 2013;41:e108.
19. Robinson MD, McCarthy DJ and Smyth GK. edgeR: a Bioconductor package for differential expression analysis of digital gene expression data. *Bioinformatics.* 2010;26:139-40.
20. Kolde R. Pheatmap: pretty heatmaps. R Packag. version 61. 2012.



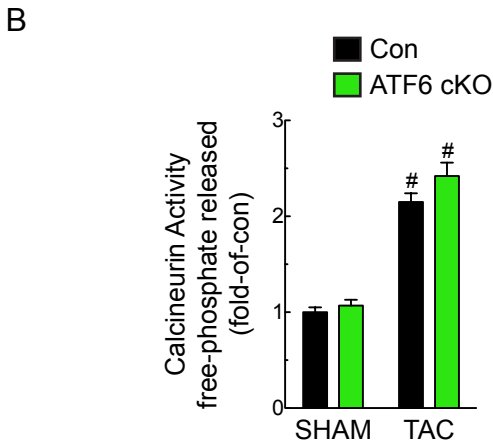
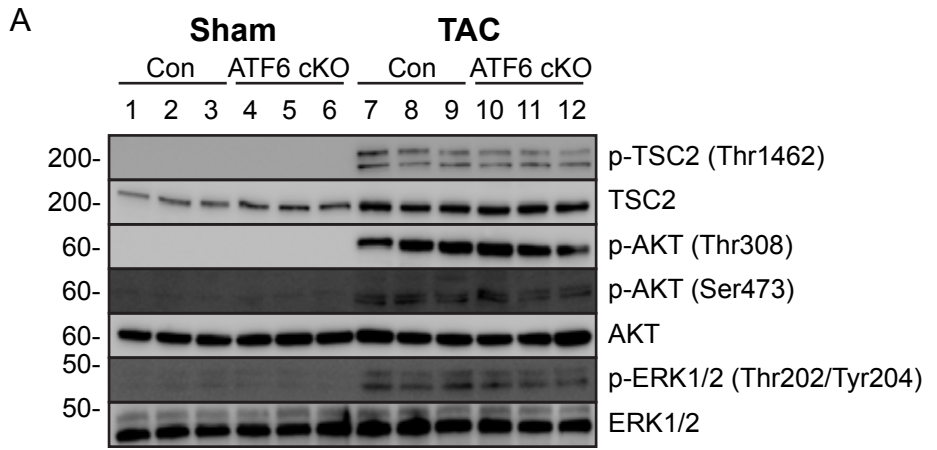
Online Figure I. Effect of cardiac myocyte-specific ATF6 gene deletion in mice subjected to TAC: **A**, mRNA for ATF6 target genes was determined by qRT-PCR. **B**, Troponin I (cTnl) levels were measured in plasma samples collected from Con or ATF6 cKO mice. Data are represented as mean \pm s.e.m. ** $P \leq 0.01$, # $P \leq 0.001$.

A GO:0007264: small GTPase mediated signal transduction

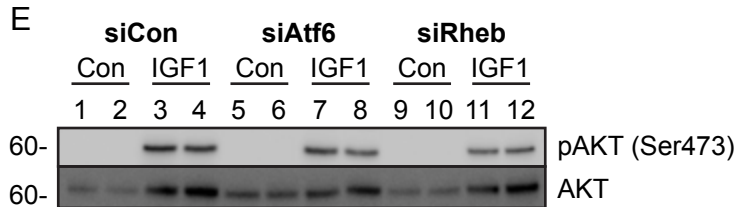
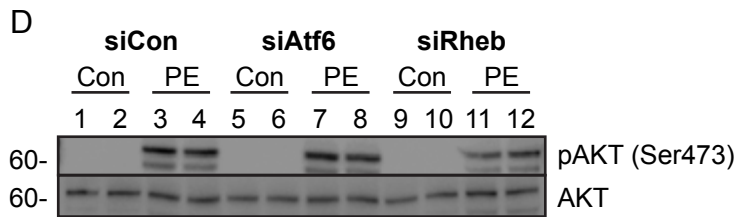
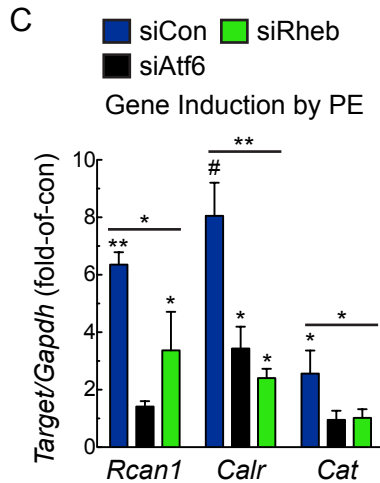
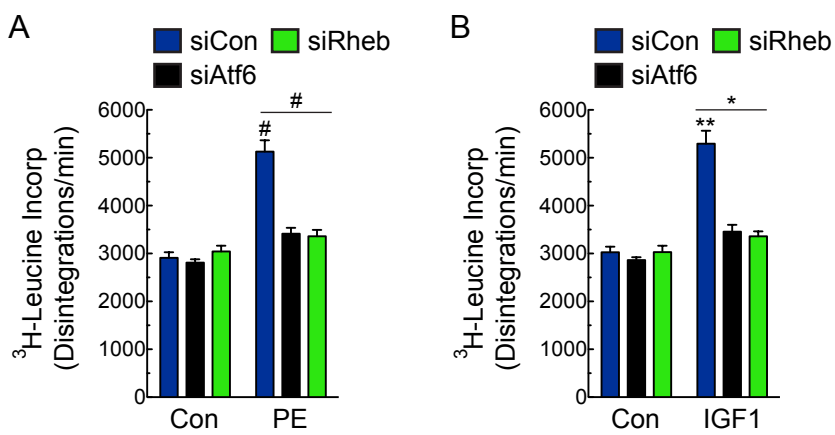
Rhoq	Arf2	Rheb	Tiam2	Rap1a	Pak4	Rap2b
Arhgap44	Rala	Mapkap1	Nckap1	Rhod	Farp1	Pak3
Ctnna1	Arhgap12	Rhoa	Arhgap35	Arhgdia	Jun	Rnd1
Ralgs1	Map2k1	Arhgef10l	Spata13	Hras	Rap2a	Gpr35
Kras	Kpnb1	Rnd3	Shoc2	Git1	Kank1	Pdpr
Erb2	Rhoc	Stmn1	Aif1	Sdcbp	Rras2	Dok2
Ralb	Hmox1	Net1	Cdc42	Itga3	Col3a1	Ect2
Arhgap1	Bcl6					



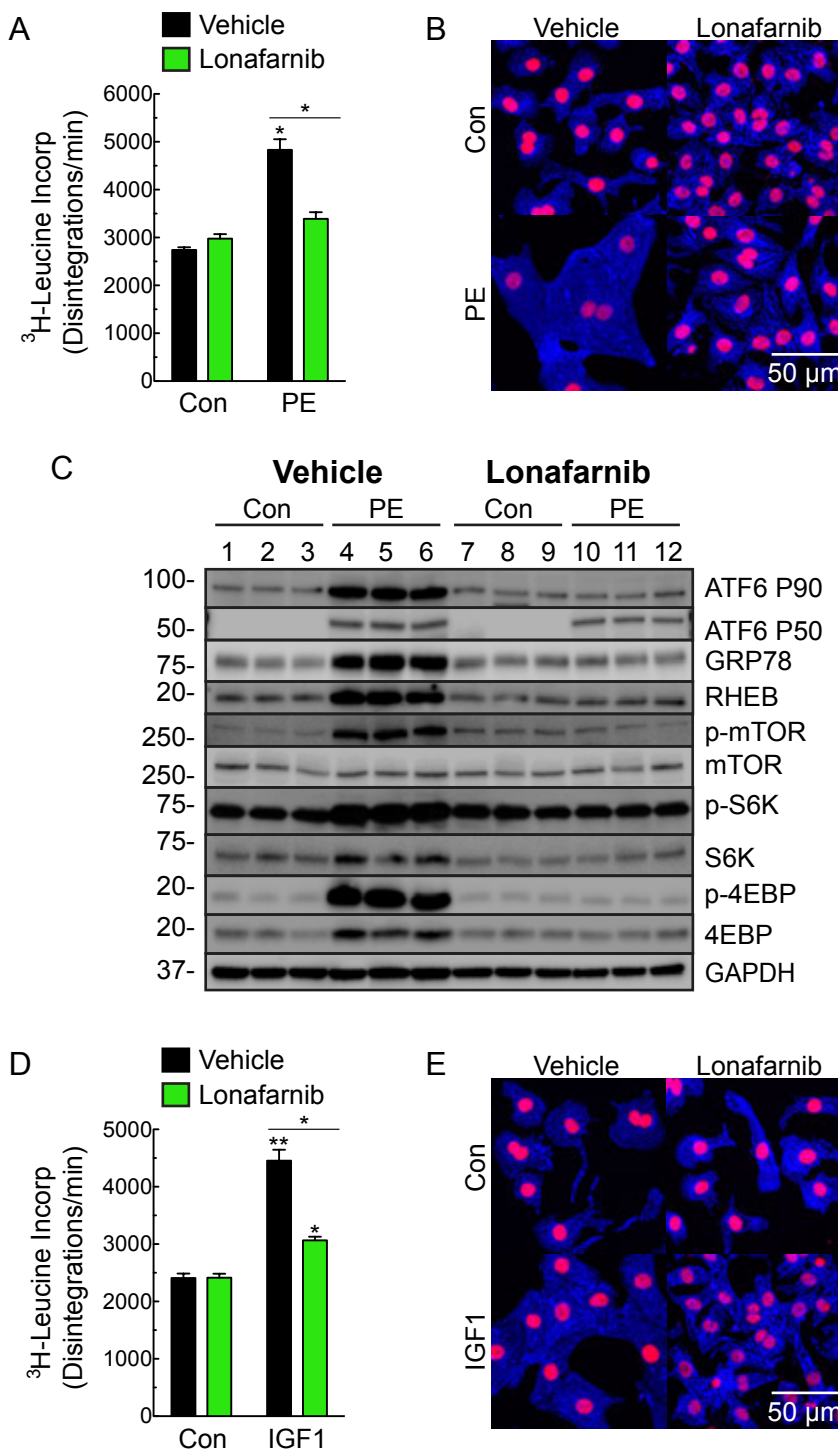
Online Figure II. ATF6-dependent induction of Rheb in mouse hearts: **A**, Table of a subset of induced genes represented by respective gene symbols in ATF6 TG mice with p values and FDR <0.05 annotated with ensemble biological process term GO:0007264. **B**, mRNA for Rheb was determined by qRT-PCR using LV extracts from ATF6-transgenic (ATF6 TG) and non-transgenic littermates after 5 days of tamoxifen administration (10mg/kg), which activates ATF6 in this mouse line. **C**, Diagram of constructs encoding different truncated forms of the rat rheb 5'-flanking sequence driving luciferase, as shown (left), i.e. rat-rheb(-1067/+123)-Luc, rat-rheb(-723/+123)-Luc, and rat-rheb(-390/+123)-Luc were transfected into NRVM which were then infected with AdV encoding ATF6(1-373) [active form], or with a control AdV. Luciferase enzyme activity in AdV-ATF6-infected cells was normalized to luciferase enzyme activity in AdV-Con-infected cells to determine the fold-induction by ATF6 (right). **D**, mRNA for Rheb was determined by qRT-PCR from LV extracts from mice treated 4 weeks with AAV9-Con or AAV9-ATF6. **E**, **F**, Immunoblot (**E**) and densitometry quantification (**F**) of RHEB protein expression AAV9-Con or AAV9-ATF6 mouse heart extracts. Data are represented as mean ± s.e.m. *P≤0.05, **P≤0.01, #P≤0.001.



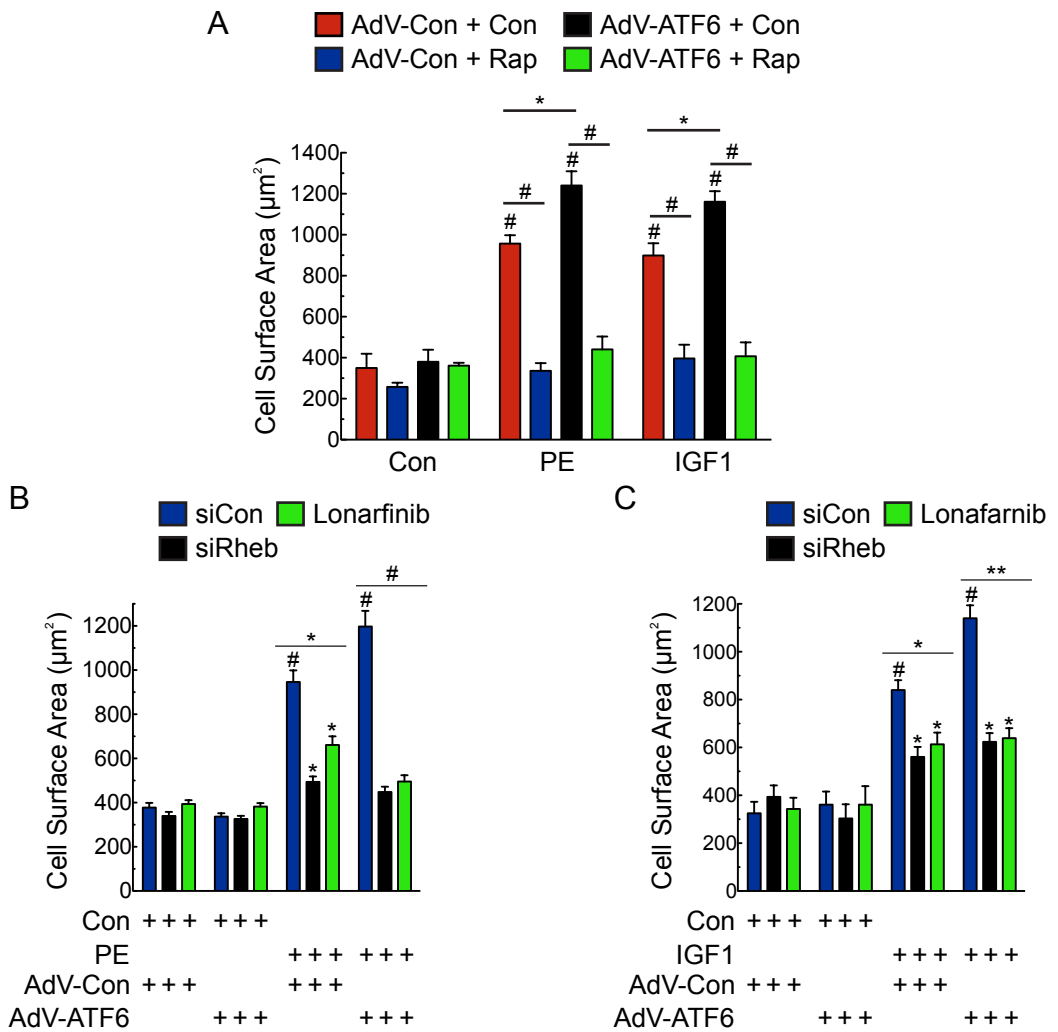
Online Figure III. Effects of ATF6 deletion on regulators of the mTORC1 pathway in hearts of mice subjected to TAC: A, Immunoblot of TSC2, AKT, and ERK1/2 protein phosphorylation and expression in LV extracts from Con or ATF6 cKO mice after 7 days of Sham or TAC. **B**, Calcineurin activity as measured by free-phosphate release in LV extracts from Con or ATF6 cKO mice after 7 days of Sham or TAC. Data are represented as mean \pm s.e.m. [#] $P \leq 0.001$.



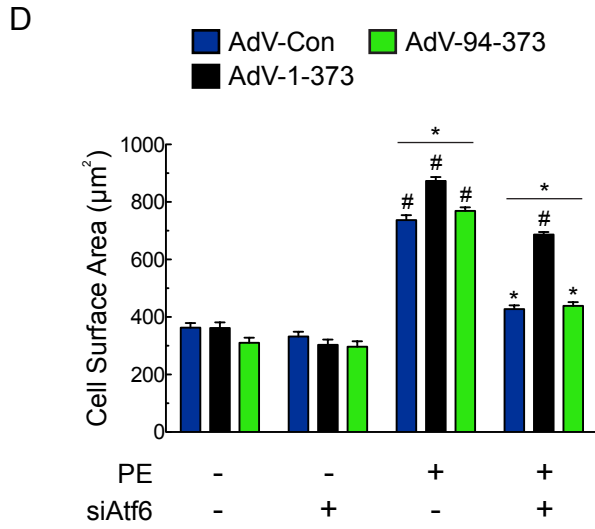
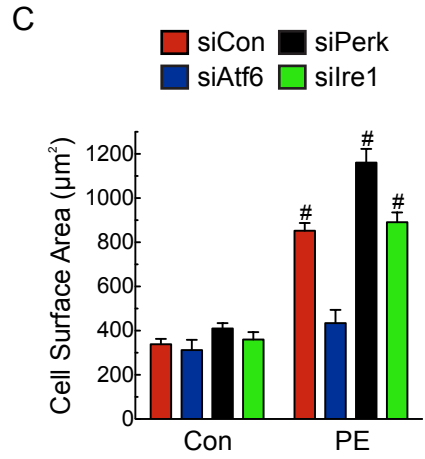
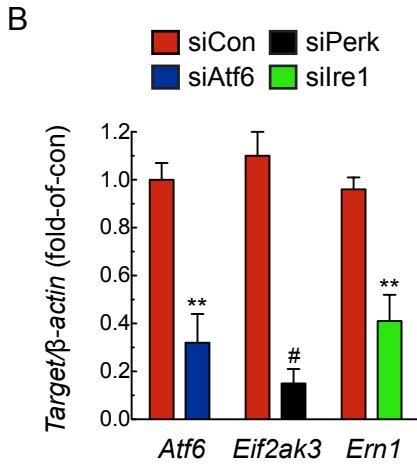
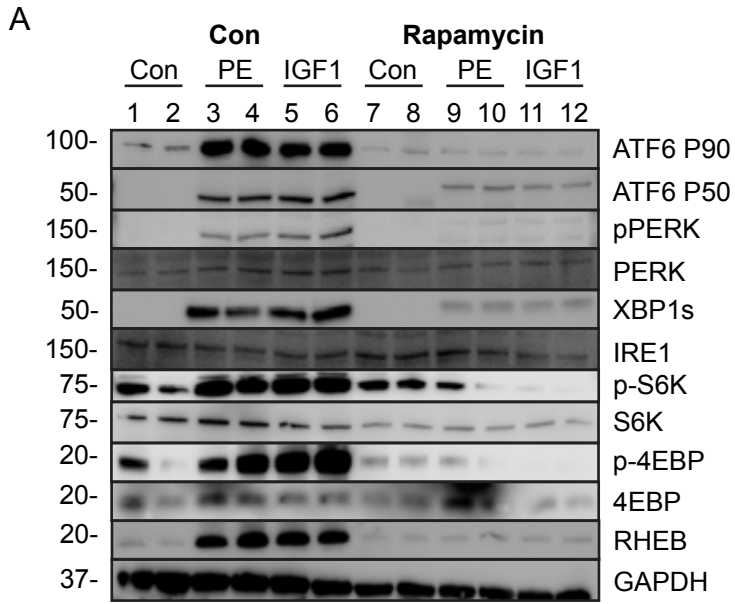
Online Figure IV. Effect of ATF6 and RHEB knockdown on the mTORC1 pathway at cardiac myocyte hypertrophy: **A-E**, NRVM were transfected with a nontargeted siRNA (siCon) or siRNAs targeted to rat ATF6 (siAtf6) or RHEB (siRheb), and then treated with or without phenylephrine (PE; 50 μ M) or IGF1 (100ng/ml) for 48 hours. **A**, **B**, Incorporation of ³H-leucine into TCA-precipitable protein in NRVM extracts was measured by scintillation counting. **E**, mRNA for ATF6 target genes was determined by qRT-PCR in coordination with target genes presented in Figure 4E. **D**, **E**, Immunoblot of NRVM. Phosphorylation of AKT on Ser473 is indicative of mTORC2 activity. Data are represented as mean \pm s.e.m. *P \leq 0.05, **P \leq 0.01, #P \leq 0.001.



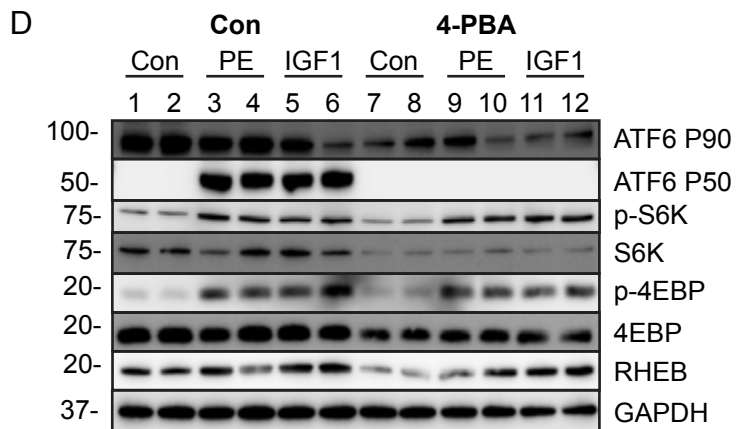
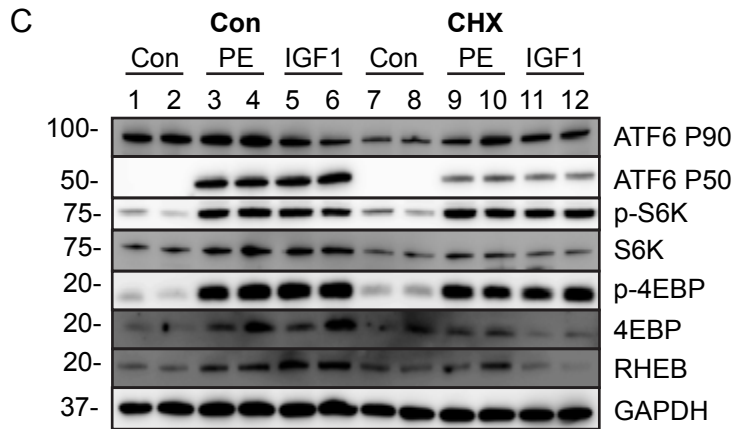
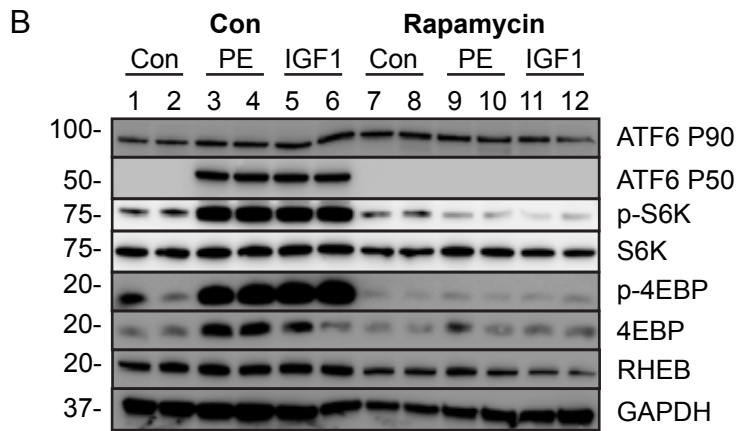
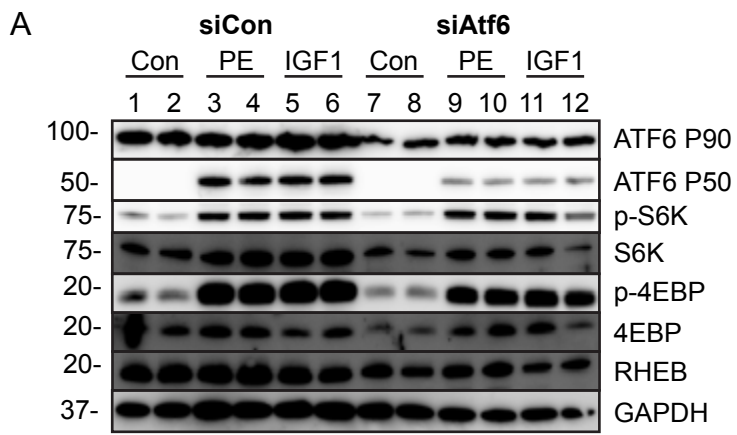
Online Figure V. Rheb-inhibitor, Lonafarnib, inhibition of cardiac myocyte hypertrophy: A-C, NRVM were treated with or without PE (50 μ M) for 48 hours in the presence or absence of the Rheb inhibitor, Lonafarnib (2 μ M). **A**, Incorporation of ³H-leucine into TCA-precipitable protein in NRVM extracts was measured by scintillation counting. **B**, ICF of NRVM stained for α -actinin (blue) and TOPRO-3 (red). Bar = 50 μ m. **C**, Immunoblot of NRVM. **D-E**, NRVM were treated with or without IGF1 (100ng/ml) for 48 hours in the presence or absence of the Rheb inhibitor, Lonafarnib (2 μ M). **D**, Incorporation of ³H-leucine into TCA-precipitable protein in NRVM extracts was measured by scintillation counting. **E**, ICF of NRVM stained for α -actinin (blue) and TOPRO-3 (red). Bar = 50 μ m. Data are represented as mean \pm s.e.m. *P \leq 0.05, **P \leq 0.01.



Online Figure VI. Effect of ATF6 overexpression on cardiac myocyte hypertrophy:
A, NRVM were infected with AdV encoding control or FLAG-ATF6(1-373) [active form] and then treated with or without phenylephrine (PE; 50µM) or IGF1 (100ng/ml), with or without rapamycin (20nM) for 48 hours, as shown. Cell surface area was determined by photomicroscopy and morphometry, then expressed as mean ± s.e.m after analyzing at least 100 cells per treatment per experiment. **B-C**, NRVM were transfected with a non-targeted siRNA (siCon) or siRNA targeted to rat RHEB (siRheb), and then infected with AdV encoding control or FLAG-ATF6(1-373) [active form]. NRVM were then treated with or without phenylephrine (PE; 50µM) (**B**) or IGF1 (100ng/ml) (**C**) with or without Lonarfinib (2µM) for 48 hours, as shown. Data are represented as mean ± s.e.m. *P ≤ 0.05, **P ≤ 0.01, #P ≤ 0.001.



Online Figure VII. mTORC1-dependent activation of the UPR during cardiac myocyte hypertrophy: A, Immunoblot of NRVM after treatment with or without phenylephrine (PE; 50 μ M) or IGF1 (100ng/ml), with or without rapamycin (20nM) for 48 hours, as shown. **B, C**, NRVM were transfected with siCon or siRNAs targeted to rat ATF6 (siAtf6), PERK (siPerk), or IRE1 (silre1) and then treated with or without phenylephrine (PE; 50 μ M) for 48 hours. Atf6, Perk (Eif2ak3) and Ire1 (Ern1) mRNA levels were determined by qRT-PCR (**B**), and cell surface area was determined by photomicroscopy and morphometry (**C**). **D**, NRVM were transfected with a nontargeted siRNA (siCon) or siRNA targeted to rat ATF6 (siAtf6) and were then infected with AdV encoding control, FLAG-ATF6(1-373) [active] or FLAG-ATF6(94-373) [inactive due to deletion of transcriptional activation domain], then treated with or without phenylephrine (PE; 50 μ M) for 48 hours. Cell surface area was determined by photomicroscopy and morphometry, then expressed as mean \pm s.e.m after analyzing at least 100 cells per treatment per experiment. Data are represented as mean \pm s.e.m. *P \leq 0.05, **P \leq 0.05, #P \leq 0.001.



Online Figure VIII. Protein synthesis-dependent activation of the UPR during cardiac myocyte hypertrophy: **A**, Immunoblot of NRVM transfected with a nontargeted siRNA (siCon) or with siRNA targeted to rat ATF6 (siAtf6) and then treated with or without phenylephrine (PE; 50 μ M) or IGF1 (100ng/ml) for 6 hours. **B**, Immunoblot of NRVM after treatment with or without phenylephrine (PE; 50 μ M) or IGF1 (100ng/ml), with or without rapamycin (20nM) for 6 hours, as shown. **C**, Immunoblot of NRVM after co-treatment with or without cyclohexamide (CHX; 100 μ g/ml) and either phenylephrine (PE; 50 μ M) or IGF1 (100ng/ml) for 6 hours. **D**, Immunoblot of NRVM after pretreatment with 4-phenylbutyrate (4-PBA; 100 μ M) for 24 hours and subsequent co-treatment with or without 4-PBA (100 μ M) and either phenylephrine (PE; 50 μ M) or IGF1 (100ng/ml) for an additional 6 hours.

Table I: 7-day TAC echocardiographic parameters for Con and ATF6 cKO mice

	Con Sham (n = 5)	ATF6 cKO Sham (n = 5)	Con TAC (n = 5)	ATF6 cKO TAC (n = 6)
FS (%)	30.40±1.91	26.71±2.31	28.28±1.89	16.12±1.41 ^{1,2}
EF (%)	58.60±2.72	52.64±3.72	55.46±2.86	34.30±2.74 ^{1,2}
LVEDV (μl)	53.75±5.29	62.55±4.99	51.26±2.23	68.32±5.21 ²
LVESV (μl)	22.47±3.07	30.08±3.98	22.83±1.80	45.35±4.73 ²
LVIDD (mm)	3.56±0.15	3.80±0.13	3.51±0.06	3.95±0.13 ²
LVIDS (mm)	2.48±0.14	2.80±0.16	2.52±0.08	3.32±0.15 ^{1,2}
PWTD (mm)	0.86±0.13	0.89±0.15	1.51±0.11 ¹	1.01±0.10 ²
PWTS (mm)	1.17±0.10	1.04±0.12	1.76±0.10 ¹	1.07±0.11 ²
AWTD (mm)	0.88±0.07	0.76±0.05	1.40±0.08 ¹	0.97±0.07 ^{1,2}
AWTS (mm)	1.08±0.04	1.02±0.08	1.72±0.03 ¹	1.10±0.07 ²
HR (bpm)	519±13.27	540±2.63	524±3.71	523±13.47
DPLR (RC/LC)	0.91±0.05	1.11±0.08	4.56±0.25 ¹	4.85±0.34 ¹
HW (mg)	118.98±5.41	120.62±3.35	183.36±6.14 ¹	154.08±3.09 ^{1,2}
BW (g)	21.57±0.78	23.85±0.80	25.78±0.64 ¹	24.43±0.59
TL (mm)	16.40±0.24	17.40±0.24	17.40±0.24	17.00±0.00
HW/BW (mg/g)	5.53±0.27	5.06±0.08	7.12±0.20 ¹	6.32±0.16 ^{1,2}
HW/TL (mg/mm)	7.26±0.33	6.93±0.11	10.53±0.25 ¹	9.06±0.18 ^{1,2}

FS = fractional shortening

EF = ejection fraction

LVEDV = left ventricular end diastolic volume

LVESV = left ventricular end systolic volume

LVIDD = left ventricular inner diameter in diastole

LVIDS = left ventricular inner diameter in systole

PWTD = left ventricular posterior wall thickness in diastole

PWTS = left ventricular posterior wall thickness in systole

AWTD = left ventricular anterior wall thickness in diastole

AWTS = left ventricular anterior wall thickness in systole

HR = heart rate in beats per minute

DPLR = Doppler ratio of right carotid blood flow velocity to left carotid blood flow velocity

HW = heart weight

BW = body weight

TL = tibia length

HW/BW = heart weight/body weight

HW/TL = heart weight/tibia length

Statistical analyses used a one-way ANOVA with a Newman-Keuls post-hoc analysis.

¹ = $p \leq 0.05$ different from respective Sham

² = $p \leq 0.05$ different from Con TAC

Table II: 4-week Free Wheel echocardiographic parameters for Con and ATF6 cKO mice

	Con Sedentary (n = 5)	ATF6 cKO Sedentary (n = 5)	Con Run (n = 5)	ATF6 cKO Run (n = 5)
FS (%)	29.19±1.46	24.22±1.64	29.24±1.74	23.03±1.75 ²
EF (%)	56.42±2.33	48.55±2.70	57.06±2.74	46.53±3.00 ²
LVEDV (μl)	79.56±16.48	72.38±6.33	50.38±7.60	71.78±5.85 ²
LVESV (μl)	35.29±7.76	37.64±4.35	22.29±3.93	38.54±4.11 ²
LVIDD (mm)	4.13±0.40	4.04±0.15	3.44±0.24	4.03±0.14 ²
LVIDS (mm)	2.93±0.30	3.07±0.16	2.45±0.21	3.10±0.14 ²
PWTD (mm)	0.75±0.14	0.89±0.14	1.77±0.11 ¹	0.79±0.03 ²
PWTS (mm)	1.08±0.08	1.21±0.15	2.06±0.08 ¹	1.08±0.04 ²
AWTD (mm)	0.81±0.06	0.84±0.07	1.22±0.08 ¹	0.96±0.09 ²
AWTS (mm)	1.11±0.03	1.14±0.05	1.48±0.07 ¹	1.09±0.07 ²
HR (bpm)	491±9.28	500±9.36	506±9.11	556±8.70 ^{1,2}
DIST (km/wk)	n/a	n/a	8.11±1.79	8.65±0.87
HW (mg)	132.02±4.51	128.32±7.28	171.16±5.24 ¹	137.02±1.40 ²
BW (g)	27.23±0.51	25.14±0.90	24.80±0.66 ¹	24.43±0.43
TL (mm)	17.00±0.00	17.20±0.20	17.20±0.20	17.60±0.24
HW/BW (mg/g)	4.85±0.14	5.09±0.16	6.90±0.13 ¹	5.61±0.09 ^{1,2}
HW/TL (mg/mm)	7.77±0.27	7.46±0.42	9.96±0.35 ¹	7.79±0.11 ²

FS = fractional shortening

EF = ejection fraction

LVEDV = left ventricular end diastolic volume

LVESV = left ventricular end systolic volume

LVIDD = left ventricular inner diameter in diastole

LVIDS = left ventricular inner diameter in systole

PWTD = left ventricular posterior wall thickness in diastole

PWTS = left ventricular posterior wall thickness in systole

AWTD = left ventricular anterior wall thickness in diastole

AWTS = left ventricular anterior wall thickness in systole

HR = heart rate in beats per minute

DIST = average distance ran per week

HW = heart weight

BW = body weight

TL = tibia length

HW/BW = heart weight/body weight

HW/TL = heart weight/tibia length

Statistical analyses used a one-way ANOVA with a Newman-Keuls post-hoc analysis.

¹ = $p \leq 0.05$ different from respective Sedentary

² = $p \leq 0.05$ different from Con Run

Online Table III - Genes Changed by ATF6 in the Heart

		p < 0.05	
Gene No.	Gene Symbol	ENSEMBL ID	log ₂ FC
1	Derl3	ENSMUSG00000009092	11.81357136
2	Bmp10	ENSMUSG00000030046	10.08553123
3	Serpib1c	ENSMUSG00000079049	9.474748328
4	Esr1	ENSMUSG00000019768	9.008620439
5	Saa3	ENSMUSG00000040026	8.404639259
6	Rec8	ENSMUSG00000002324	7.080680613
7	Gm8424	ENSMUSG00000081194	6.43393998
8	Sdf2l1	ENSMUSG00000022769	6.422401383
9	Vmn2r3	ENSMUSG00000091572	6.388726375
10	Gm1627	ENSMUSG00000100987	6.167009426
11	Slc7a11	ENSMUSG00000027737	6.022939919
12	Epyc	ENSMUSG00000019936	5.970480515
13	Far1	ENSMUSG00000030759	5.898776763
14	Myl7	ENSMUSG00000020469	5.765310795
15	Ube2c	ENSMUSG00000001403	5.703447206
16	Arntl	ENSMUSG00000055116	5.68993575
17	Pdia4	ENSMUSG00000025823	5.653529589
18	Mthfd2	ENSMUSG00000005667	5.640699455
19	Slc6a2	ENSMUSG00000055368	5.588147698
20	Slc7a3	ENSMUSG00000031297	5.585746991
21	Pak3	ENSMUSG00000031284	5.576617158
22	Chil3	ENSMUSG00000040809	5.544097671
23	Mybphl	ENSMUSG00000068745	5.418282086
24	Pycr1	ENSMUSG00000025140	5.415421318
25	Mefv	ENSMUSG00000022534	5.273792403
26	Psat1	ENSMUSG00000024640	5.200998995
27	Serpina3f	ENSMUSG00000066363	5.179387737
28	Baalc	ENSMUSG00000022296	5.165927848
29	Myl4	ENSMUSG00000061086	5.142184528
30	Sln	ENSMUSG00000042045	5.062686483
31	Ptx3	ENSMUSG00000027832	5.060941359
32	Prkcz	ENSMUSG00000029053	5.04750561
33	Gm33474	ENSMUSG00000106554	4.984196961
34	Acox2	ENSMUSG00000021751	4.824390864
35	Phgdh	ENSMUSG00000053398	4.816582392
36	Ptprt	ENSMUSG00000053141	4.730415496
37	Manf	ENSMUSG00000032575	4.726713953
38	Asns	ENSMUSG00000029752	4.620079425
39	Gm11382	ENSMUSG00000074973	4.614035415
40	Polr3k	ENSMUSG00000038628	4.549235916
41	Tnni1	ENSMUSG00000026418	4.526836544
42	Cxcl5	ENSMUSG00000029371	4.443899107
43	Tubb3	ENSMUSG00000062380	4.421978788

44	Tk1	ENSMUSG00000025574	4.417099686
45	Mlana	ENSMUSG00000024806	4.402834241
46	Ccl2	ENSMUSG00000035385	4.389626965
47	Selp	ENSMUSG00000026580	4.375541912
48	P4hb	ENSMUSG00000025130	4.375151476
49	Gabrg3	ENSMUSG00000055026	4.295137994
50	Mcoln2	ENSMUSG00000011008	4.238921524
51	Timp1	ENSMUSG00000001131	4.214956842
52	7530428D23Rik	ENSMUSG000000103441	4.200585247
53	Mmp12	ENSMUSG00000049723	4.177679228
54	Sphkap	ENSMUSG00000026163	4.144898204
55	Bmp3	ENSMUSG00000029335	4.139366775
56	Il1rn	ENSMUSG00000026981	4.091671943
57	Hsp90b1	ENSMUSG00000020048	4.073873276
58	Clec4e	ENSMUSG00000030142	4.040821306
59	Prkc2	ENSMUSG000000108314	4.038600449
60	Dok5	ENSMUSG00000027560	3.978150578
61	E2f1	ENSMUSG00000027490	3.975272909
62	Hp	ENSMUSG00000031722	3.959608332
63	Hyou1	ENSMUSG00000032115	3.944982062
64	Fgf12	ENSMUSG00000022523	3.939196334
65	Sycp2	ENSMUSG00000060445	3.935533061
66	Gdf15	ENSMUSG00000038508	3.934450583
67	Rbm15b	ENSMUSG00000074102	3.931228987
68	Spp1	ENSMUSG00000029304	3.740713979
69	Ccl7	ENSMUSG00000035373	3.738093438
70	Tmem163	ENSMUSG00000026347	3.731074518
71	Gm7967	ENSMUSG000000100009	3.730896653
72	Adamts4	ENSMUSG00000006403	3.718658173
73	Xrcc3	ENSMUSG00000021287	3.706565382
74	Cxcr6	ENSMUSG00000048521	3.700892285
75	Plac8	ENSMUSG00000029322	3.680345573
76	Crel2	ENSMUSG00000023272	3.666193145
77	Tnc	ENSMUSG00000028364	3.591714397
78	Rxfp1	ENSMUSG00000034009	3.535189978
79	Tnfsf18	ENSMUSG00000066755	3.524499913
80	Ereg	ENSMUSG00000029377	3.416991129
81	Gm7901	ENSMUSG000000101431	3.414907051
82	Cxcl10	ENSMUSG00000034855	3.389971448
83	Card14	ENSMUSG00000013483	3.357137465
84	Aldh18a1	ENSMUSG00000025007	3.34458723
85	Dnajb11	ENSMUSG00000004460	3.343407519
86	Gm15344	ENSMUSG00000084899	3.294729535
87	Slc2a6	ENSMUSG00000036067	3.284007038
88	Ccr2	ENSMUSG00000049103	3.277942748
89	Cyp2e1	ENSMUSG00000025479	3.272304905
90	Lrp8	ENSMUSG00000028613	3.2721959

91	Socs3	ENSMUSG00000053113	3.254763524
92	Hspa5	ENSMUSG00000026864	3.226595312
93	Tspyl2	ENSMUSG00000041096	3.182915422
94	Nxpe5	ENSMUSG00000047592	3.170840319
95	Slc27a3	ENSMUSG00000027932	3.160858267
96	Ch25h	ENSMUSG00000050370	3.156766066
97	Lman1l	ENSMUSG00000056271	3.086917291
98	Hn1l	ENSMUSG00000024165	3.058111074
99	D030028A08Rik	ENSMUSG00000078700	3.024411342
100	Trib3	ENSMUSG00000032715	3.01669847
101	Oip5	ENSMUSG00000072980	3.007680092
102	Calr	ENSMUSG00000003814	3.002423682
103	Ptrh1	ENSMUSG00000053746	2.996601041
104	Sel1l	ENSMUSG00000020964	2.984189709
105	Pgp	ENSMUSG00000043445	2.977330198
106	Fhl1	ENSMUSG00000023092	2.962677997
107	Hspa1a	ENSMUSG00000091971	2.946993662
108	Akr1b3	ENSMUSG00000001642	2.926261072
109	Aldh1a2	ENSMUSG00000013584	2.923052074
110	Gm37006	ENSMUSG00000103885	2.917999382
111	Slfn4	ENSMUSG00000000204	2.911860183
112	Gm10097	ENSMUSG00000096553	2.910195446
113	F10	ENSMUSG00000031444	2.898660594
114	Gm12138	ENSMUSG00000082087	2.871691575
115	Cdkn2b	ENSMUSG00000073802	2.859130135
116	4732465J04Rik	ENSMUSG00000101517	2.838500759
117	Mt2	ENSMUSG00000031762	2.836149018
118	Serpina3n	ENSMUSG00000021091	2.821965398
119	Cilp2	ENSMUSG00000044006	2.806837587
120	Elk1	ENSMUSG00000009406	2.803602336
121	Ints3	ENSMUSG00000027933	2.794929571
122	Gm6644	ENSMUSG00000100309	2.788194109
123	2610028H24Rik	ENSMUSG00000009114	2.776943846
124	Lmntd1	ENSMUSG00000054966	2.766244614
125	B230217C12Rik	ENSMUSG00000050538	2.760138761
126	Sele	ENSMUSG00000026582	2.753570014
127	Ebp	ENSMUSG00000031168	2.744096448
128	Alkbh2	ENSMUSG00000044339	2.704625956
129	Gm6736	ENSMUSG00000071414	2.697352753
130	Fgr	ENSMUSG00000028874	2.688598098
131	Eda2r	ENSMUSG00000034457	2.682140385
132	Serpina3g	ENSMUSG00000041481	2.656149339
133	Itgax	ENSMUSG00000030789	2.646619905
134	Hspa1b	ENSMUSG00000090877	2.614593952
135	Stbd1	ENSMUSG00000047963	2.612770661
136	Slc7a5	ENSMUSG00000040010	2.611412306
137	Fanca	ENSMUSG00000032815	2.600943825

138	Gpr141	ENSMUSG00000053101	2.599376007
139	Myc	ENSMUSG00000022346	2.593094825
140	Gm9768	ENSMUSG00000108391	2.589201067
141	Serpina9	ENSMUSG00000058260	2.569835526
142	H2-Ke6	ENSMUSG00000073422	2.539940112
143	B430219N15Rik	ENSMUSG00000085211	2.535694452
144	Lgals3	ENSMUSG00000050335	2.519191675
145	Pilra	ENSMUSG00000046245	2.516259782
146	Dolpp1	ENSMUSG00000026856	2.514853363
147	Gm43660	ENSMUSG00000107352	2.505444971
148	Gm3571	ENSMUSG00000090610	2.49879397
149	Pdia6	ENSMUSG00000020571	2.490430091
150	Ppp1r3d	ENSMUSG00000049999	2.480900989
151	Shisa6	ENSMUSG00000053930	2.47963875
152	Tnfrsf12a	ENSMUSG00000023905	2.479420744
153	Fos	ENSMUSG00000021250	2.471681076
154	C920009B18Rik	ENSMUSG00000097352	2.461909181
155	Cpne5	ENSMUSG00000024008	2.456456201
156	Gm4841	ENSMUSG00000068606	2.452944216
157	Tfec	ENSMUSG00000029553	2.45290359
158	Cenpw	ENSMUSG00000075266	2.449517084
159	Tlr1	ENSMUSG00000044827	2.449281283
160	Gm24305	ENSMUSG00000095590	2.445442278
161	Gtse1	ENSMUSG00000022385	2.431922128
162	Gm29040	ENSMUSG00000099576	2.428158893
163	Rab26os	ENSMUSG00000093565	2.423793102
164	Arf2	ENSMUSG00000062421	2.42044934
165	Dnajc3	ENSMUSG00000022136	2.41721018
166	Cdk2ap2	ENSMUSG00000024856	2.41009384
167	1200007C13Rik	ENSMUSG00000087684	2.390563475
168	Clec4d	ENSMUSG00000030144	2.384137488
169	Cdkn1a	ENSMUSG00000023067	2.375206669
170	Hmox1	ENSMUSG00000005413	2.374030372
171	Ddias	ENSMUSG00000030641	2.3659262
172	Csf2rb2	ENSMUSG00000071714	2.362173452
173	2210407C18Rik	ENSMUSG00000037145	2.360698164
174	Dkk3	ENSMUSG00000030772	2.36049145
175	Gm26606	ENSMUSG00000097337	2.358506742
176	Lrrc71	ENSMUSG00000023084	2.338508612
177	Xbp1	ENSMUSG00000020484	2.336362417
178	Ncam1	ENSMUSG00000039542	2.332206947
179	Cxcl1	ENSMUSG00000029380	2.332199941
180	Gprin3	ENSMUSG00000045441	2.317360823
181	Sept5	ENSMUSG00000072214	2.313294592
182	Syvn1	ENSMUSG00000024807	2.306530263
183	Egr2	ENSMUSG00000037868	2.304716168
184	Thbs1	ENSMUSG00000040152	2.295796614

185	Kcnc3	ENSMUSG00000062785	2.290653415
186	Kifc1	ENSMUSG00000079553	2.287334021
187	Gale	ENSMUSG00000028671	2.284048043
188	Nans	ENSMUSG00000028334	2.275578636
189	Nusap1	ENSMUSG00000027306	2.255037554
190	Rcan1	ENSMUSG00000022951	2.212202653
191	Slfn1	ENSMUSG00000078763	2.212112935
192	Gm17709	ENSMUSG00000091952	2.209253708
193	Avil	ENSMUSG00000025432	2.201618781
194	Mvd	ENSMUSG00000006517	2.199845318
195	Unc5c	ENSMUSG00000059921	2.196062762
196	Sesn2	ENSMUSG00000028893	2.195520396
197	Cdca3	ENSMUSG00000023505	2.191457262
198	Napsa	ENSMUSG00000002204	2.188994743
199	Chka	ENSMUSG00000024843	2.186135159
200	Zfp850	ENSMUSG00000096916	2.184406999
201	2200002D01Rik	ENSMUSG00000030587	2.182975708
202	Tbcb	ENSMUSG00000006095	2.182783885
203	Cenpk	ENSMUSG00000021714	2.180064742
204	Ormdl2	ENSMUSG00000025353	2.177591587
205	Clec4n	ENSMUSG00000023349	2.172999515
206	2810474O19Rik	ENSMUSG00000032712	2.169593649
207	Ms4a4c	ENSMUSG00000024675	2.169515604
208	Nde1	ENSMUSG00000022678	2.146751019
209	Serpina3i	ENSMUSG00000079014	2.138122645
210	Asf1b	ENSMUSG00000005470	2.137415133
211	Ears2	ENSMUSG00000030871	2.137228298
212	Gpr35	ENSMUSG00000026271	2.134014304
213	Junb	ENSMUSG00000052837	2.133716588
214	Spc25	ENSMUSG00000005233	2.129056067
215	Dmxl1	ENSMUSG00000037416	2.127947217
216	Msr1	ENSMUSG00000025044	2.126320408
217	Wfs1	ENSMUSG00000039474	2.121447861
218	Uck2	ENSMUSG00000026558	2.113344049
219	Zfp324	ENSMUSG00000004500	2.097824653
220	Adam8	ENSMUSG00000025473	2.09172395
221	Ccl12	ENSMUSG00000035352	2.08771107
222	Kctd8	ENSMUSG00000037653	2.078933632
223	Ntng2	ENSMUSG00000035513	2.064808181
224	Sfrp5	ENSMUSG00000018822	2.061985858
225	Pdia3	ENSMUSG00000027248	2.058758685
226	Sh2d5	ENSMUSG00000045349	2.053762515
227	Adamts15	ENSMUSG00000033453	2.051962365
228	Slamf8	ENSMUSG00000053318	2.041095586
229	Lad1	ENSMUSG00000041782	2.039938823
230	Nlrp3	ENSMUSG00000032691	2.034710962
231	Gm10130	ENSMUSG00000095315	2.026437197

232	Eif1a	ENSMUSG00000057561	2.022963037
233	Samsn1	ENSMUSG00000022876	2.017177449
234	Ankrd42	ENSMUSG00000041343	2.015608579
235	Morf4l2	ENSMUSG00000031422	2.003946107
236	Slc6a9	ENSMUSG00000028542	2.002328136
237	Xlr3b	ENSMUSG00000073125	2.002130317
238	Piga	ENSMUSG00000031381	2.001658825
239	Nfil3	ENSMUSG00000056749	1.997276455
240	1500015O10Rik	ENSMUSG00000026051	1.981376136
241	Aldh1l2	ENSMUSG00000020256	1.980183895
242	Tpx2	ENSMUSG00000027469	1.979014627
243	Slc20a1	ENSMUSG00000027397	1.978291357
244	Blvrb	ENSMUSG00000040466	1.971647348
245	Hist1h2ab	ENSMUSG00000061615	1.970698593
246	Bex1	ENSMUSG00000050071	1.963875025
247	Tnf	ENSMUSG00000024401	1.963341889
248	Lrrc10b	ENSMUSG00000090291	1.960004863
249	D16Ert472e	ENSMUSG00000022864	1.942668191
250	2900092N22Rik	ENSMUSG000000104034	1.935048799
251	Pnpo	ENSMUSG00000018659	1.933798517
252	Adam12	ENSMUSG00000054555	1.920686384
253	Btg2	ENSMUSG00000020423	1.919087802
254	Chad	ENSMUSG00000039084	1.916603137
255	Idi1	ENSMUSG00000058258	1.911564895
256	M6pr-ps	ENSMUSG00000080832	1.907252581
257	Rtn4	ENSMUSG00000020458	1.890110721
258	Stx11	ENSMUSG00000039232	1.877917576
259	Vcp-rs	ENSMUSG00000083327	1.866506145
260	2700038G22Rik	ENSMUSG00000097180	1.857497369
261	Rnd1	ENSMUSG00000054855	1.856688099
262	Serpinh1	ENSMUSG00000070436	1.856610681
263	Vcp	ENSMUSG00000028452	1.854155205
264	Tubb4b-ps2	ENSMUSG00000099997	1.853558273
265	AW011738	ENSMUSG00000078349	1.840325275
266	Pin1	ENSMUSG00000032171	1.829870336
267	Pcdh11x	ENSMUSG00000034755	1.829636281
268	Mettl27	ENSMUSG00000040557	1.827642833
269		ENSMUSG00000064168	1.824874552
270	Adamts8	ENSMUSG00000031994	1.822492136
271	Nfkbid	ENSMUSG00000036931	1.821751403
272	Nhp2	ENSMUSG00000001056	1.821565655
273	Icam4	ENSMUSG00000001014	1.816106568
274	Ginm1	ENSMUSG00000040006	1.811234451
275	Cd44	ENSMUSG00000005087	1.806952418
276	Tenm4	ENSMUSG00000048078	1.806469533
277	Ccnf	ENSMUSG00000072082	1.79495856
278	Gm28187	ENSMUSG00000099375	1.790163645

279	AI506816	ENSMUSG00000105987	1.786008502
280	Tnfaip2	ENSMUSG00000021281	1.780321378
281	Gas2l3	ENSMUSG00000074802	1.776794858
282	Hsf2bp	ENSMUSG00000002076	1.776085215
283	Fasn	ENSMUSG00000025153	1.772576521
284	Rhoq	ENSMUSG00000024143	1.77164729
285	Zfp469	ENSMUSG00000043903	1.764803209
286	Rrp12	ENSMUSG00000035049	1.764797566
287	B3gnt5	ENSMUSG00000022686	1.763194956
288	Sqle	ENSMUSG00000022351	1.74614843
289	Gm44193	ENSMUSG00000107559	1.744119957
290	2700078F05Rik	ENSMUSG00000103722	1.74092107
291	Atf3	ENSMUSG00000026628	1.736691794
292	Dusp5	ENSMUSG00000034765	1.735880351
293	Armc7	ENSMUSG00000057219	1.7290977
294	Myrf1	ENSMUSG00000034057	1.72736617
295	BC022687	ENSMUSG00000037594	1.724962995
296	Uchl1	ENSMUSG00000029223	1.723117731
297	Mybl1	ENSMUSG00000025912	1.712405563
298	Snhg15	ENSMUSG00000085156	1.708595817
299	Trmt61a	ENSMUSG00000060950	1.700813943
300	Engase	ENSMUSG00000033857	1.700119749
301	Gm14857	ENSMUSG00000081289	1.695715714
302	Slc2a8	ENSMUSG00000026791	1.69467734
303	Hagh	ENSMUSG00000024158	1.694606394
304	Txnrd1	ENSMUSG00000020250	1.692519589
305	Cfp	ENSMUSG00000001128	1.688643231
306	Vwc2	ENSMUSG00000050830	1.68668911
307	Fam167a	ENSMUSG00000035095	1.686618007
308	Itgam	ENSMUSG00000030786	1.682160168
309	Ddit3	ENSMUSG00000025408	1.681542641
310	Map3k3	ENSMUSG00000020700	1.675749333
311	Pvt1	ENSMUSG00000097039	1.675264628
312	Bcl3	ENSMUSG00000053175	1.673181926
313	Cenpi	ENSMUSG00000031262	1.673171107
314	Slc1a4	ENSMUSG00000020142	1.672319322
315	Loxl4	ENSMUSG00000025185	1.66021152
316	Birc5	ENSMUSG00000017716	1.655877869
317	Emb	ENSMUSG00000021728	1.650733426
318	Sbno2	ENSMUSG00000035673	1.650593127
319	Ubald2	ENSMUSG00000050628	1.650501705
320	Chac1	ENSMUSG00000027313	1.646133269
321	Fst	ENSMUSG00000021765	1.646130913
322	Klra2	ENSMUSG00000030187	1.645709693
323	Uggt1	ENSMUSG00000037470	1.644961843
324	Mmp3	ENSMUSG00000043613	1.642238674
325	Gm9260	ENSMUSG00000106239	1.638809044

326	Csf2rb	ENSMUSG00000071713	1.638798976
327	Arid4a	ENSMUSG00000048118	1.637927577
328	Mpv17l2	ENSMUSG00000035559	1.637687304
329	Egr1	ENSMUSG00000038418	1.633002072
330	Pgk1	ENSMUSG00000062070	1.629109112
331	Trp63	ENSMUSG00000022510	1.62107416
332	Tnni2	ENSMUSG00000031097	1.618747065
333	Cyb5r1	ENSMUSG00000026456	1.609318021
334	Slc17a7	ENSMUSG00000070570	1.604700213
335	Gm42725	ENSMUSG00000105601	1.603763447
336	Igf2bp2	ENSMUSG00000033581	1.600812966
337	Thop1	ENSMUSG00000004929	1.600765487
338	Suco	ENSMUSG00000040297	1.598969712
339	Sertad3	ENSMUSG00000055200	1.598348345
340	Ect2	ENSMUSG00000027699	1.595965295
341	Cd200r1	ENSMUSG00000022667	1.595525098
342	Cdca2	ENSMUSG00000048922	1.595195402
343	Shroom3	ENSMUSG00000029381	1.581363529
344	Cat	ENSMUSG00000027187	1.581206905
345	Isyna1	ENSMUSG00000019139	1.580324046
346	Gclm	ENSMUSG00000028124	1.578931649
347	Tuba1c	ENSMUSG00000043091	1.578448169
348	Ccr1	ENSMUSG00000025804	1.577197402
349	Ckap2	ENSMUSG00000037725	1.570621326
350	E2f8	ENSMUSG00000046179	1.566293037
351	Top2a	ENSMUSG00000020914	1.564537824
352	Gars	ENSMUSG00000029777	1.563576397
353	Pgbd5	ENSMUSG00000050751	1.560744026
354	Gm37018	ENSMUSG00000102950	1.559964399
355	Mxd1	ENSMUSG00000001156	1.559822684
356	2310030G06Rik	ENSMUSG00000032062	1.558835095
357	Gm12092	ENSMUSG00000084850	1.557193143
358	Os9	ENSMUSG00000040462	1.556819869
359	Calu	ENSMUSG00000029767	1.552245573
360	Sptlc2	ENSMUSG00000021036	1.547928702
361	Hmgcs1	ENSMUSG00000093930	1.541408389
362	Plek	ENSMUSG00000020120	1.53988097
363	Pemt	ENSMUSG00000000301	1.539235376
364	Spdl1	ENSMUSG00000069910	1.535588415
365	Appl1	ENSMUSG00000040760	1.534526106
366	Ankrd1	ENSMUSG00000024803	1.532520407
367	Agtrap	ENSMUSG00000029007	1.530067499
368	Odc1	ENSMUSG00000011179	1.529290011
369	Ccl11	ENSMUSG00000020676	1.5290234
370	Gm5526	ENSMUSG00000084817	1.528484975
371	Zfp593	ENSMUSG00000028840	1.525871795
372	Ppib	ENSMUSG00000032383	1.525753398

373	Gm37258	ENSMUSG00000102760	1.522556443
374	Neto2	ENSMUSG00000036902	1.516386822
375	Kpnb1	ENSMUSG00000001440	1.516098943
376	Hist1h3g	ENSMUSG00000099517	1.515072055
377	Cks2	ENSMUSG00000062248	1.50652198
378	Gm37795	ENSMUSG00000102813	1.506341996
379	Pclaf	ENSMUSG00000040204	1.505488381
380	Cdk1	ENSMUSG00000019942	1.502538423
381	B230217O12Rik	ENSMUSG00000097785	1.502532816
382	Cep55	ENSMUSG00000024989	1.502132531
383	Gm13481	ENSMUSG00000086353	1.498347419
384	Clec3a	ENSMUSG00000008874	1.49783155
385	Itga7	ENSMUSG00000025348	1.49235615
386	Cdc6	ENSMUSG00000017499	1.487626593
387	Pirt	ENSMUSG00000048070	1.487265198
388	Vcan	ENSMUSG00000021614	1.484980991
389	Flnc	ENSMUSG00000068699	1.48355526
390	Angptl6	ENSMUSG00000038742	1.483255396
391	Tbccd1	ENSMUSG00000004462	1.480213903
392	Lilrb4a	ENSMUSG00000062593	1.478050587
393	Gm14636	ENSMUSG00000073274	1.477286849
394	Hist2h2ab	ENSMUSG00000063689	1.474500867
395	Gm43499	ENSMUSG00000106739	1.473440243
396	Slc9a7	ENSMUSG00000037341	1.47208978
397	Pmm1	ENSMUSG00000022474	1.469739665
398	Lcp1	ENSMUSG00000021998	1.465687722
399	Togaram2	ENSMUSG00000045761	1.462654704
400	Kcnma1	ENSMUSG00000063142	1.453088907
401	Tubb4b	ENSMUSG00000036752	1.451557295
402	Gm10698	ENSMUSG00000079884	1.45061928
403	Al839979	ENSMUSG00000107355	1.449119566
404	Ccne1	ENSMUSG00000002068	1.447445984
405	Add3	ENSMUSG00000025026	1.447244999
406	Piwil2	ENSMUSG00000033644	1.44722344
407	Hist1h1a	ENSMUSG00000049539	1.446221052
408	Ptpn7	ENSMUSG00000031506	1.445728984
409	Gm42514	ENSMUSG00000105553	1.442490661
410	Ctps	ENSMUSG00000028633	1.438371947
411	Coro1a	ENSMUSG00000030707	1.437823862
412	Rasef	ENSMUSG00000043003	1.437469131
413	Mgl2	ENSMUSG00000040950	1.436187652
414	Mettl1	ENSMUSG00000006732	1.436107039
415	Icam1	ENSMUSG00000037405	1.435857964
416	Tnfaip6	ENSMUSG00000053475	1.435627103
417	Acta2	ENSMUSG00000035783	1.435284206
418	Atf4	ENSMUSG00000042406	1.433688739
419	Copz1	ENSMUSG00000060992	1.430038805

420	Gm5621	ENSMUSG00000057626	1.429304345
421	Cd52	ENSMUSG00000000682	1.428954184
422	1110038B12Rik	ENSMUSG00000092203	1.428291662
423	Spryd3	ENSMUSG00000036966	1.427522411
424	Slc1a2	ENSMUSG00000005089	1.426300546
425	Tubb2a	ENSMUSG00000058672	1.421754195
426	Pold4	ENSMUSG00000024854	1.420881931
427	Wisp1	ENSMUSG00000005124	1.417477785
428	Dpep2	ENSMUSG00000053687	1.41535261
429	Ms4a6d	ENSMUSG00000024679	1.411589263
430	Dtl	ENSMUSG00000037474	1.409796483
431	Siah2	ENSMUSG00000036432	1.408822208
432	Stox2	ENSMUSG00000038143	1.407948117
433	Gadd45g	ENSMUSG00000021453	1.407408956
434	Gm12989	ENSMUSG00000083678	1.404923716
435	Mcm10	ENSMUSG00000026669	1.403036914
436	Shank1	ENSMUSG00000038738	1.401781001
437	Casq1	ENSMUSG00000007122	1.400434602
438	Ddx39	ENSMUSG00000005481	1.39988641
439	Kif4	ENSMUSG00000034311	1.399067027
440	Ssr3	ENSMUSG00000027828	1.398708309
441	Hist1h3b	ENSMUSG00000069267	1.394372841
442	Tfcp2l1	ENSMUSG00000026380	1.393161629
443	Taf13	ENSMUSG00000048100	1.392998942
444	Gm7993	ENSMUSG00000107092	1.388597857
445	Gm45531	ENSMUSG00000110353	1.387891961
446	Gm1966	ENSMUSG00000073902	1.387819539
447	Chek1	ENSMUSG00000032113	1.38723691
448	Sptbn4	ENSMUSG00000011751	1.386241892
449	Rp2	ENSMUSG00000060090	1.385912245
450	Atf5	ENSMUSG00000038539	1.385340179
451	Dcaf11	ENSMUSG00000022214	1.381885962
452	Fam46b	ENSMUSG00000046694	1.378167116
453	Ckap4	ENSMUSG00000046841	1.377983134
454	Ccnb2	ENSMUSG00000032218	1.375884366
455	Slc39a14	ENSMUSG00000022094	1.373201831
456	Gcat	ENSMUSG00000006378	1.372933003
457	Parvg	ENSMUSG00000022439	1.372192156
458	Dlg2	ENSMUSG00000052572	1.371734306
459	Fzd5	ENSMUSG00000045005	1.371696261
460	Fam26e	ENSMUSG00000049872	1.367206577
461	Il33	ENSMUSG00000024810	1.363591102
462	Col8a2	ENSMUSG00000056174	1.363224893
463	Kn1	ENSMUSG00000027326	1.362172771
464	Tubb4b-ps1	ENSMUSG00000095159	1.361518755
465	Gmppb	ENSMUSG00000070284	1.360384561
466	Edem1	ENSMUSG00000030104	1.359504073

467	Xpo1	ENSMUSG00000020290	1.358919462
468	Mmp9	ENSMUSG00000017737	1.354393221
469	B4galt5	ENSMUSG00000017929	1.346974419
470	Prg4	ENSMUSG00000006014	1.342563561
471	Snhg5	ENSMUSG00000097195	1.338052351
472	Gm12250	ENSMUSG00000082292	1.336648238
473	Nr6a1	ENSMUSG00000063972	1.335957529
474	Brca1	ENSMUSG00000017146	1.335918773
475	Rufy4	ENSMUSG00000061815	1.335781939
476	Wdr46	ENSMUSG00000024312	1.335465454
477	Pask	ENSMUSG00000026274	1.335125088
478	Pgk1-rs7	ENSMUSG00000066632	1.333537124
479	Ccl9	ENSMUSG00000019122	1.331399831
480	Gm6158	ENSMUSG00000090381	1.330544091
481	Uhrf1	ENSMUSG00000001228	1.324781216
482	Ush1c	ENSMUSG00000030838	1.319572423
483	Aldh1a3	ENSMUSG00000015134	1.318057841
484	Cdca8	ENSMUSG00000028873	1.317159825
485	Ncf4	ENSMUSG00000071715	1.313516064
486	Fbxo36	ENSMUSG00000073633	1.312734301
487	Col12a1	ENSMUSG00000032332	1.311033634
488	Shisa3	ENSMUSG00000050010	1.311018626
489	Tbrg1	ENSMUSG00000011114	1.311000765
490	Ccr5	ENSMUSG00000079227	1.310358961
491	Gm15328	ENSMUSG00000086095	1.308210775
492	Derl2	ENSMUSG00000018442	1.307259566
493	Pde4b	ENSMUSG00000028525	1.306643448
494	Nr2c2ap	ENSMUSG00000071078	1.304422618
495	Kif9	ENSMUSG00000032489	1.302670479
496	Herpud1	ENSMUSG00000031770	1.302564699
497	Slc41a3	ENSMUSG00000030089	1.30110197
498	Kcnq1ot1	ENSMUSG000000101609	1.300853761
499	Ppa1	ENSMUSG00000020089	1.299245627
500	Pdk3	ENSMUSG00000035232	1.298552717
501	Arid5a	ENSMUSG00000037447	1.297558156
502	F730043M19Rik	ENSMUSG00000052125	1.29514611
503	Atp8b4	ENSMUSG00000060131	1.294764027
504	Eef1e1	ENSMUSG00000001707	1.293534944
505	Dcbld2	ENSMUSG00000035107	1.290393328
506	Spn	ENSMUSG00000051457	1.290033875
507	B4galnt1	ENSMUSG00000006731	1.28891425
508	Msrb1	ENSMUSG00000075705	1.281903924
509	Zfp697	ENSMUSG00000050064	1.279477024
510	Lrrc49	ENSMUSG00000047766	1.276088543
511	Rfx7	ENSMUSG00000037674	1.274375178
512	Rras2	ENSMUSG00000055723	1.273857494
513	B930095G15Rik	ENSMUSG00000085133	1.273024667

514	6430548M08Rik	ENSMUSG00000031824	1.2728817
515	Hs3st3b1	ENSMUSG00000070407	1.272752395
516	Pak4	ENSMUSG00000030602	1.271858364
517	Rpl3-ps1	ENSMUSG00000084349	1.269581012
518	Dcun1d4	ENSMUSG00000051674	1.269561257
519	Tmem189	ENSMUSG00000090213	1.268538681
520	Hcn1	ENSMUSG00000021730	1.268156092
521	Tmem50b	ENSMUSG00000022964	1.267450664
522	Lpin3	ENSMUSG00000027412	1.267349798
523	Wbp1	ENSMUSG00000030035	1.266661045
524	Pim1	ENSMUSG00000024014	1.265560591
525	Ncapg	ENSMUSG00000015880	1.2654372
526	Hectd2os	ENSMUSG00000087579	1.264197733
527	Nipsnap3b	ENSMUSG00000015247	1.263768222
528	G530011O06Rik	ENSMUSG00000072844	1.263713637
529	Esd	ENSMUSG00000021996	1.261243754
530	Otub2	ENSMUSG00000021203	1.259221277
531	Tctn2	ENSMUSG00000029386	1.258207556
532	Mum1l1	ENSMUSG00000042515	1.257306282
533	Npl	ENSMUSG00000042684	1.251704294
534	Slc10a3	ENSMUSG00000032806	1.251594014
535	Nme1	ENSMUSG00000037601	1.248493132
536	Cass4	ENSMUSG00000074570	1.247895241
537	Mfsd12	ENSMUSG00000034854	1.247329755
538	Nppb	ENSMUSG00000029019	1.247247828
539	Mesd	ENSMUSG00000038503	1.245358334
540	Eif2ak3	ENSMUSG00000031668	1.244652688
541	Gm7367	ENSMUSG00000047370	1.237312066
542	Kcnj5	ENSMUSG00000032034	1.236827526
543	Tfg	ENSMUSG00000022757	1.23233869
544	6430710C18Rik	ENSMUSG00000085427	1.231385968
545	Phlda3	ENSMUSG00000041801	1.231236934
546	Rgs7bp	ENSMUSG00000021719	1.228422741
547	Ostc	ENSMUSG00000041084	1.226963586
548	Adat3	ENSMUSG00000035370	1.224450689
549	Mafk	ENSMUSG00000018143	1.224360772
550	Ccna2	ENSMUSG00000027715	1.22429789
551	Stat3	ENSMUSG00000004040	1.220096548
552	Fam122b	ENSMUSG00000036022	1.214434032
553	Usp18	ENSMUSG00000030107	1.213368784
554	Esyt1	ENSMUSG00000025366	1.210954025
555	Alcam	ENSMUSG00000022636	1.210629983
556	Mki67	ENSMUSG00000031004	1.206938756
557	Psm5	ENSMUSG00000068749	1.206060018
558	Cars	ENSMUSG00000010755	1.205057184
559	Spag5	ENSMUSG0000002055	1.205018018
560	Ptgs2	ENSMUSG00000032487	1.203540576

561	Akip1	ENSMUSG00000031023	1.202559927
562	Myh7	ENSMUSG00000053093	1.20046659
563	Trim16	ENSMUSG00000047821	1.200163728
564	Hsp90aa1	ENSMUSG00000021270	1.198763826
565	Zbp1	ENSMUSG00000027514	1.198082831
566	Tfrc	ENSMUSG00000022797	1.197497585
567	Tmem173	ENSMUSG00000024349	1.196917013
568	Rrp9	ENSMUSG00000041506	1.196173589
569	Ccl8	ENSMUSG00000009185	1.195247161
570	Aspm	ENSMUSG00000033952	1.194041169
571	Gm38359	ENSMUSG00000103317	1.193897614
572	Dok2	ENSMUSG00000022102	1.193717167
573	Tyk2	ENSMUSG00000032175	1.190501275
574	Esco2	ENSMUSG00000022034	1.185134026
575	Rpl3	ENSMUSG00000060036	1.183677711
576	Rpl10	ENSMUSG00000008682	1.183173662
577	Cenpn	ENSMUSG00000031756	1.182370776
578	Casp4	ENSMUSG00000033538	1.181148662
579	Gm7332	ENSMUSG00000080875	1.175857669
580	Zbtb3	ENSMUSG00000071661	1.175706805
581	D10Wsu102e	ENSMUSG00000020255	1.175461387
582	Fam72a	ENSMUSG00000055184	1.174842741
583	Gipc1	ENSMUSG00000019433	1.173894119
584	Hspa1l	ENSMUSG00000007033	1.172493484
585	Stt3b	ENSMUSG00000032437	1.170914991
586	Itgb2	ENSMUSG00000000290	1.169997355
587	Arrdc3	ENSMUSG00000074794	1.169678464
588	Nudcd1	ENSMUSG00000038736	1.168817163
589	Pik3r3	ENSMUSG00000028698	1.167333543
590	Ppan	ENSMUSG00000004100	1.166826929
591	Clec11a	ENSMUSG00000004473	1.164850642
592	Nr4a2	ENSMUSG00000026826	1.163633754
593	Trmt10a	ENSMUSG00000004127	1.162878389
594	Plxnb2	ENSMUSG00000036606	1.161690849
595	Gja5	ENSMUSG00000057123	1.160544506
596	Hist1h2af	ENSMUSG00000061991	1.159729615
597	Slc16a6	ENSMUSG00000041920	1.157421983
598	Mdn1	ENSMUSG00000058006	1.157364083
599	Capg	ENSMUSG00000056737	1.156060338
600	Anln	ENSMUSG00000036777	1.156054529
601	Sash3	ENSMUSG00000031101	1.153727702
602	Dbf4	ENSMUSG00000002297	1.15302495
603	Ttf2	ENSMUSG00000033222	1.152826279
604	Gm8394	ENSMUSG00000050490	1.152190004
605	Hck	ENSMUSG00000003283	1.149489868
606	Cage1	ENSMUSG00000044566	1.146471431
607	Knstrn	ENSMUSG00000027331	1.146277923

608	Fzd2	ENSMUSG00000050288	1.145634205
609	Mx1	ENSMUSG00000000386	1.14494589
610	Dstn	ENSMUSG00000015932	1.142341577
611	Tlr2	ENSMUSG00000027995	1.141801924
612	Usp1	ENSMUSG00000028560	1.140379401
613	Prkcsh	ENSMUSG00000003402	1.140233021
614	Ptpre	ENSMUSG00000041836	1.138809485
615	Dph5	ENSMUSG00000033554	1.13657609
616	Srpx	ENSMUSG00000090084	1.134293016
617	Olfm1	ENSMUSG00000026833	1.133848828
618	Heatr1	ENSMUSG00000050244	1.133491875
619	Azin1	ENSMUSG00000037458	1.132883442
620	Rpsa-ps9	ENSMUSG00000082895	1.132775108
621	Ppp1r15a	ENSMUSG00000040435	1.131558837
622	Snhg1	ENSMUSG00000108414	1.130862556
623	Grk3	ENSMUSG00000042249	1.130640537
624	Aurka	ENSMUSG00000027496	1.129311021
625	Ift43	ENSMUSG00000007867	1.127582151
626	Ing1	ENSMUSG00000045969	1.125978778
627	Zfp566	ENSMUSG00000078768	1.125891655
628	Fgl2	ENSMUSG00000039899	1.123987257
629	Pdpm	ENSMUSG00000028583	1.122759466
630	Asb16	ENSMUSG00000034768	1.122276057
631	Aqp4	ENSMUSG00000024411	1.122151756
632	Aars	ENSMUSG00000031960	1.120957875
633	Dusp23	ENSMUSG00000026544	1.11810292
634	Paip2b	ENSMUSG00000045896	1.115897527
635	Gstcd	ENSMUSG00000028018	1.115730709
636	Coq8b	ENSMUSG00000003762	1.115288686
637	Rap2b	ENSMUSG00000036894	1.114326427
638	Cntn2	ENSMUSG00000053024	1.112534684
639	Zmynd19	ENSMUSG00000026974	1.111641171
640	Tmbim1	ENSMUSG00000006301	1.111517063
641	Grk5	ENSMUSG00000003228	1.110747505
642	Tmed2	ENSMUSG00000029390	1.109476899
643	Smyd5	ENSMUSG00000033706	1.102683445
644	Ibtk	ENSMUSG00000035941	1.101475027
645	C330027C09Rik	ENSMUSG00000033031	1.099547502
646	Abca12	ENSMUSG00000050296	1.095786221
647	Vars	ENSMUSG00000007029	1.093832221
648	Sars	ENSMUSG00000068739	1.093735011
649	Map2k3os	ENSMUSG00000042549	1.091347636
650	Gm6210	ENSMUSG00000107951	1.089886298
651	Lmbrd2	ENSMUSG00000039704	1.087412152
652	Stip1	ENSMUSG00000024966	1.086537039
653	Ubfd1	ENSMUSG00000030870	1.085322293
654	Tubb6	ENSMUSG00000001473	1.085001017

655	Ung	ENSMUSG00000029591	1.08455813
656	Socs1	ENSMUSG00000038037	1.083140057
657	Shq1	ENSMUSG00000035378	1.082574401
658	Tiam2	ENSMUSG00000023800	1.082496268
659	Hist1h2ac	ENSMUSG00000069270	1.082203199
660	Nol12	ENSMUSG00000033099	1.082003866
661	Dpy19l1	ENSMUSG00000043067	1.079606873
662	Arrdc4	ENSMUSG00000042659	1.079340688
663	Plk4	ENSMUSG00000025758	1.078923652
664	Avpi1	ENSMUSG00000018821	1.078296992
665	Wdr44	ENSMUSG00000036769	1.077086586
666	Runx1	ENSMUSG00000022952	1.076810666
667	Tmem45a	ENSMUSG00000022754	1.076558315
668	Opn3	ENSMUSG00000026525	1.073604491
669	Ppox	ENSMUSG00000062729	1.073267217
670	Bbc3	ENSMUSG00000002083	1.072287344
671	Iars	ENSMUSG00000037851	1.071964574
672	Gsk3b	ENSMUSG00000022812	1.070813224
673	Clcf1	ENSMUSG00000040663	1.064614037
674	Tesk2	ENSMUSG00000033985	1.063742128
675	Cenpt	ENSMUSG00000036672	1.06146737
676	Ttc41	ENSMUSG00000044937	1.061089629
677	Cdc7	ENSMUSG00000029283	1.059243045
678	Gpatch4	ENSMUSG00000028069	1.05907009
679	Gm12346	ENSMUSG00000083899	1.058665929
680	Has2	ENSMUSG00000022367	1.057616501
681	Pold2	ENSMUSG00000020471	1.056373421
682	Pim2	ENSMUSG00000031155	1.054490917
683	Slc26a2	ENSMUSG00000034320	1.05224895
684	Phkg2	ENSMUSG00000030815	1.052031009
685	Vbp1	ENSMUSG00000031197	1.051255794
686	Bcat1	ENSMUSG00000030268	1.050279226
687	Tmem184c	ENSMUSG00000031617	1.049938119
688	Gm5812	ENSMUSG00000051639	1.048363636
689	Cers6	ENSMUSG00000027035	1.047851043
690	Il17ra	ENSMUSG00000002897	1.047462251
691	Derl1	ENSMUSG00000022365	1.047444175
692	Wif1	ENSMUSG00000020218	1.047119083
693	Cks1b	ENSMUSG00000028044	1.046554899
694	Ccdc134	ENSMUSG00000068114	1.045129946
695	Farp1	ENSMUSG00000025555	1.04389361
696	Tars	ENSMUSG00000022241	1.043266521
697	Rpn2	ENSMUSG00000027642	1.039931574
698	Nop16	ENSMUSG00000025869	1.03963659
699	Msmo1	ENSMUSG00000031604	1.038855593
700	Cdv3-ps	ENSMUSG00000090389	1.037316451
701	Yif1a	ENSMUSG00000024875	1.037258808

702	Zfp568	ENSMUSG00000074221	1.036068891
703	Col7a1	ENSMUSG00000025650	1.034000942
704	Oasl1	ENSMUSG00000041827	1.033131634
705	Mcfd2	ENSMUSG00000024150	1.025906718
706	Slc7a7	ENSMUSG00000000958	1.025602479
707	Rab6a	ENSMUSG00000030704	1.024779016
708	Erp29	ENSMUSG00000029616	1.02083526
709	1810055G02Rik	ENSMUSG00000035372	1.01858213
710	Lrrc59	ENSMUSG00000020869	1.018185595
711	Heatr5a	ENSMUSG00000035181	1.018091303
712	Marcks1	ENSMUSG00000047945	1.017402547
713	Mvp	ENSMUSG00000030681	1.017384365
714	Per1	ENSMUSG00000020893	1.017223008
715	Aif1	ENSMUSG00000024397	1.016551272
716	Gn13	ENSMUSG00000042354	1.01648494
717	Hells	ENSMUSG00000025001	1.016223913
718	Mcm5	ENSMUSG00000005410	1.0143332
719	N4bp2os	ENSMUSG00000106978	1.013382364
720	Krt80	ENSMUSG00000037185	1.012635222
721	Hist1h2bb	ENSMUSG00000075031	1.01137536
722	Psm11	ENSMUSG00000017428	1.011018617
723	Nsdhl	ENSMUSG00000031349	1.010787814
724	Fam174b	ENSMUSG00000078670	1.010025926
725	Gm7895	ENSMUSG00000100347	1.009476227
726	Gm25360	ENSMUSG00000094655	1.009366206
727	St6galnac4	ENSMUSG00000079442	1.009190701
728	Steap2	ENSMUSG00000015653	1.008242338
729	M6pr	ENSMUSG00000007458	1.007816687
730	Spi1	ENSMUSG00000002111	1.005558321
731	Srm	ENSMUSG00000006442	1.005149292
732	Gm6563	ENSMUSG00000051255	1.004539333
733	Cmtr2	ENSMUSG00000046441	1.004455668
734	Isoc2a	ENSMUSG00000086784	1.002035749
735	Mob3c	ENSMUSG00000028709	1.001988325
736	Atad5	ENSMUSG00000017550	1.000331972
737	Kcnn3	ENSMUSG00000000794	0.99982441
738	Dnajb9	ENSMUSG00000014905	0.999482146
739	B230216N24Rik	ENSMUSG00000089706	0.999150399
740	Olfml2b	ENSMUSG00000038463	0.998856338
741	Col11a2	ENSMUSG00000024330	0.99846639
742	Bambi	ENSMUSG00000024232	0.998400037
743	Cotl1	ENSMUSG00000031827	0.997762408
744	Snap23	ENSMUSG00000027287	0.99717774
745	Mak16	ENSMUSG00000031578	0.996282623
746	Rnf5	ENSMUSG00000015478	0.995026243
747	Snhg4	ENSMUSG00000097769	0.994877612
748	Dusp8	ENSMUSG00000037887	0.992982688

749	Shisa4	ENSMUSG00000041889	0.991855458
750	Gsg1l	ENSMUSG00000046182	0.991643791
751	Canx	ENSMUSG00000020368	0.99103089
752	Gm8203	ENSMUSG000000101878	0.989511615
753	Armc6	ENSMUSG00000002343	0.989498202
754	Slx4ip	ENSMUSG00000027281	0.98930013
755	Gm13456	ENSMUSG00000082536	0.988812863
756	Ints2	ENSMUSG00000018068	0.987187817
757	Golt1b	ENSMUSG00000030245	0.985137192
758	Hspb1	ENSMUSG00000004951	0.984501964
759	Rpf2	ENSMUSG00000038510	0.984054313
760	Scml4	ENSMUSG00000044770	0.983279986
761	Ppp1r14b	ENSMUSG00000056612	0.982912048
762	Nme6	ENSMUSG00000032478	0.982882597
763	Ccl6	ENSMUSG00000018927	0.982589258
764	Lhfpl2	ENSMUSG00000045312	0.980846806
765	Rnf181	ENSMUSG00000055850	0.980432741
766	Mb21d1	ENSMUSG00000032344	0.980115292
767	Cad	ENSMUSG00000013629	0.979420976
768	Got1	ENSMUSG00000025190	0.979355287
769	Lmcd1	ENSMUSG00000057604	0.978649847
770	Lamc2	ENSMUSG00000026479	0.97554956
771	Cyld	ENSMUSG00000036712	0.974943338
772	Nktr	ENSMUSG00000032525	0.971355026
773	Gm4540	ENSMUSG00000092072	0.971285941
774	Cnpy3	ENSMUSG00000023973	0.971164845
775	Glipr2	ENSMUSG00000028480	0.970473478
776	Fam98c	ENSMUSG00000030590	0.97018368
777	Bcl6	ENSMUSG00000022508	0.969489625
778	Stat2	ENSMUSG00000040033	0.96069757
779	Gm14048	ENSMUSG00000080989	0.959293156
780	Zdhhc24	ENSMUSG00000006463	0.958629392
781	Ifi211	ENSMUSG00000026536	0.957641599
782	Gm12655	ENSMUSG00000087128	0.95733895
783	Map1b	ENSMUSG00000052727	0.95634716
784	Il6st	ENSMUSG00000021756	0.95314068
785	Pck2	ENSMUSG00000040618	0.953104793
786	Ubtd1	ENSMUSG00000025171	0.952484985
787	Gm13127	ENSMUSG00000070610	0.952072131
788	Il4ra	ENSMUSG00000030748	0.950384327
789	Suv39h2	ENSMUSG00000026646	0.950314164
790	Hgf	ENSMUSG00000028864	0.949086932
791	Hmgcr	ENSMUSG00000021670	0.948321994
792	Stk19	ENSMUSG00000061207	0.94671894
793	Enah	ENSMUSG00000022995	0.945605411
794	Cenpl	ENSMUSG00000026708	0.945413278
795	Mllt3	ENSMUSG00000028496	0.944147681

796	Gm38253	ENSMUSG00000102780	0.943228673
797	Dram1	ENSMUSG00000020057	0.942235891
798	Fkbp2	ENSMUSG00000056629	0.939827021
799	Gm28229	ENSMUSG00000101335	0.939355326
800	Lair1	ENSMUSG00000055541	0.938493164
801	Mapkapk2	ENSMUSG00000016528	0.936458386
802	Pcgf6	ENSMUSG00000025050	0.935665477
803	Zfp367	ENSMUSG00000044934	0.934484588
804	Tm2d2	ENSMUSG00000031556	0.933364167
805	Sec11a	ENSMUSG00000025724	0.930747552
806	Kif5b	ENSMUSG00000006740	0.930384309
807	Clvs1	ENSMUSG00000041216	0.929682573
808	5430416N02Rik	ENSMUSG00000097772	0.927749382
809	Gpx4	ENSMUSG00000075706	0.926359853
810	Mroh1	ENSMUSG00000022558	0.926118233
811	Klf6	ENSMUSG00000000078	0.92183922
812	Cenpc1	ENSMUSG00000029253	0.921501563
813	Nfkb2	ENSMUSG00000025225	0.920852777
814	Rnf19b	ENSMUSG00000028793	0.920537936
815	Osmr	ENSMUSG00000022146	0.918933908
816	Pus7	ENSMUSG00000057541	0.917310055
817	Sarnp	ENSMUSG00000078427	0.916958299
818	Mt1	ENSMUSG00000031765	0.916867703
819	Enho	ENSMUSG00000028445	0.91608576
820	Grn	ENSMUSG00000034708	0.915517395
821	Rasl11b	ENSMUSG00000049907	0.913181622
822	Fkbp11	ENSMUSG00000003355	0.913036698
823	Plau	ENSMUSG00000021822	0.912940093
824	Lipa	ENSMUSG00000024781	0.910771572
825	Gm5560	ENSMUSG00000067161	0.91077063
826	Zfp948	ENSMUSG00000067931	0.909510608
827	Sac3d1	ENSMUSG00000024790	0.909267499
828	Jpt1	ENSMUSG00000020737	0.909190468
829	Apex1	ENSMUSG00000035960	0.908491689
830	Trmt6	ENSMUSG00000037376	0.907990576
831	Rheb	ENSMUSG00000028945	0.907606311
832	Fam198b	ENSMUSG00000027955	0.907554858
833	Bax	ENSMUSG00000003873	0.907449126
834	Rpn1	ENSMUSG00000030062	0.906935746
835	Gm11478	ENSMUSG00000083992	0.905994986
836	Zdhhc9	ENSMUSG00000036985	0.905808959
837	Slc38a4	ENSMUSG00000022464	0.904812847
838	Gm26672	ENSMUSG00000097330	0.902397251
839	Rcl1	ENSMUSG00000024785	0.901908816
840	Tpp2	ENSMUSG00000041763	0.901477192
841	Snhg6	ENSMUSG00000098234	0.899789841
842	Lgi2	ENSMUSG00000039252	0.897646502

843	Zfp462	ENSMUSG00000060206	0.896480563
844	Lrif1	ENSMUSG00000056260	0.895298737
845	Kif11	ENSMUSG00000012443	0.892626767
846	Thsd4	ENSMUSG00000032289	0.892486283
847	Rragd	ENSMUSG00000028278	0.889950586
848	Ccdc86	ENSMUSG00000024732	0.889519185
849	Usp53	ENSMUSG00000039701	0.889057897
850	Mob3a	ENSMUSG00000003348	0.888369885
851	Zfas1	ENSMUSG00000074578	0.887650048
852	Nop58	ENSMUSG00000026020	0.887388208
853	Gm6223	ENSMUSG00000096647	0.887365225
854	Gfod1	ENSMUSG00000051335	0.887152785
855	Tmem97	ENSMUSG00000037278	0.886737284
856	Jun	ENSMUSG00000052684	0.886098371
857	Ncs1	ENSMUSG00000062661	0.885836675
858	Csf2ra	ENSMUSG00000059326	0.884172744
859	Ltv1	ENSMUSG00000019814	0.884018053
860	Sh3pxd2b	ENSMUSG00000040711	0.880479476
861	Tob1	ENSMUSG00000037573	0.880452628
862	Man1a	ENSMUSG00000003746	0.880287851
863	Dusp10	ENSMUSG00000039384	0.879694355
864	Gm45457	ENSMUSG00000110411	0.878622714
865	Tprn	ENSMUSG00000048707	0.876324704
866	March3	ENSMUSG00000032656	0.876120534
867	Hist1h1c	ENSMUSG00000036181	0.872327463
868	Rpl36a-ps3	ENSMUSG00000071141	0.871135433
869	Trabd	ENSMUSG00000015363	0.870610656
870	Gm12295	ENSMUSG00000085162	0.870583756
871	Cstf3	ENSMUSG00000027176	0.870545915
872	Prkaca	ENSMUSG00000005469	0.870147833
873	BC031181	ENSMUSG00000036299	0.870006603
874	Yrdc	ENSMUSG00000028889	0.869735199
875	Mtmr4	ENSMUSG00000018401	0.866029558
876	Hsd17b12	ENSMUSG00000027195	0.86408055
877	Snrnp25	ENSMUSG00000040767	0.86236488
878	Slc35b1	ENSMUSG00000020873	0.862043131
879	Uxs1	ENSMUSG00000057363	0.861861965
880	Rhoc	ENSMUSG00000002233	0.861369588
881	Atp8b2	ENSMUSG00000060671	0.859678124
882	Relb	ENSMUSG00000002983	0.859378177
883	Arhgap19	ENSMUSG00000025154	0.859244571
884	Klhl21	ENSMUSG00000073700	0.858928128
885	Ier5	ENSMUSG00000056708	0.858885901
886	Slc35e4	ENSMUSG00000048807	0.858665598
887	Ifi205	ENSMUSG00000054203	0.856980021
888	Igtp	ENSMUSG00000078853	0.855072616
889	Fam96b	ENSMUSG00000031879	0.854406453

890	Arpc3	ENSMUSG00000029465	0.854351924
891	Clock	ENSMUSG00000029238	0.853340465
892	Grwd1	ENSMUSG00000053801	0.852420254
893	Tuba1a	ENSMUSG00000072235	0.851395906
894	Mtbp	ENSMUSG00000022369	0.847799005
895	Baz1a	ENSMUSG00000035021	0.847175088
896	Tlr4	ENSMUSG00000039005	0.846219844
897	Hsp25-ps1	ENSMUSG00000078915	0.845951106
898	Gm45220	ENSMUSG00000109279	0.844793295
899	Abca4	ENSMUSG00000028125	0.84421429
900	Lrrc3b	ENSMUSG00000045201	0.844018318
901	Hnrnpa3	ENSMUSG00000059005	0.842870906
902	Tsr1	ENSMUSG00000038335	0.842141274
903	Rhod	ENSMUSG00000041845	0.840435869
904	Creld1	ENSMUSG00000030284	0.840289076
905	Dda1	ENSMUSG00000074247	0.839225255
906	Vwa5a	ENSMUSG00000023186	0.838955985
907	Abi3bp	ENSMUSG00000035258	0.838946299
908	Prmt3	ENSMUSG00000030505	0.838927104
909	Zfp322a	ENSMUSG00000046351	0.836133767
910	Fam46a	ENSMUSG00000032265	0.836070746
911	Stmn1	ENSMUSG00000028832	0.835738151
912	Mis12	ENSMUSG00000040599	0.835615698
913	Oat	ENSMUSG00000030934	0.834136647
914	Med19	ENSMUSG00000027080	0.833175877
915	Pla2g4a	ENSMUSG00000056220	0.83298215
916	Dzip3	ENSMUSG00000064061	0.83208629
917	Gda	ENSMUSG00000058624	0.831307598
918	Tcea1-ps1	ENSMUSG00000067869	0.830474395
919	Rbmx2	ENSMUSG00000031107	0.830185857
920	Gas5	ENSMUSG00000053332	0.830002317
921	Tlnrd1	ENSMUSG00000070462	0.829861228
922	Ipo5	ENSMUSG00000030662	0.8274388
923	Golim4	ENSMUSG00000034109	0.826919132
924	Zbtb40	ENSMUSG00000060862	0.825764322
925	Gcsh	ENSMUSG00000034424	0.825080405
926	Nubp1	ENSMUSG00000022503	0.823716909
927	Adgrd1	ENSMUSG00000044017	0.823705721
928	Eif4a-ps4	ENSMUSG00000101188	0.822285582
929	Tgfbr1	ENSMUSG00000007613	0.819006418
930	Sec23a	ENSMUSG00000020986	0.818675812
931	Katnb1	ENSMUSG00000031787	0.815531235
932	Ascc3	ENSMUSG00000038774	0.815042677
933	Creb3l2	ENSMUSG00000038648	0.81439726
934	Amer1	ENSMUSG00000050332	0.812900011
935	Gtf2f2	ENSMUSG00000067995	0.812866099
936	Psmid14	ENSMUSG00000026914	0.811361474

937	Tcea1	ENSMUSG00000033813	0.810968429
938	Fads3	ENSMUSG00000024664	0.809540069
939	Spata13	ENSMUSG00000021990	0.808825986
940	Fcgr2b	ENSMUSG00000026656	0.808137326
941	Gm12258	ENSMUSG00000072915	0.80795738
942	Fxyd5	ENSMUSG00000009687	0.807277415
943	Tyropb	ENSMUSG00000030579	0.807110129
944	Selenoi	ENSMUSG00000075703	0.805764874
945	Tnfrsf11a	ENSMUSG00000026321	0.805378296
946	Surf4	ENSMUSG00000014867	0.805330078
947	Ahnak2	ENSMUSG00000072812	0.80520946
948	Xpot	ENSMUSG00000034667	0.805192336
949	Rpl13a	ENSMUSG00000074129	0.804787789
950	Ankrd49	ENSMUSG00000031931	0.804318284
951	Lmnb2	ENSMUSG00000062075	0.804229027
952	Tmem183a	ENSMUSG00000042305	0.80371481
953	Ifi204	ENSMUSG00000073489	0.803687915
954	Mydgf	ENSMUSG00000019579	0.803441204
955	Pja2	ENSMUSG00000024083	0.802786062
956	Erbp2	ENSMUSG00000062312	0.802684133
957	Nckap1l	ENSMUSG00000022488	0.801160539
958	Eef1a1	ENSMUSG00000037742	0.79904953
959	Popdc3	ENSMUSG00000019848	0.797193966
960	Rps19bp1	ENSMUSG00000051518	0.796956637
961	Galns	ENSMUSG00000015027	0.79645697
962	Actr3	ENSMUSG00000026341	0.795827554
963	Gpx3	ENSMUSG00000018339	0.795421727
964	Pinx1	ENSMUSG00000021958	0.794583212
965	Emd	ENSMUSG00000001964	0.794213198
966	Dap	ENSMUSG00000039168	0.793663404
967	Fryl	ENSMUSG00000070733	0.793585949
968	Gm12844	ENSMUSG00000084260	0.792949051
969	Cenpx	ENSMUSG00000025144	0.792844995
970	Alg8	ENSMUSG00000035704	0.792373737
971	Nars	ENSMUSG00000024587	0.79112078
972	Klf7	ENSMUSG00000025959	0.790947492
973	Ddx31	ENSMUSG00000026806	0.790395442
974	Mogs	ENSMUSG00000030036	0.788864385
975	Med10	ENSMUSG00000021598	0.788246323
976	Ifrd1	ENSMUSG00000001627	0.7880196
977	Rrp15	ENSMUSG00000001305	0.786998678
978	Extl1	ENSMUSG00000028838	0.786757054
979	Prr13	ENSMUSG00000023048	0.786660343
980	Gpn2	ENSMUSG00000028848	0.786223513
981	Mvk	ENSMUSG00000041939	0.785041015
982	Casp3	ENSMUSG00000031628	0.783183801
983	Ddx50	ENSMUSG00000020076	0.783123916

984	Usp39	ENSMUSG00000056305	0.782950199
985	Wdr4	ENSMUSG00000024037	0.782833194
986	Gpn1	ENSMUSG00000064037	0.782525316
987	Ppm1b	ENSMUSG00000061130	0.781952441
988	Snd1	ENSMUSG00000001424	0.781466948
989	lkbkg	ENSMUSG00000004221	0.781330934
990	Dynll1	ENSMUSG00000009013	0.780116711
991	Arpc4	ENSMUSG00000079426	0.779585176
992	Ccdc115	ENSMUSG00000042111	0.779252872
993	Eif4a1	ENSMUSG00000059796	0.778100092
994	Ftsj3	ENSMUSG00000020706	0.777306748
995	Fbxw9	ENSMUSG00000008167	0.777211512
996	Leo1	ENSMUSG00000042487	0.776732527
997	Rhoa	ENSMUSG00000007815	0.776493294
998	Gm12112	ENSMUSG00000081254	0.77566347
999	Bahcc1	ENSMUSG00000039741	0.775052378
1000	Pum3	ENSMUSG00000041360	0.774948414
1001	Gm45221	ENSMUSG00000109005	0.774602671
1002	Lyz2	ENSMUSG00000069516	0.774524955
1003	1600002K03Rik	ENSMUSG00000035595	0.774418722
1004	Fkbp7	ENSMUSG00000002732	0.773717985
1005	Fn1	ENSMUSG00000026193	0.773362062
1006	Sap30l	ENSMUSG00000020519	0.773262893
1007	Tes	ENSMUSG00000029552	0.772626119
1008	Slc39a6	ENSMUSG00000024270	0.771398846
1009	Zc2hc1a	ENSMUSG00000043542	0.771017675
1010	Thyn1	ENSMUSG00000035443	0.770797183
1011	Ddah1	ENSMUSG00000028194	0.769961103
1012	Ccng1	ENSMUSG00000020326	0.769197013
1013	Sgms2	ENSMUSG00000050931	0.768717188
1014	Taf7	ENSMUSG00000051316	0.768132124
1015	Adprhl1	ENSMUSG00000031448	0.767639577
1016	Wdpcp	ENSMUSG00000020319	0.766627398
1017	Utp18	ENSMUSG00000054079	0.765916084
1018	Aen	ENSMUSG00000030609	0.765640168
1019	Fosl2	ENSMUSG00000029135	0.76503642
1020	Eprs	ENSMUSG00000026615	0.76403217
1021	Spcs3	ENSMUSG00000054408	0.763733035
1022	Zfp202	ENSMUSG00000025602	0.763239857
1023	Ddx21	ENSMUSG00000020075	0.761090656
1024	Ifit3b	ENSMUSG00000062488	0.760911452
1025	Itga3	ENSMUSG00000001507	0.760586711
1026	Sec61b	ENSMUSG00000053317	0.760554414
1027	Acot9	ENSMUSG00000025287	0.760485931
1028	Rap2a	ENSMUSG00000051615	0.760193646
1029	Plxna1	ENSMUSG00000030084	0.760040367
1030	Col3a1	ENSMUSG00000026043	0.759873146

1031	Litaf	ENSMUSG00000022500	0.757875884
1032	Ugdh	ENSMUSG00000029201	0.75650923
1033	Slc25a5	ENSMUSG00000016319	0.755661677
1034	Taf4b	ENSMUSG00000054321	0.755349399
1035	Atp6v1h	ENSMUSG00000033793	0.755164921
1036	Pprc1	ENSMUSG00000055491	0.754992697
1037	Ero1b	ENSMUSG00000057069	0.754878836
1038	Atp13a3	ENSMUSG00000022533	0.754297559
1039	Scara3	ENSMUSG00000034463	0.753649119
1040	Rab20	ENSMUSG00000031504	0.753365513
1041	Pfkip	ENSMUSG00000021196	0.750610364
1042	Fam185a	ENSMUSG00000047221	0.750106396
1043	Snhg12	ENSMUSG00000086290	0.749717222
1044	Cib1	ENSMUSG00000030538	0.74771931
1045	Bola2	ENSMUSG00000047721	0.746320287
1046	Selenos	ENSMUSG00000075701	0.745582972
1047	Cbx6	ENSMUSG00000089715	0.745101247
1048	Wars	ENSMUSG00000021266	0.743841568
1049	Cacna1h	ENSMUSG00000024112	0.742510804
1050	Arhgef10l	ENSMUSG00000040964	0.741971201
1051	Zwint	ENSMUSG00000019923	0.740927247
1052	Ywhaz	ENSMUSG00000022285	0.739821073
1053	Hsph1	ENSMUSG00000029657	0.739234336
1054	Lars	ENSMUSG00000024493	0.738810973
1055	Amn1	ENSMUSG00000068250	0.73819553
1056	Dapk3	ENSMUSG00000034974	0.735756947
1057	Rars	ENSMUSG00000018848	0.735425061
1058	Sap130	ENSMUSG00000024260	0.735274982
1059	Clptm1l	ENSMUSG00000021610	0.735101427
1060	Fbl	ENSMUSG00000046865	0.732474301
1061	Itpk1	ENSMUSG00000057963	0.732267051
1062	Sema3a	ENSMUSG00000028883	0.732207001
1063	Mon1b	ENSMUSG00000078908	0.732016876
1064	Shoc2	ENSMUSG00000024976	0.731088633
1065	Hist1h3e	ENSMUSG00000069273	0.731064742
1066	Fem1b	ENSMUSG00000032244	0.731036087
1067	Urb2	ENSMUSG00000031976	0.730985248
1068	Actn1	ENSMUSG00000015143	0.729523694
1069	Tmem167	ENSMUSG00000012422	0.728202541
1070	Utp20	ENSMUSG00000004356	0.727887583
1071	Acsl3	ENSMUSG00000032883	0.726157803
1072	Hipk2	ENSMUSG00000061436	0.726075305
1073	Hfe	ENSMUSG00000006611	0.725174423
1074	Wdr75	ENSMUSG00000025995	0.725124244
1075	2310022B05Rik	ENSMUSG00000031983	0.724824673
1076	Smg1	ENSMUSG00000030655	0.724789024
1077	Rps26	ENSMUSG00000025362	0.723623341

1078	Pfn1	ENSMUSG00000018293	0.723399628
1079	Nup88	ENSMUSG00000040667	0.721541853
1080	Spata24	ENSMUSG00000024352	0.72114141
1081	P2ry2	ENSMUSG00000032860	0.720427675
1082	Cav3	ENSMUSG00000062694	0.719875911
1083	Cfl1	ENSMUSG00000056201	0.719785535
1084	Herc4	ENSMUSG00000020064	0.719381863
1085	Selenof	ENSMUSG00000037072	0.719245944
1086	Cxcl16	ENSMUSG00000018920	0.717932582
1087	Gm10110	ENSMUSG00000062093	0.716952245
1088	Cyb5r3	ENSMUSG00000018042	0.716716913
1089	Slc3a2	ENSMUSG00000010095	0.716602287
1090	Noc3l	ENSMUSG00000024999	0.716426765
1091	Ddx54	ENSMUSG00000029599	0.715670612
1092	Mcrs1	ENSMUSG00000037570	0.714953137
1093	Igf1r	ENSMUSG00000005533	0.714498197
1094	Prkcd	ENSMUSG00000021948	0.7128372
1095	Fam49b	ENSMUSG00000022378	0.712197402
1096	Nop2	ENSMUSG00000038279	0.710666914
1097	Ttc9c	ENSMUSG00000071660	0.707842691
1098	Zfp954	ENSMUSG00000062116	0.707420379
1099	Zfpm1	ENSMUSG00000049577	0.706576066
1100	Pgs1	ENSMUSG00000017715	0.706202908
1101	Tspyl5	ENSMUSG00000038984	0.705293119
1102	Mpp7	ENSMUSG00000057440	0.704277435
1103	Tnfrsf1a	ENSMUSG00000030341	0.704189614
1104	Otulin	ENSMUSG00000046034	0.704115093
1105	Kank1	ENSMUSG00000032702	0.702975445
1106	Rpsa	ENSMUSG00000032518	0.702748438
1107	Rcc2	ENSMUSG00000040945	0.702261881
1108	Srxn1	ENSMUSG00000032802	0.701460756
1109	Slc2a1	ENSMUSG00000028645	0.700955335
1110	Cct3	ENSMUSG00000001416	0.69967866
1111	Mad2l1	ENSMUSG00000029910	0.69840823
1112	Asna1	ENSMUSG00000052456	0.698282921
1113	Ckb	ENSMUSG00000001270	0.698075616
1114	Nifk	ENSMUSG00000026377	0.697968583
1115	Lmo4	ENSMUSG00000028266	0.697798413
1116	Rrp7a	ENSMUSG00000018040	0.69721061
1117	Rps15a	ENSMUSG00000008683	0.695995515
1118	Nsd2	ENSMUSG00000057406	0.695643756
1119	Nup43	ENSMUSG00000040034	0.695320906
1120	G2e3	ENSMUSG00000035293	0.694936906
1121	Ifi27	ENSMUSG00000064215	0.694884649
1122	Gas7	ENSMUSG00000033066	0.694061823
1123	Sertad1	ENSMUSG00000008384	0.692249697
1124	Vcam1	ENSMUSG00000027962	0.691728936

1125	Ralb	ENSMUSG00000004451	0.69153584
1126	Igsf10	ENSMUSG00000036334	0.691271506
1127	Gm10073	ENSMUSG00000060019	0.68938212
1128	Stam	ENSMUSG00000026718	0.689018094
1129	Maged1	ENSMUSG00000025151	0.68891575
1130	Plpp1	ENSMUSG00000021759	0.688901161
1131	Gan	ENSMUSG00000052557	0.686545609
1132	Synpo2l	ENSMUSG00000039376	0.686398231
1133	Htt	ENSMUSG00000029104	0.686383182
1134	Gem	ENSMUSG00000028214	0.686188335
1135	Pvr	ENSMUSG00000040511	0.685411045
1136	Lins1	ENSMUSG00000053091	0.683541269
1137	Cyb561	ENSMUSG00000019590	0.683530223
1138	Heatr5b	ENSMUSG00000039414	0.683422176
1139	Pabpc4	ENSMUSG00000011257	0.682692924
1140	Fam111a	ENSMUSG00000024691	0.682321473
1141	Nudt4	ENSMUSG00000020029	0.681346251
1142	Erc8	ENSMUSG00000021694	0.681173255
1143	Tspan31	ENSMUSG00000006736	0.680937093
1144	Sema3c	ENSMUSG00000028780	0.680773986
1145	Slc25a28	ENSMUSG00000040414	0.680093591
1146	Zbtb7b	ENSMUSG00000028042	0.679923023
1147	9130011E15Rik	ENSMUSG00000039901	0.678730954
1148	Anxa6	ENSMUSG00000018340	0.677924858
1149	Csnk1g1	ENSMUSG00000032384	0.67790772
1150	Aste1	ENSMUSG00000032567	0.677790507
1151	Mx2	ENSMUSG00000023341	0.677562512
1152	Ago2	ENSMUSG00000036698	0.677518908
1153	Gm8355	ENSMUSG00000093798	0.676679781
1154	Polr2h	ENSMUSG00000021018	0.67613414
1155	B4galt1	ENSMUSG00000028413	0.676056464
1156	Col27a1	ENSMUSG00000045672	0.67596004
1157	Dysf	ENSMUSG00000033788	0.675477748
1158	Ebna1bp2	ENSMUSG00000028729	0.675301472
1159	Snrpa	ENSMUSG00000061479	0.675264485
1160	Sacm1l	ENSMUSG00000025240	0.674974673
1161	Sept11	ENSMUSG00000058013	0.674586578
1162	Nip7	ENSMUSG00000031917	0.67427054
1163	Zfp35	ENSMUSG00000063281	0.673101415
1164	Rpsa-ps10	ENSMUSG00000047676	0.67298466
1165	Rbm19	ENSMUSG00000029594	0.671834375
1166	Papss1	ENSMUSG00000028032	0.670756067
1167	Gm15710	ENSMUSG00000084111	0.669958309
1168	Atp10a	ENSMUSG00000025324	0.66964081
1169	Eif2s2	ENSMUSG00000074656	0.669289656
1170	Rhobtb3	ENSMUSG00000021589	0.669280554
1171	Ifit1	ENSMUSG00000034459	0.669162863

1172	Rps27l	ENSMUSG00000036781	0.668752047
1173	Mex3c	ENSMUSG00000037253	0.668191088
1174	Rangap1	ENSMUSG00000022391	0.667900592
1175	Tmtc3	ENSMUSG00000036676	0.667784074
1176	Sptssa	ENSMUSG00000044408	0.666057059
1177	Rpl36al	ENSMUSG00000049751	0.665684482
1178	Utp14a	ENSMUSG00000063785	0.663737961
1179	Slc35b4	ENSMUSG00000018999	0.663657564
1180	Nt5e	ENSMUSG00000032420	0.662443118
1181	Alg14	ENSMUSG00000039887	0.662411485
1182	Bak1	ENSMUSG00000057789	0.66107869
1183	Sulf2	ENSMUSG00000006800	0.660960059
1184	Plekho2	ENSMUSG00000050721	0.660295218
1185	Clic4	ENSMUSG00000037242	0.660096493
1186	Gmcs	ENSMUSG00000038372	0.659058531
1187	Dennd4a	ENSMUSG00000053641	0.658649715
1188	D1Ert622e	ENSMUSG00000044768	0.657605772
1189	Nuak1	ENSMUSG00000020032	0.657568401
1190	Gm9892	ENSMUSG00000052825	0.657255832
1191	Gys1	ENSMUSG00000003865	0.655983247
1192	Dnaaf5	ENSMUSG00000025857	0.654063659
1193	Rps19-ps6	ENSMUSG00000096942	0.654044111
1194	Aimp2	ENSMUSG00000029610	0.652181821
1195	Ranbp1	ENSMUSG00000005732	0.651469332
1196	Akirin1	ENSMUSG00000023075	0.651233528
1197	Magt1	ENSMUSG00000031232	0.651042114
1198	Tmem8b	ENSMUSG00000078716	0.650505945
1199	Cnot1	ENSMUSG00000036550	0.649904527
1200	Lrrfip1	ENSMUSG00000026305	0.648583949
1201	Dlgap4	ENSMUSG00000061689	0.647999278
1202	Cttn	ENSMUSG00000031078	0.647377419
1203	Csrp1	ENSMUSG00000026421	0.646229032
1204		ENSMUSG00000109908	0.646091023
1205	Calm1	ENSMUSG00000001175	0.645126522
1206	Btg1	ENSMUSG00000036478	0.645011658
1207	Thumpd3	ENSMUSG00000030264	0.643791002
1208	Eif6	ENSMUSG00000027613	0.643730306
1209	Alg12	ENSMUSG00000035845	0.64288158
1210	Preli1	ENSMUSG00000021486	0.642585588
1211	Sft2d1	ENSMUSG00000073468	0.642332084
1212	Gtf2f1	ENSMUSG00000002658	0.641609494
1213	Arhgdia	ENSMUSG00000025132	0.641402122
1214	Lpp	ENSMUSG00000033306	0.641290026
1215	Herc2	ENSMUSG00000030451	0.641123786
1216	Ssr4	ENSMUSG00000002014	0.64044671
1217	Sec11c	ENSMUSG00000024516	0.639828566
1218	Osbpl9	ENSMUSG00000028559	0.639498317

1219	Net1	ENSMUSG00000021215	0.637143851
1220	Smc2	ENSMUSG00000028312	0.634767001
1221	Gm4202	ENSMUSG00000091421	0.634523293
1222	Cyp51	ENSMUSG00000001467	0.63435002
1223	Col6a3	ENSMUSG00000048126	0.633595473
1224	Pign	ENSMUSG00000056536	0.63355999
1225	Tuba1b	ENSMUSG00000023004	0.63198989
1226	Uso1	ENSMUSG00000029407	0.63104944
1227	Epn3	ENSMUSG00000010080	0.630938757
1228	Ppp2r1b	ENSMUSG00000032058	0.630364598
1229	Tmem43	ENSMUSG00000030095	0.630081801
1230	Nup98	ENSMUSG00000063550	0.629392191
1231	Lrrc28	ENSMUSG00000030556	0.629353958
1232	Cptp	ENSMUSG00000029073	0.629064149
1233	Map2k1	ENSMUSG00000004936	0.628573741
1234	Atp6ap2	ENSMUSG00000031007	0.628390821
1235	Cbwd1	ENSMUSG00000024878	0.6280778
1236	Sdad1	ENSMUSG00000029415	0.627165797
1237	Col1a1	ENSMUSG00000001506	0.626620549
1238	Exosc2	ENSMUSG00000039356	0.625799426
1239	Alkbh6	ENSMUSG00000042831	0.624868934
1240	Mtm1	ENSMUSG00000031337	0.624794263
1241	Tma16	ENSMUSG00000025591	0.624759039
1242	Git1	ENSMUSG00000011877	0.623695541
1243	Chchd6	ENSMUSG00000030086	0.62330958
1244	Ptpn2	ENSMUSG00000024539	0.621793951
1245	Noc4l	ENSMUSG00000033294	0.621598922
1246	Rnd3	ENSMUSG00000017144	0.619969972
1247	Rps26-ps1	ENSMUSG00000059775	0.619435377
1248	Hinfp	ENSMUSG00000032119	0.618940271
1249	Rnf4	ENSMUSG00000029110	0.618481098
1250	Gadd45a	ENSMUSG00000036390	0.617931993
1251	Cdc42se2	ENSMUSG00000052298	0.61765282
1252	Tusc2	ENSMUSG00000010054	0.614390119
1253	Nup205	ENSMUSG00000038759	0.61390988
1254	Hras	ENSMUSG00000025499	0.613823609
1255	H2afz	ENSMUSG00000037894	0.613687268
1256	Crls1	ENSMUSG00000027357	0.613582286
1257	1810022K09Rik	ENSMUSG00000078784	0.61310472
1258	Prdm4	ENSMUSG00000035529	0.612345211
1259	Utp23	ENSMUSG00000022313	0.612224386
1260	Abca7	ENSMUSG00000035722	0.610961443
1261	Slc43a2	ENSMUSG00000038178	0.609567402
1262	Arhgap1	ENSMUSG00000027247	0.609348442
1263	1110065P20Rik	ENSMUSG00000078570	0.608295661
1264	Mlec	ENSMUSG00000048578	0.607575492
1265	Ctgf	ENSMUSG00000019997	0.607389662

1266	Tubb5	ENSMUSG00000001525	0.60692508
1267	Fstl1	ENSMUSG00000022816	0.606903738
1268	Cript	ENSMUSG00000024146	0.606393596
1269	Cdkn2d	ENSMUSG000000096472	0.606364933
1270	Slc38a1	ENSMUSG00000023169	0.606175017
1271	Snrnp40	ENSMUSG00000074088	0.606046247
1272	Rpl37rt	ENSMUSG00000072692	0.605870647
1273	Ticam1	ENSMUSG00000047123	0.605515294
1274	Mknk1	ENSMUSG00000028708	0.605372644
1275	Zpr1	ENSMUSG00000032078	0.605301172
1276	Ptov1	ENSMUSG00000038502	0.605065096
1277	Borcs6	ENSMUSG00000045176	0.603991584
1278	Pwp2	ENSMUSG00000032834	0.603470513
1279	Cd302	ENSMUSG00000060703	0.602227963
1280	Col4a5	ENSMUSG00000031274	0.601840054
1281	Dcun1d3	ENSMUSG00000048787	0.601495354
1282	Tmem41b	ENSMUSG00000047554	0.601304134
1283	Ak6	ENSMUSG00000078941	0.600480642
1284	Abhd17c	ENSMUSG00000038459	0.6004754
1285	Adam9	ENSMUSG00000031555	0.598811296
1286	Tspan9	ENSMUSG00000030352	0.597732982
1287	Tmbim6	ENSMUSG00000023010	0.597709731
1288	Evi5l	ENSMUSG00000011832	0.597197721
1289	Mcm6	ENSMUSG00000026355	0.596849969
1290	Hspa8	ENSMUSG00000015656	0.596785008
1291	Myo9a	ENSMUSG00000039585	0.595772587
1292	Cdv3	ENSMUSG00000032803	0.594391759
1293	Rps5	ENSMUSG00000012848	0.59352121
1294	Gpr108	ENSMUSG00000005823	0.592814952
1295	Wsb1	ENSMUSG00000017677	0.592735969
1296	Rps19	ENSMUSG00000040952	0.592580642
1297	Hmg20b	ENSMUSG00000020232	0.5917954
1298	Flna	ENSMUSG00000031328	0.590876496
1299	Ccdc25	ENSMUSG00000022035	0.588484211
1300	Maea	ENSMUSG00000079562	0.588459912
1301	Ap3m1	ENSMUSG00000021824	0.588426438
1302	Leprot	ENSMUSG00000035212	0.587584642
1303	Rpl14	ENSMUSG00000025794	0.587384075
1304	Pbdc1	ENSMUSG00000031226	0.587199446
1305	Itm2c	ENSMUSG00000026223	0.586300683
1306	Klf2	ENSMUSG00000055148	0.586213082
1307	Yars	ENSMUSG00000028811	0.585805997
1308	Ctnnal1	ENSMUSG00000038816	0.585104715
1309	Anxa2	ENSMUSG00000032231	0.584881521
1310	Tomm70a	ENSMUSG00000022752	0.584741477
1311	Sdsl	ENSMUSG00000029596	0.584574705
1312	9930021J03Rik	ENSMUSG00000046138	0.58445531

1313	Tssc1	ENSMUSG00000036613	0.583745402
1314	Pde12	ENSMUSG00000043702	0.582926616
1315	Sbf1	ENSMUSG00000036529	0.582653681
1316	Fam174a	ENSMUSG00000051185	0.582472213
1317	Taldo1	ENSMUSG00000025503	0.582320022
1318	D930016D06Rik	ENSMUSG00000097392	0.581637646
1319	Dcaf13	ENSMUSG00000022300	0.581585018
1320	Exoc1	ENSMUSG00000036435	0.581250128
1321	Ltbr	ENSMUSG00000030339	0.581166184
1322	Ppp2r5a	ENSMUSG00000026626	0.581147697
1323	Ttc37	ENSMUSG00000033991	0.580241398
1324	Ipo4	ENSMUSG00000002319	0.580236941
1325	Bag2	ENSMUSG00000042215	0.579701437
1326	Dse	ENSMUSG00000039497	0.579658773
1327	Rhbdd1	ENSMUSG00000026142	0.578566976
1328	Fam208b	ENSMUSG00000033799	0.578445914
1329	Rpl12	ENSMUSG00000038900	0.575352258
1330	Tmem208	ENSMUSG00000014856	0.575008895
1331	Cyb5b	ENSMUSG00000031924	0.574780909
1332	Trove2	ENSMUSG00000018199	0.573184709
1333	Ddx10	ENSMUSG00000053289	0.573045385
1334	Fat1	ENSMUSG00000070047	0.572118107
1335	Fbn1	ENSMUSG00000027204	0.571995332
1336	B3gat3	ENSMUSG00000071649	0.571481092
1337	Nlk	ENSMUSG00000017376	0.57134959
1338	Dnajc2	ENSMUSG00000029014	0.571336165
1339	Gm37084	ENSMUSG00000102856	0.5710928
1340	Pspc1	ENSMUSG00000021938	0.57058026
1341	Btaf1	ENSMUSG00000040565	0.569496277
1342	Loxl1	ENSMUSG00000032334	0.568574626
1343	Hand2	ENSMUSG00000038193	0.568356416
1344	Cfap36	ENSMUSG00000020462	0.567957448
1345	Emp2	ENSMUSG00000022505	0.567116638
1346	Tmem160	ENSMUSG00000019158	0.566839725
1347	Rala	ENSMUSG00000008859	0.566565194
1348	Gba	ENSMUSG00000028048	0.566345276
1349	Sec23b	ENSMUSG00000027429	0.565988723
1350	Bud31	ENSMUSG00000038722	0.56464418
1351	Pno1	ENSMUSG00000020116	0.563941008
1352	Gm15459	ENSMUSG00000100801	0.562548494
1353	Rpe	ENSMUSG00000026005	0.56228236
1354	Pdlim1	ENSMUSG00000055044	0.562234977
1355	Arih1	ENSMUSG00000025234	0.561272177
1356	Sf3b6	ENSMUSG00000037361	0.561260446
1357	L2hgdh	ENSMUSG00000020988	0.561232297
1358	Rps27a	ENSMUSG00000020460	0.561222534
1359	Mpp6	ENSMUSG00000038388	0.560892157

1360	Prmt2	ENSMUSG00000020230	0.560223307
1361	Rack1	ENSMUSG00000020372	0.560178981
1362	Rab5a	ENSMUSG00000017831	0.55994017
1363	Slc11a2	ENSMUSG00000023030	0.559739773
1364	Blvra	ENSMUSG00000001999	0.559022061
1365	Lnpk	ENSMUSG00000009207	0.558561254
1366	Sumf1	ENSMUSG00000030101	0.558050627
1367	Dusp27	ENSMUSG00000026564	0.557232968
1368	Zfp330	ENSMUSG000000031711	0.556388189
1369	Tasp1	ENSMUSG00000039033	0.555967599
1370	Asap2	ENSMUSG000000052632	0.555036211
1371	Ptpn1	ENSMUSG00000027540	0.554938869
1372	Zbtb6	ENSMUSG000000066798	0.554409184
1373	Hnrnpf	ENSMUSG000000042079	0.553946945
1374	Ppip5k1	ENSMUSG000000033526	0.553921651
1375	Arhgap12	ENSMUSG000000041225	0.553714279
1376	Ddost	ENSMUSG000000028757	0.552975811
1377	Fcf1	ENSMUSG000000021243	0.551800679
1378	Gm10275	ENSMUSG000000069682	0.551041155
1379	Rnft1	ENSMUSG000000020521	0.549530386
1380	Gm15500	ENSMUSG000000086583	0.549512492
1381	Cct2	ENSMUSG000000034024	0.549296809
1382	Esyt2	ENSMUSG000000021171	0.549186355
1383	Anapc10	ENSMUSG000000036977	0.548612062
1384	Gfpt1	ENSMUSG000000029992	0.548423544
1385	Ufm1	ENSMUSG000000027746	0.547345291
1386	Rps12	ENSMUSG000000061983	0.547126738
1387	Wbscr22	ENSMUSG000000005378	0.546905029
1388	Plekho1	ENSMUSG000000015745	0.546833989
1389	Jund	ENSMUSG000000071076	0.546304886
1390	Tcerg1	ENSMUSG000000024498	0.546265948
1391	Tesk1	ENSMUSG000000028458	0.545899804
1392	Eif2s1	ENSMUSG000000021116	0.545643719
1393	Mtr	ENSMUSG000000021311	0.544752927
1394	Fam192a	ENSMUSG000000031774	0.5444488305
1395	Cacul1	ENSMUSG000000033417	0.54428689
1396	Ran	ENSMUSG000000029430	0.542801135
1397	Commd4	ENSMUSG000000032299	0.542503083
1398	Pcdhgc3	ENSMUSG000000102918	0.541874673
1399	Gsr	ENSMUSG000000031584	0.541721894
1400	Ascc2	ENSMUSG000000020412	0.540838018
1401	Edem3	ENSMUSG000000043019	0.540722206
1402	Scamp2	ENSMUSG000000040188	0.540442832
1403	Gyg	ENSMUSG000000019528	0.539156464
1404	Tatdn1	ENSMUSG000000050891	0.538008144
1405	Tgm2	ENSMUSG000000037820	0.537466052
1406	Snrpf	ENSMUSG000000020018	0.536775913

1407	Uba5	ENSMUSG00000032557	0.536745484
1408	Gnptab	ENSMUSG00000035311	0.536514154
1409	Smpx	ENSMUSG00000041476	0.536432807
1410	Zc3h7a	ENSMUSG00000037965	0.536316795
1411	Gm26917	ENSMUSG00000097971	0.53567106
1412	Gls	ENSMUSG00000026103	0.535524031
1413	Sdcbp	ENSMUSG00000028249	0.534253874
1414	Arhgap20	ENSMUSG00000053199	0.534000412
1415	Anxa7	ENSMUSG00000021814	0.532414861
1416	Gm6136	ENSMUSG00000084106	0.532066705
1417	Maged2	ENSMUSG00000025268	0.531469614
1418	Rpl13	ENSMUSG00000000740	0.531304063
1419	Txndc17	ENSMUSG00000020803	0.530715324
1420	Polr1b	ENSMUSG00000027395	0.530455322
1421	Pgrmc2	ENSMUSG00000049940	0.528930034
1422	Sec61a1	ENSMUSG00000030082	0.528825325
1423	Selenok	ENSMUSG00000042682	0.528515985
1424	Mettl2	ENSMUSG00000020691	0.52787577
1425	Nedd4l	ENSMUSG00000024589	0.527241157
1426	Hspa14	ENSMUSG00000109865	0.526804674
1427	Rpl4	ENSMUSG00000032399	0.526427875
1428	Timm17b	ENSMUSG00000031158	0.526378283
1429	Ogfrl1	ENSMUSG00000026158	0.525974161
1430	Twf2	ENSMUSG00000023277	0.524151338
1431	Qars	ENSMUSG00000032604	0.52410875
1432	Zcchc7	ENSMUSG00000035649	0.523261157
1433	Sec24a	ENSMUSG00000036391	0.523249415
1434	Gm9794	ENSMUSG00000107176	0.522853865
1435	Vapa	ENSMUSG00000024091	0.521932574
1436	Cct5	ENSMUSG00000022234	0.521632792
1437	Ythdc2	ENSMUSG00000034653	0.521246085
1438	Rps18	ENSMUSG00000008668	0.521134919
1439	Gtf3c6	ENSMUSG00000019837	0.520981546
1440	Imp4	ENSMUSG00000026127	0.520974461
1441	Atp6v0a2	ENSMUSG00000038023	0.520967279
1442	Eef1d	ENSMUSG00000055762	0.520926659
1443	Pabpc1	ENSMUSG00000022283	0.520114387
1444	Usp9x	ENSMUSG00000031010	0.520076771
1445	Mtmr9	ENSMUSG00000035078	0.519041252
1446	Uap1	ENSMUSG00000026670	0.518762823
1447	Lmna	ENSMUSG00000028063	0.518272094
1448	Msn	ENSMUSG00000031207	0.51705165
1449	Rpl37	ENSMUSG00000041841	0.516447015
1450	Arpc1b	ENSMUSG00000029622	0.515515079
1451	Elof1	ENSMUSG00000013822	0.515378858
1452	Khsrp	ENSMUSG00000007670	0.515315131
1453	Uba6	ENSMUSG00000035898	0.515108656

1454	Dpysl3	ENSMUSG00000024501	0.51427296
1455	Ergic1	ENSMUSG00000001576	0.513845711
1456	Mib1	ENSMUSG00000024294	0.513508284
1457	Snx6	ENSMUSG00000005656	0.513002019
1458	Ddx27	ENSMUSG00000017999	0.512623582
1459	Rspry1	ENSMUSG00000050079	0.512027889
1460	Scfd1	ENSMUSG00000020952	0.511947739
1461	Bysl	ENSMUSG00000023988	0.510829898
1462	Pnp	ENSMUSG00000021871	0.510733136
1463	Adamts2	ENSMUSG00000036545	0.510538921
1464	Ralgps1	ENSMUSG00000038831	0.510487815
1465	Exosc9	ENSMUSG00000027714	0.509835303
1466	Abce1	ENSMUSG00000058355	0.509233442
1467	Dyrk2	ENSMUSG00000028630	0.508790477
1468	Dis3	ENSMUSG00000033166	0.508518208
1469	Rplp1	ENSMUSG00000007892	0.508212368
1470	Ccdc6	ENSMUSG00000048701	0.507225369
1471	Hspa13	ENSMUSG00000032932	0.507138892
1472	Wdr43	ENSMUSG00000041057	0.506417679
1473	Epb41	ENSMUSG00000028906	0.505875092
1474	Mtpn	ENSMUSG00000029840	0.505665596
1475	Atr	ENSMUSG00000032409	0.505648778
1476	Nupl1	ENSMUSG00000063895	0.505096689
1477	Traf7	ENSMUSG00000052752	0.504886147
1478	Ptges3-ps	ENSMUSG00000040078	0.504635487
1479	Rps20	ENSMUSG00000028234	0.504393132
1480	Eif5a	ENSMUSG00000078812	0.502601419
1481	Tbce	ENSMUSG00000039233	0.502541866
1482	Psme2	ENSMUSG00000079197	0.502236661
1483	Plaa	ENSMUSG00000028577	0.501379027
1484	Mtdh	ENSMUSG00000022255	0.501300669
1485	Rpl15	ENSMUSG00000012405	0.50108021
1486	Rps23	ENSMUSG00000049517	0.50065545
1487	Larp1	ENSMUSG00000037331	0.500420423
1488	Eif2a	ENSMUSG00000027810	0.500170125
1489	1110008F13Rik	ENSMUSG00000027637	0.499021313
1490	Ap2b1	ENSMUSG00000035152	0.498820397
1491	Pes1	ENSMUSG00000020430	0.498363938
1492	Pigm	ENSMUSG00000050229	0.498275869
1493	Nmt1	ENSMUSG00000020936	0.498171532
1494	Set	ENSMUSG00000054766	0.498097334
1495	Ttc13	ENSMUSG00000037300	0.498063021
1496	Utp11	ENSMUSG00000028907	0.497994406
1497	Naa25	ENSMUSG00000042719	0.497062382
1498	Twf1	ENSMUSG00000022451	0.496746642
1499	Nacc1	ENSMUSG00000001910	0.496606494
1500	Ngdn	ENSMUSG00000022204	0.496259281

1501	Exoc2	ENSMUSG00000021357	0.495969666
1502	Rps8	ENSMUSG00000047675	0.495867146
1503	Sept10	ENSMUSG00000019917	0.495383284
1504	Dhx29	ENSMUSG00000042426	0.494292892
1505	Nelfe	ENSMUSG00000024369	0.494029333
1506	Snx4	ENSMUSG00000022808	0.492311794
1507	Dnajb2	ENSMUSG00000026203	0.491360664
1508	Rrp36	ENSMUSG00000023971	0.490777527
1509	Vcpip1	ENSMUSG00000045210	0.489566213
1510	Btf3	ENSMUSG00000021660	0.488985218
1511	Snap29	ENSMUSG00000022765	0.488839177
1512	Gdap2	ENSMUSG00000027865	0.486409295
1513	Col5a2	ENSMUSG00000026042	0.48619249
1514	Tnpo1	ENSMUSG00000009470	0.485193635
1515	Mtmr12	ENSMUSG00000039458	0.484172984
1516	Kdelr2	ENSMUSG00000079111	0.484165692
1517	Zfp809	ENSMUSG00000057982	0.483616479
1518	Wnk1	ENSMUSG00000045962	0.482921099
1519	Cdc42	ENSMUSG00000006699	0.48291774
1520	Rpain	ENSMUSG00000018449	0.482469071
1521	Ifnar1	ENSMUSG00000022967	0.481257099
1522	Capza1	ENSMUSG00000070372	0.48085383
1523	Pex2	ENSMUSG00000040374	0.480696842
1524	Usp22	ENSMUSG00000042506	0.480619961
1525	Ap1s1	ENSMUSG00000004849	0.480458595
1526	Ank3	ENSMUSG00000069601	0.480387379
1527	BC017643	ENSMUSG00000039294	0.480156834
1528	Nrd1	ENSMUSG00000053510	0.479951824
1529	Atp6v1a	ENSMUSG00000052459	0.479716457
1530	Cpeb2	ENSMUSG00000039782	0.479321725
1531	Rpl27a	ENSMUSG00000046364	0.478058747
1532	Rplp0	ENSMUSG00000067274	0.477678845
1533	Tmem57	ENSMUSG00000028826	0.477620117
1534	Aspscr1	ENSMUSG00000025142	0.476714939
1535	Rpl35a	ENSMUSG00000060636	0.476592185
1536	Eif3c	ENSMUSG00000030738	0.476556054
1537	Fer	ENSMUSG00000000127	0.475780649
1538	Nsun2	ENSMUSG00000021595	0.475446391
1539	Tmem159	ENSMUSG00000030917	0.474912436
1540	Pikfyve	ENSMUSG00000025949	0.474014519
1541	Rap1a	ENSMUSG00000068798	0.47161947
1542	Zfp277	ENSMUSG00000055917	0.471340675
1543	Kras	ENSMUSG00000030265	0.47105097
1544	Prrc1	ENSMUSG00000024594	0.46918257
1545	Meis1	ENSMUSG00000020160	0.468645237
1546	Tatdn2	ENSMUSG00000056952	0.468427648
1547	Rpl18	ENSMUSG00000059070	0.468298467

1548	Apobec2	ENSMUSG00000040694	0.467918891
1549	Nop9	ENSMUSG00000019297	0.467913558
1550	Ppme1	ENSMUSG00000030718	0.467808746
1551	Hnrnpab	ENSMUSG00000020358	0.467596901
1552	Rps7	ENSMUSG00000061477	0.467217561
1553	Polr3d	ENSMUSG00000000776	0.466640189
1554	Tmem131	ENSMUSG00000026116	0.466395694
1555	Rprd1a	ENSMUSG00000040446	0.46630709
1556	Large1	ENSMUSG00000004383	0.465827982
1557	Ppm1a	ENSMUSG00000021096	0.465810417
1558	Impdh2	ENSMUSG00000062867	0.464314265
1559	Foxk2	ENSMUSG00000039275	0.464100051
1560	Slc39a1	ENSMUSG00000052310	0.463241415
1561	Sec22b	ENSMUSG00000027879	0.462370633
1562	Rnf220	ENSMUSG00000028677	0.462087496
1563	Hprt	ENSMUSG00000025630	0.461867288
1564	Stt3a	ENSMUSG00000032116	0.460882392
1565	Rusc2	ENSMUSG00000035969	0.460422338
1566	Fbxo30	ENSMUSG00000047648	0.459889961
1567	Ptbp1	ENSMUSG00000006498	0.459552879
1568	Pdcd6ip	ENSMUSG00000032504	0.459538872
1569	Pak1ip1	ENSMUSG00000038683	0.45920386
1570	Rpl5	ENSMUSG00000058558	0.45759172
1571	Gclc	ENSMUSG00000032350	0.457365506
1572	Atp6v0e	ENSMUSG00000015575	0.455534365
1573	Tspo	ENSMUSG00000041736	0.455357739
1574	Rngtt	ENSMUSG00000028274	0.45518463
1575	Arpc5	ENSMUSG00000008475	0.455169113
1576	Vta1	ENSMUSG00000019868	0.455165181
1577	Nup153	ENSMUSG00000021374	0.452302113
1578	Rpl19-ps11	ENSMUSG00000081094	0.451845185
1579	Sdc2	ENSMUSG00000022261	0.451375996
1580	Kpna2	ENSMUSG00000018362	0.451108853
1581	Cct7	ENSMUSG00000030007	0.451064726
1582	Plekha3	ENSMUSG00000002733	0.450449321
1583	Trim47	ENSMUSG00000020773	0.450051423
1584	Ell2	ENSMUSG00000001542	0.449405846
1585	Psm13	ENSMUSG00000025487	0.449189383
1586	Ube2s	ENSMUSG00000060860	0.448979167
1587	Ncln	ENSMUSG00000020238	0.448881513
1588	Tprgl	ENSMUSG00000029030	0.447808781
1589	Anxa5	ENSMUSG00000027712	0.447580481
1590	C1galt1	ENSMUSG00000042460	0.447490504
1591	Otud6b	ENSMUSG00000040550	0.447360687
1592	Gpr89	ENSMUSG00000028096	0.446185855
1593	Rpl6	ENSMUSG00000029614	0.445430246
1594	Creb3	ENSMUSG00000028466	0.444868288

1595	Acbd3	ENSMUSG00000026499	0.444834976
1596	Myl6	ENSMUSG00000090841	0.44477446
1597	Celf2	ENSMUSG00000002107	0.443389626
1598	Stk4	ENSMUSG00000018209	0.44306901
1599	Stam2	ENSMUSG00000055371	0.442407482
1600	Bcl10	ENSMUSG00000028191	0.441448134
1601	Ankrd13a	ENSMUSG00000041870	0.441141247
1602	Ubxn4	ENSMUSG00000026353	0.440828321
1603	Txn1	ENSMUSG00000028367	0.440760263
1604	Nt5c2	ENSMUSG00000025041	0.440499317
1605	Vim	ENSMUSG00000026728	0.440447875
1606	Tnpo2	ENSMUSG00000031691	0.440413941
1607	Actl6a	ENSMUSG00000027671	0.439581209
1608	Apc	ENSMUSG00000005871	0.438561537
1609	Ipo7	ENSMUSG00000066232	0.438287864
1610	Atxn10	ENSMUSG00000016541	0.438244785
1611	Clec16a	ENSMUSG00000068663	0.438069619
1612	Hspb2	ENSMUSG00000038086	0.437749757
1613	Klh28	ENSMUSG00000020948	0.436341544
1614	Tapt1	ENSMUSG00000046985	0.4344988
1615	Lnx2	ENSMUSG00000016520	0.433632558
1616	Raph1	ENSMUSG00000026014	0.433568542
1617	Rab8a	ENSMUSG00000003037	0.433239524
1618	Dnajc14	ENSMUSG00000025354	0.432367351
1619	Lig3	ENSMUSG00000020697	0.43221014
1620	Ppp1r10	ENSMUSG00000039220	0.432036417
1621	Golgb1	ENSMUSG00000034243	0.431179617
1622	Agps	ENSMUSG00000042410	0.429622442
1623	2410004B18Rik	ENSMUSG00000036873	0.429123234
1624	Polr1d	ENSMUSG00000029642	0.429083038
1625	Ifit2	ENSMUSG00000045932	0.428185087
1626	Pdpk1	ENSMUSG00000024122	0.427992282
1627	Shc1	ENSMUSG00000042626	0.427736386
1628	Rpl11	ENSMUSG00000059291	0.427510886
1629	Psen1	ENSMUSG00000019969	0.425337299
1630	Mob1b	ENSMUSG00000006262	0.424911449
1631	Dnajb14	ENSMUSG00000074212	0.424691855
1632	Pdcl	ENSMUSG00000009030	0.423479042
1633	Nfe2l1	ENSMUSG00000038615	0.423458423
1634	Cerk	ENSMUSG00000035891	0.422612544
1635	Uspl1	ENSMUSG00000041264	0.422298345
1636	Zfr	ENSMUSG00000022201	0.422083471
1637	Zzef1	ENSMUSG00000055670	0.421255634
1638	Arhgap35	ENSMUSG00000058230	0.421243693
1639	Cpsf2	ENSMUSG00000041781	0.421154457
1640	Senp2	ENSMUSG00000022855	0.420867142
1641	Vkorc1l1	ENSMUSG00000066735	0.419948769

1642	Tor1aip2	ENSMUSG00000050565	0.419690379
1643	Gopc	ENSMUSG00000019861	0.418279038
1644	Rpl19	ENSMUSG00000017404	0.417853569
1645	Ormdl3	ENSMUSG00000038150	0.41609523
1646	Vps50	ENSMUSG00000001376	0.416003245
1647	Tmem167b	ENSMUSG00000068732	0.4141696
1648	Atp2b1	ENSMUSG00000019943	0.413375903
1649	Ctr9	ENSMUSG00000005609	0.411103842
1650	Rpl32	ENSMUSG000000057841	0.410686893
1651	Shmt2	ENSMUSG00000025403	0.410606786
1652	Nfu1	ENSMUSG00000029993	0.410467612
1653	Rtfdc1	ENSMUSG00000027502	0.409129447
1654	Rpl36a	ENSMUSG00000079435	0.406900204
1655	Arhgap44	ENSMUSG00000033389	0.406653807
1656	Mapkap1	ENSMUSG00000038696	0.403232633
1657	Cdc27	ENSMUSG00000020687	0.397319585
1658	Rpl38	ENSMUSG000000057322	0.395963629
1659	Rps28	ENSMUSG000000067288	0.395527258
1660	Agpat5	ENSMUSG000000031467	0.395433606
1661	Usp16	ENSMUSG00000025616	0.394837266
1662	Kmt2c	ENSMUSG00000038056	0.393548682
1663	Rps11	ENSMUSG00000003429	0.390542775
1664	Nckap1	ENSMUSG00000027002	0.39046974
1665	Rps6	ENSMUSG00000028495	0.389588619
1666	Rpl23	ENSMUSG000000071415	0.388202902
1667	Spcs1	ENSMUSG00000021917	0.388074753
1668	Rer1	ENSMUSG00000029048	0.387121349
1669	Rpl21	ENSMUSG000000041453	0.387085901
1670	Herpud2	ENSMUSG000000008429	0.387057779
1671	Tex2	ENSMUSG000000040548	0.387042778
1672	Rpl34	ENSMUSG000000062006	0.384011235
1673	Rad23b	ENSMUSG00000028426	0.382016811
1674	Smurf2	ENSMUSG00000018363	0.381844884
1675	Ssu72	ENSMUSG00000029038	0.378402997
1676	Actr2	ENSMUSG00000020152	0.372350328
1677	Sec16a	ENSMUSG00000026924	0.368718913
1678	Vcl	ENSMUSG00000021823	0.367809184
1679	Kcmf1	ENSMUSG000000055239	0.366537133
1680	Hist1h2bc	ENSMUSG00000018102	0.366213554
1681	Ap3d1	ENSMUSG00000020198	0.365877498
1682	Gspt1	ENSMUSG000000062203	0.362498791
1683	Emg1	ENSMUSG000000004268	0.36048787
1684	Rpl26	ENSMUSG000000060938	0.358523171
1685	Papola	ENSMUSG00000021111	0.353600692
1686	Ltn1	ENSMUSG000000052299	0.346780688
1687	Zbtb18	ENSMUSG000000063659	0.345898917
1688	Dync1i2	ENSMUSG00000027012	0.343053737

1689	Gm12338	ENSMUSG00000081485	-0.32659715
1690	Stard13	ENSMUSG00000016128	-0.33002037
1691	Mcur1	ENSMUSG00000021371	-0.331018492
1692	Anapc16	ENSMUSG00000020107	-0.334941423
1693	Ctcf	ENSMUSG00000005698	-0.340043238
1694	Gid4	ENSMUSG00000018415	-0.341031179
1695	Suclg1	ENSMUSG00000052738	-0.344632806
1696	Phkb	ENSMUSG00000036879	-0.345880192
1697	Mrpl16	ENSMUSG00000024683	-0.347104116
1698	Nt5c3	ENSMUSG00000029780	-0.347197258
1699	Ndufa4	ENSMUSG00000029632	-0.347321075
1700	Dld	ENSMUSG00000020664	-0.348359566
1701	Ndufs5	ENSMUSG00000028648	-0.349959395
1702	Mtif2	ENSMUSG00000020459	-0.351120021
1703	Mrpl41	ENSMUSG00000036850	-0.351442806
1704	Flcn	ENSMUSG00000032633	-0.353979766
1705	Apoo	ENSMUSG00000079508	-0.354620094
1706	Rpa1	ENSMUSG00000000751	-0.354874065
1707	Aplp2	ENSMUSG00000031996	-0.355060563
1708	Eif4a2	ENSMUSG00000022884	-0.355081246
1709	Ktn1	ENSMUSG00000021843	-0.35553506
1710	Idh3a	ENSMUSG00000032279	-0.356127016
1711	Ghr	ENSMUSG00000055737	-0.356919536
1712	Uqcr11	ENSMUSG00000020163	-0.363028684
1713	Arhgef6	ENSMUSG00000031133	-0.364397921
1714	Snapin	ENSMUSG00000001018	-0.364730865
1715	Rab12	ENSMUSG00000023460	-0.366912246
1716	Zbtb44	ENSMUSG00000047412	-0.3678623
1717	Tfb2m	ENSMUSG00000026492	-0.368367894
1718	Bola3	ENSMUSG00000045160	-0.368409315
1719	AI314180	ENSMUSG00000050812	-0.370341583
1720	Pkig	ENSMUSG00000035268	-0.370865955
1721	Gfm1	ENSMUSG00000027774	-0.372045633
1722	Rfc1	ENSMUSG00000029191	-0.373279742
1723	Mrps7	ENSMUSG00000046756	-0.373571505
1724	Tmem70	ENSMUSG00000025940	-0.373700669
1725	Rgl2	ENSMUSG00000041354	-0.374237516
1726	Comt	ENSMUSG00000000326	-0.374500043
1727	Ttc3	ENSMUSG00000040785	-0.375445622
1728	Slc2a4	ENSMUSG00000018566	-0.376367489
1729	Apbb2	ENSMUSG00000029207	-0.376437254
1730	Slc29a1	ENSMUSG00000023942	-0.377334309
1731	Ephb4	ENSMUSG00000029710	-0.378476259
1732	Podxl	ENSMUSG00000025608	-0.378840206
1733	Acad8	ENSMUSG00000031969	-0.380084657
1734	Nfs1	ENSMUSG00000027618	-0.380273806
1735	Mov10l1	ENSMUSG00000015365	-0.380571431

1736	Rbfa	ENSMUSG00000024570	-0.380868045
1737	Vdac1	ENSMUSG00000020402	-0.38107449
1738	Cmtm4	ENSMUSG00000096188	-0.381093678
1739	Gns	ENSMUSG00000034707	-0.382467044
1740	Vezf1	ENSMUSG00000018377	-0.382484952
1741	Ahcyl1	ENSMUSG00000027893	-0.383608464
1742	Ppp2r3a	ENSMUSG00000043154	-0.383720923
1743	Ciapi1	ENSMUSG00000031781	-0.384716711
1744	Adh5	ENSMUSG00000028138	-0.385524887
1745	Jmy	ENSMUSG00000021690	-0.386333091
1746	Palld	ENSMUSG00000058056	-0.38674525
1747	Hibch	ENSMUSG00000041426	-0.386842623
1748	Mrpl45	ENSMUSG00000018882	-0.386998359
1749	Irak1	ENSMUSG00000031392	-0.388013884
1750	Etfb	ENSMUSG00000004610	-0.388530487
1751	Shroom4	ENSMUSG00000068270	-0.38858819
1752	Palmd	ENSMUSG00000033377	-0.38982511
1753	Prex2	ENSMUSG00000048960	-0.389829878
1754	Ank	ENSMUSG00000022265	-0.390274588
1755	Bves	ENSMUSG00000071317	-0.39070521
1756	Spin1	ENSMUSG00000021395	-0.391893133
1757	Uqcc1	ENSMUSG00000005882	-0.392293332
1758	Mlip	ENSMUSG00000032355	-0.393328936
1759	Adgre5	ENSMUSG00000002885	-0.39416034
1760	5730455P16Rik	ENSMUSG00000057181	-0.394775112
1761	Uaca	ENSMUSG00000034485	-0.395337858
1762	Mrpl50	ENSMUSG00000044018	-0.39562716
1763	P4ha2	ENSMUSG00000018906	-0.396374056
1764	Tcf4	ENSMUSG00000053477	-0.396465483
1765	Supv3l1	ENSMUSG00000020079	-0.39674517
1766	Pdrg1	ENSMUSG00000027472	-0.396891552
1767	Xdh	ENSMUSG00000024066	-0.397427326
1768	Mrps31	ENSMUSG00000031533	-0.399327557
1769	Mrpl42	ENSMUSG00000062981	-0.400101018
1770	Tsnax	ENSMUSG00000056820	-0.400419765
1771	Pdss2	ENSMUSG00000038240	-0.401185742
1772	Prdx2	ENSMUSG00000005161	-0.401256028
1773	Ecsit	ENSMUSG00000066839	-0.401710685
1774	Plekha2	ENSMUSG00000031557	-0.402065752
1775	Smpd13a	ENSMUSG00000019872	-0.402201202
1776	1810037117Rik	ENSMUSG00000054091	-0.4027868
1777	Sf3b2	ENSMUSG00000024853	-0.402934623
1778	Stard8	ENSMUSG00000031216	-0.403251273
1779	Ndufc1	ENSMUSG00000037152	-0.403557617
1780	Uqcrb	ENSMUSG00000021520	-0.40472659
1781	Filip1	ENSMUSG00000034898	-0.404808973
1782	Man2a2	ENSMUSG00000038886	-0.404907511

1783	Csnk1e	ENSMUSG00000022433	-0.405508405
1784	Mmaa	ENSMUSG00000037022	-0.405567551
1785	Man2c1	ENSMUSG00000032295	-0.405740406
1786	Atp5j2	ENSMUSG00000038690	-0.406058583
1787	Rcor3	ENSMUSG00000037395	-0.406366566
1788	Ndufa1	ENSMUSG00000016427	-0.406645634
1789	Ptprg	ENSMUSG00000021745	-0.40686054
1790	Rad23a	ENSMUSG00000003813	-0.406870035
1791	Vegfa	ENSMUSG00000023951	-0.407265505
1792	Cox5a	ENSMUSG00000000088	-0.4082817
1793	Eid1	ENSMUSG000000091337	-0.408287989
1794	St3gal6	ENSMUSG00000022747	-0.408502881
1795	Cenpb	ENSMUSG00000068267	-0.409653595
1796	Atp5o	ENSMUSG00000022956	-0.412328593
1797	Cox6c	ENSMUSG00000014313	-0.412378508
1798	Ets1	ENSMUSG00000032035	-0.412577739
1799	Smim14	ENSMUSG00000037822	-0.412740696
1800	Hars2	ENSMUSG00000019143	-0.41348714
1801	Tspan3	ENSMUSG00000032324	-0.413902501
1802	Zfp106	ENSMUSG00000027288	-0.413933106
1803	Atp5l	ENSMUSG00000038717	-0.415039908
1804	Rev1	ENSMUSG00000026082	-0.416685113
1805	Nedd4	ENSMUSG00000032216	-0.417731119
1806	Cbr4	ENSMUSG00000031641	-0.417802571
1807	Mrps16	ENSMUSG00000049960	-0.418700587
1808	Ndufb9	ENSMUSG00000022354	-0.418964058
1809	Rrm2b	ENSMUSG00000022292	-0.41953781
1810	Wrnip1	ENSMUSG00000021400	-0.41975903
1811	Cd200	ENSMUSG00000022661	-0.420676199
1812	Zc3h7b	ENSMUSG00000022390	-0.421420534
1813	Cttnbip1	ENSMUSG00000028988	-0.422896573
1814	Smarcc2	ENSMUSG00000025369	-0.423145415
1815	Hmox2	ENSMUSG00000004070	-0.424059285
1816	Msra	ENSMUSG00000054733	-0.425212209
1817	Tbc1d4	ENSMUSG00000033083	-0.425428003
1818	Fnip2	ENSMUSG00000061175	-0.425637595
1819	Smim10l1	ENSMUSG00000072704	-0.426200429
1820	Mllt6	ENSMUSG00000038437	-0.426853875
1821	A430105l19Rik	ENSMUSG00000045838	-0.42714695
1822	Cox4i1	ENSMUSG00000031818	-0.427344389
1823	Atp5h	ENSMUSG00000034566	-0.428650804
1824	Lgr6	ENSMUSG00000042793	-0.428864712
1825	Kansl1l	ENSMUSG00000026004	-0.428936192
1826	Zcchc24	ENSMUSG00000055538	-0.428954267
1827	Epm2aip1	ENSMUSG00000046785	-0.429076658
1828	Tek	ENSMUSG00000006386	-0.429972944
1829	Rftn1	ENSMUSG00000039316	-0.430023071

1830	Glrx	ENSMUSG00000021591	-0.430608355
1831	Pde3a	ENSMUSG00000041741	-0.431316752
1832	Selenoo	ENSMUSG00000035757	-0.431788726
1833	Cep68	ENSMUSG00000044066	-0.433319355
1834	Cygb	ENSMUSG00000020810	-0.433380582
1835	Timm8b	ENSMUSG00000039016	-0.434000733
1836	Mrpl18	ENSMUSG00000057388	-0.434135841
1837	Pgm2l1	ENSMUSG00000030729	-0.434628608
1838	Tcaim	ENSMUSG00000046603	-0.434875459
1839	Mrps33	ENSMUSG00000029918	-0.436279358
1840	Dtnbp1	ENSMUSG00000057531	-0.436589855
1841	Aifm2	ENSMUSG00000020085	-0.437862777
1842	Carnmt1	ENSMUSG00000024726	-0.437956886
1843	Pgm2	ENSMUSG00000025791	-0.439670892
1844	Ndufv1	ENSMUSG00000037916	-0.440429544
1845	Ndufc2	ENSMUSG00000030647	-0.440578639
1846	Polr3gl	ENSMUSG00000028104	-0.440798662
1847	Tnfrsf21	ENSMUSG00000023915	-0.440842091
1848	Ndufb11	ENSMUSG00000031059	-0.441603042
1849	Rapgef3	ENSMUSG00000022469	-0.441829968
1850	Acadsb	ENSMUSG00000030861	-0.444605804
1851	Gtf3c1	ENSMUSG00000032777	-0.444671925
1852	Reln	ENSMUSG00000042453	-0.444903345
1853	Lrba	ENSMUSG00000028080	-0.445188289
1854	Twnk	ENSMUSG00000025209	-0.44587355
1855	Stard9	ENSMUSG00000033705	-0.446203538
1856	Alas1	ENSMUSG00000032786	-0.44675888
1857	Txnrc15	ENSMUSG00000021497	-0.447884249
1858	Arhgef15	ENSMUSG00000052921	-0.448100767
1859	Fastk	ENSMUSG00000028959	-0.448346517
1860	Ndufa7	ENSMUSG00000041881	-0.449967011
1861	Thbd	ENSMUSG00000074743	-0.450155336
1862	Adgrl4	ENSMUSG00000039167	-0.45172235
1863	Cacna1c	ENSMUSG00000051331	-0.452305951
1864	Timm29	ENSMUSG00000048429	-0.452729912
1865	Jph1	ENSMUSG00000042686	-0.452941575
1866	Rn7sk	ENSMUSG00000065037	-0.453002356
1867	Foxo3	ENSMUSG00000048756	-0.453234902
1868	Tspan12	ENSMUSG00000029669	-0.453579874
1869	Mpc1	ENSMUSG00000023861	-0.454010318
1870	Arap3	ENSMUSG00000024451	-0.454430577
1871	Tmtc1	ENSMUSG00000030306	-0.454589227
1872	Bcap29	ENSMUSG00000020650	-0.45519177
1873	Tinagl1	ENSMUSG00000028776	-0.455269169
1874	Ndufb5	ENSMUSG00000027673	-0.456644444
1875	Ank2	ENSMUSG00000032826	-0.457002989
1876	Spg7	ENSMUSG00000000738	-0.457273898

1877	Clpb	ENSMUSG00000001829	-0.45828199
1878	Uty	ENSMUSG00000068457	-0.458496734
1879	Ermp1	ENSMUSG00000046324	-0.458528901
1880	Slc25a4	ENSMUSG00000031633	-0.458537686
1881	Map2k7	ENSMUSG00000002948	-0.459089576
1882	Slc16a10	ENSMUSG00000019838	-0.459239262
1883	Sod2	ENSMUSG00000006818	-0.460048499
1884	Suclg2	ENSMUSG00000061838	-0.460555344
1885	Ppp1r3c	ENSMUSG00000067279	-0.46061362
1886	Cisd1	ENSMUSG00000037710	-0.461040091
1887	Cers4	ENSMUSG00000008206	-0.461041525
1888	Fnbp1l	ENSMUSG00000039735	-0.462111249
1889	Cdh13	ENSMUSG00000031841	-0.462446889
1890	Naa35	ENSMUSG00000021555	-0.463136319
1891	Mcc	ENSMUSG00000071856	-0.463216951
1892	E2f6	ENSMUSG00000057469	-0.463828688
1893	Rxra	ENSMUSG00000015846	-0.46390427
1894	Plxna2	ENSMUSG00000026640	-0.464090077
1895	Tfpi	ENSMUSG00000027082	-0.464151348
1896	Nectin2	ENSMUSG00000062300	-0.464518076
1897	Id1	ENSMUSG00000042745	-0.465373756
1898	Atp5k	ENSMUSG00000050856	-0.465861938
1899	Fgd4	ENSMUSG00000022788	-0.465947898
1900	Polrmt	ENSMUSG00000020329	-0.466013171
1901	Gdi1	ENSMUSG00000015291	-0.466500275
1902	Cyth1	ENSMUSG00000017132	-0.466603943
1903	Rdh14	ENSMUSG00000020621	-0.467924562
1904	Man2b1	ENSMUSG00000005142	-0.467970752
1905	Cebpzos	ENSMUSG00000062691	-0.468072836
1906	Cox10	ENSMUSG00000042148	-0.46855685
1907	Lamb1	ENSMUSG00000002900	-0.468698685
1908	Sdhb	ENSMUSG00000009863	-0.469939549
1909	Smim8	ENSMUSG00000028295	-0.470234616
1910	Rora	ENSMUSG00000032238	-0.470431033
1911	Sash1	ENSMUSG00000015305	-0.471569521
1912	Ndufa10	ENSMUSG00000026260	-0.471907212
1913	Inpp1	ENSMUSG00000032737	-0.471926812
1914	Cog6	ENSMUSG00000027742	-0.472050199
1915	Abca8b	ENSMUSG00000020620	-0.472167165
1916	Pfkl	ENSMUSG00000020277	-0.472372865
1917	Fbxo3	ENSMUSG00000027180	-0.472386005
1918	Epha2	ENSMUSG00000006445	-0.472681309
1919	Lsm3	ENSMUSG00000034192	-0.472934874
1920	Mcu	ENSMUSG00000009647	-0.47390754
1921	Zfp46	ENSMUSG00000051351	-0.474136595
1922	Mylk3	ENSMUSG00000031698	-0.47469853
1923	Hexim1	ENSMUSG00000048878	-0.474915967

1924	Reep5	ENSMUSG00000005873	-0.475325833
1925	Phldb2	ENSMUSG00000033149	-0.475769131
1926	Tor1aip1	ENSMUSG00000026466	-0.475785048
1927	Gm14539	ENSMUSG00000084830	-0.476505704
1928	Npr2	ENSMUSG00000028469	-0.476959568
1929	Ndufa13	ENSMUSG00000036199	-0.477006508
1930	Tnni3k	ENSMUSG00000040086	-0.47721625
1931	Meox2	ENSMUSG00000036144	-0.477585602
1932	Sptb	ENSMUSG00000021061	-0.477789659
1933	Dgke	ENSMUSG0000000276	-0.477813778
1934	Mhrt	ENSMUSG00000097652	-0.478564073
1935	Timp3	ENSMUSG00000020044	-0.479300268
1936	Clip1	ENSMUSG00000049550	-0.479458231
1937	Cry2	ENSMUSG00000068742	-0.479977792
1938	Tmed4	ENSMUSG00000004394	-0.480344669
1939	Taf9b	ENSMUSG00000047242	-0.480447869
1940	Bbs2	ENSMUSG00000031755	-0.480648668
1941	Dnajc30	ENSMUSG00000061118	-0.482118886
1942	Sqor	ENSMUSG00000005803	-0.48252714
1943	Got2	ENSMUSG00000031672	-0.482837514
1944	Pcmt2	ENSMUSG00000027589	-0.483453963
1945	Ipo13	ENSMUSG00000033365	-0.483853739
1946	Msh3	ENSMUSG00000014850	-0.484420729
1947	Lama5	ENSMUSG00000015647	-0.484493385
1948	Mtg1	ENSMUSG00000039018	-0.484557299
1949	Smim20	ENSMUSG00000061461	-0.48501137
1950	Slc4a3	ENSMUSG00000006576	-0.48533774
1951	Dtx3	ENSMUSG00000040415	-0.485346335
1952	BC002163	ENSMUSG00000081824	-0.48553041
1953	Myl2	ENSMUSG00000013936	-0.485587731
1954	Coq10a	ENSMUSG00000039914	-0.485795885
1955	Cipc	ENSMUSG00000034157	-0.485832112
1956	Usmg5	ENSMUSG00000071528	-0.485849192
1957	Lpgat1	ENSMUSG00000026623	-0.485877902
1958	Fabp5	ENSMUSG00000027533	-0.486619568
1959	Bcl2l13	ENSMUSG00000009112	-0.487594302
1960	Jcad	ENSMUSG00000033960	-0.487967018
1961	Dsp	ENSMUSG00000054889	-0.488635126
1962	Rsad1	ENSMUSG00000039096	-0.490113874
1963	Ptprs	ENSMUSG00000013236	-0.491214759
1964	Tmem60	ENSMUSG00000045435	-0.491417203
1965	Dhrs1	ENSMUSG00000002332	-0.491445875
1966	Pex6	ENSMUSG00000002763	-0.492441239
1967	Uros	ENSMUSG00000030979	-0.493265423
1968	Plekha6	ENSMUSG00000041757	-0.493672018
1969	Coq7	ENSMUSG00000030652	-0.493836532
1970	Fahd1	ENSMUSG00000045316	-0.493997542

1971	Ldb3	ENSMUSG00000021798	-0.494007521
1972	Mrps21	ENSMUSG00000054312	-0.494314602
1973	Ndufa9	ENSMUSG00000000399	-0.494557785
1974	Ndufa5	ENSMUSG00000023089	-0.494981118
1975	Fmo1	ENSMUSG00000040181	-0.495617612
1976	Msh2	ENSMUSG00000024151	-0.495685067
1977	A630072M18Rik	ENSMUSG00000101013	-0.495706507
1978	Uqcrc2	ENSMUSG00000030884	-0.496340757
1979	4930578C19Rik	ENSMUSG00000037358	-0.496965055
1980	Gm10250	ENSMUSG00000068706	-0.497151867
1981	Slc25a12	ENSMUSG00000027010	-0.49772638
1982	Yae1d1	ENSMUSG00000075054	-0.497888164
1983	Itpkb	ENSMUSG00000038855	-0.498209082
1984	Ndufb4	ENSMUSG00000022820	-0.498355141
1985	Hsd17b10	ENSMUSG00000025260	-0.498427365
1986	Pter	ENSMUSG00000026730	-0.498531238
1987	Sgk1	ENSMUSG00000019970	-0.49854871
1988	Spry1	ENSMUSG00000037211	-0.498721526
1989	Rgs3	ENSMUSG00000059810	-0.498745317
1990	Trip10	ENSMUSG00000019487	-0.499011963
1991	Stap2	ENSMUSG00000038781	-0.499049928
1992	Scp2	ENSMUSG00000028603	-0.499407896
1993	Asb8	ENSMUSG00000048175	-0.499712609
1994	Mavs	ENSMUSG00000037523	-0.499742633
1995	Taz	ENSMUSG00000009995	-0.500141313
1996	Tmem141	ENSMUSG00000026939	-0.500241169
1997	Ndufb8	ENSMUSG00000025204	-0.501315562
1998	Oma1	ENSMUSG00000035069	-0.501666246
1999	Lrpprc	ENSMUSG00000024120	-0.502034908
2000	Prrg1	ENSMUSG00000047996	-0.502152213
2001	Eef1a2	ENSMUSG00000016349	-0.502163664
2002	Mapk14	ENSMUSG00000053436	-0.50273589
2003	Synpo2	ENSMUSG00000050315	-0.503117568
2004	Gm24336	ENSMUSG00000077391	-0.503120293
2005	mt-Nd5	ENSMUSG00000064367	-0.503480609
2006	Araf	ENSMUSG00000001127	-0.503613737
2007	Rarb	ENSMUSG00000017491	-0.504450356
2008	Atp5g3	ENSMUSG00000018770	-0.504692715
2009	Agf	ENSMUSG00000033400	-0.505072435
2010	Ctsh	ENSMUSG00000032359	-0.505149262
2011	Aamdc	ENSMUSG00000035642	-0.505593643
2012	Abcb8	ENSMUSG00000028973	-0.506077791
2013	Agpat2	ENSMUSG00000026922	-0.506377875
2014	Il17rd	ENSMUSG00000040717	-0.506428322
2015	Tnni3	ENSMUSG00000035458	-0.506799461
2016	Sdhc	ENSMUSG00000058076	-0.507034424
2017	Ndrp2	ENSMUSG00000004558	-0.508516892

2018	Zfp189	ENSMUSG00000039634	-0.508517962
2019	Dguok	ENSMUSG00000014554	-0.508771379
2020	Sucla2	ENSMUSG00000022110	-0.50884998
2021	Ndufs6	ENSMUSG00000021606	-0.509185461
2022	Ccser2	ENSMUSG00000058690	-0.510071947
2023	Nub1	ENSMUSG00000028954	-0.510809042
2024	Tpra1	ENSMUSG00000002871	-0.511350163
2025	Pigp	ENSMUSG00000022940	-0.511460763
2026	Myo18b	ENSMUSG00000072720	-0.511561045
2027	Mpc2	ENSMUSG00000026568	-0.512019154
2028	Cd59a	ENSMUSG00000032679	-0.51205851
2029	Rnf150	ENSMUSG00000047747	-0.512159164
2030	Dlst	ENSMUSG00000004789	-0.512538436
2031	Wdr41	ENSMUSG00000042015	-0.513011152
2032	Shroom2	ENSMUSG00000045180	-0.513029325
2033	Dlat	ENSMUSG00000000168	-0.513160027
2034	Ddrgk1	ENSMUSG00000068290	-0.513170347
2035	Pde4dip	ENSMUSG00000038170	-0.513244328
2036	Itpripl1	ENSMUSG00000074825	-0.51328966
2037	Numa1	ENSMUSG00000066306	-0.513641914
2038	Serac1	ENSMUSG00000015659	-0.514078979
2039	Lzts2	ENSMUSG00000035342	-0.514129781
2040	Atp5sl	ENSMUSG00000057229	-0.51500631
2041	Tmem164	ENSMUSG00000047045	-0.515103515
2042	Enpp5	ENSMUSG00000023960	-0.515297892
2043	Stx3	ENSMUSG00000041488	-0.515417429
2044	Oxa1l	ENSMUSG00000000959	-0.515418591
2045	Ppt1	ENSMUSG00000028657	-0.515568171
2046	Rapgef5	ENSMUSG00000041992	-0.515703306
2047	Oxnad1	ENSMUSG00000021906	-0.515790707
2048	Kank3	ENSMUSG00000042099	-0.515830382
2049	Cdkl1	ENSMUSG00000020990	-0.51616523
2050	Mri1	ENSMUSG00000004996	-0.516393709
2051	Smim19	ENSMUSG00000031534	-0.518245643
2052	Mrpl28	ENSMUSG00000024181	-0.518409728
2053	Pdpr	ENSMUSG00000033624	-0.518507964
2054	Osbpl1a	ENSMUSG00000044252	-0.518958127
2055	Pcp4l1	ENSMUSG00000038370	-0.519000315
2056	Tpi1	ENSMUSG00000023456	-0.519242934
2057	Atp5s	ENSMUSG00000054894	-0.5194767
2058	Mpc1-ps	ENSMUSG00000091498	-0.519612732
2059	Rcsd1	ENSMUSG00000040723	-0.519665016
2060	Sema3g	ENSMUSG00000021904	-0.519781263
2061	B4gat1	ENSMUSG00000047379	-0.520238344
2062	Rgs5	ENSMUSG00000026678	-0.520650108
2063	Apip	ENSMUSG00000010911	-0.521321785
2064	Nsun4	ENSMUSG00000028706	-0.52210889

2065	Gadd45gip1	ENSMUSG00000033751	-0.522153683
2066	Dnajc19	ENSMUSG00000027679	-0.522242961
2067	Fundc2	ENSMUSG00000031198	-0.522678557
2068	Flt1	ENSMUSG00000029648	-0.522794395
2069	Sparcl1	ENSMUSG00000029309	-0.523157839
2070	Plscr4	ENSMUSG00000032377	-0.523405332
2071	Prrx1	ENSMUSG00000026586	-0.52369073
2072	Gm43185	ENSMUSG00000104621	-0.523832049
2073	Nicn1	ENSMUSG00000032606	-0.523892882
2074	Gab1	ENSMUSG00000031714	-0.524940392
2075	Erg	ENSMUSG00000040732	-0.525724942
2076	Rasgrf2	ENSMUSG00000021708	-0.526410438
2077	Cobll1	ENSMUSG00000034903	-0.527084863
2078	Gm25395	ENSMUSG00000087968	-0.527095161
2079	Coa7	ENSMUSG00000048351	-0.527731415
2080	Ablim3	ENSMUSG00000032735	-0.527969009
2081	Klh124	ENSMUSG00000062901	-0.527988182
2082	Plekhg5	ENSMUSG00000039713	-0.528518378
2083	Aven	ENSMUSG00000003604	-0.52890111
2084	Uqcrfs1	ENSMUSG00000038462	-0.528921791
2085	Myadml2	ENSMUSG00000025141	-0.52926663
2086	Abl1	ENSMUSG00000026842	-0.529968934
2087	Srpk2	ENSMUSG00000062604	-0.529979216
2088	Ebf3	ENSMUSG00000010476	-0.530034174
2089	Eif2b4	ENSMUSG00000029145	-0.530988001
2090	Smpd1	ENSMUSG00000037049	-0.531888914
2091	Txnrd2	ENSMUSG00000075704	-0.532002696
2092	Neurl2	ENSMUSG00000039873	-0.532450604
2093	Spr	ENSMUSG00000033735	-0.532878999
2094	Rapgef2	ENSMUSG00000062232	-0.53305432
2095	Reep1	ENSMUSG00000052852	-0.533747583
2096	Repin1	ENSMUSG00000052751	-0.533887403
2097	Clstn1	ENSMUSG00000039953	-0.534208261
2098	Stat5b	ENSMUSG00000020919	-0.534617192
2099	Ppp1r13b	ENSMUSG00000021285	-0.534709741
2100	Gnb5	ENSMUSG00000032192	-0.534892236
2101	Osbpl6	ENSMUSG00000042359	-0.534894054
2102	Bphl	ENSMUSG00000038286	-0.535000413
2103	Ppfibp2	ENSMUSG00000036528	-0.53649997
2104	Grsf1	ENSMUSG00000044221	-0.537682027
2105	Galt	ENSMUSG00000036073	-0.537758313
2106	Egfl7	ENSMUSG00000026921	-0.538029436
2107	Pik3r1	ENSMUSG00000041417	-0.538126723
2108	Lamtor4	ENSMUSG00000050552	-0.53834156
2109	Cdc14b	ENSMUSG00000033102	-0.538914089
2110	Eif4e	ENSMUSG00000028156	-0.539936784
2111	Cox14	ENSMUSG00000023020	-0.540267833

2112	Casq2	ENSMUSG00000027861	-0.540519494
2113	Tmed1	ENSMUSG00000032180	-0.540610932
2114	Rorc	ENSMUSG00000028150	-0.540749298
2115	Ctso	ENSMUSG00000028015	-0.541390369
2116	Fcgrt	ENSMUSG00000003420	-0.541687569
2117	9030617O03Rik	ENSMUSG00000021185	-0.541748808
2118	Ccdc88c	ENSMUSG00000021182	-0.541849452
2119	Fech	ENSMUSG00000024588	-0.54234129
2120	Btbd1	ENSMUSG00000025103	-0.54238738
2121	Naa38	ENSMUSG00000059278	-0.542578839
2122	Hspa12b	ENSMUSG00000074793	-0.54258742
2123	Pde1c	ENSMUSG00000004347	-0.542927201
2124	Idh3b	ENSMUSG00000027406	-0.543102202
2125	Uqcc3	ENSMUSG00000071654	-0.543214407
2126	Ogdh	ENSMUSG00000020456	-0.543340957
2127	Rbm20	ENSMUSG00000043639	-0.543644368
2128	Clpp	ENSMUSG00000002660	-0.544902501
2129	Haghl	ENSMUSG00000061046	-0.545113455
2130	Smoc2	ENSMUSG00000023886	-0.545236467
2131	Gid8	ENSMUSG00000027573	-0.545310605
2132	Mal	ENSMUSG00000027375	-0.545362434
2133	Rcbtb2	ENSMUSG00000022106	-0.54540507
2134	Ndufb10	ENSMUSG00000040048	-0.545519229
2135	Mcts2	ENSMUSG00000042814	-0.545826839
2136	Mmab	ENSMUSG00000029575	-0.545909525
2137	Stat5a	ENSMUSG00000004043	-0.546141328
2138	Ndufb3	ENSMUSG00000026032	-0.547102483
2139	Gnpat	ENSMUSG00000031985	-0.54808785
2140	Fam117b	ENSMUSG00000041040	-0.548411002
2141	Thtpa	ENSMUSG00000045691	-0.54986356
2142	Prepl	ENSMUSG00000024127	-0.550011687
2143	1600014C10Rik	ENSMUSG00000054676	-0.550415455
2144	Trib2	ENSMUSG00000020601	-0.550737716
2145	Angptl2	ENSMUSG00000004105	-0.550816393
2146	Tmem126a	ENSMUSG00000030615	-0.551399718
2147	Appl2	ENSMUSG00000020263	-0.551485075
2148	Foxred1	ENSMUSG00000039048	-0.551843845
2149	Ogfod3	ENSMUSG00000025169	-0.551923838
2150	Sgo2a	ENSMUSG00000026039	-0.552513527
2151	Mapk12	ENSMUSG00000022610	-0.554062557
2152	Pde4d	ENSMUSG00000021699	-0.554099419
2153	Nt5dc2	ENSMUSG00000071547	-0.554394438
2154	Zfp383	ENSMUSG00000099689	-0.554564778
2155	Hibadh	ENSMUSG00000029776	-0.555443412
2156	Rsrp1	ENSMUSG00000037266	-0.555764673
2157	Per2	ENSMUSG0000005866	-0.555989009
2158	ErbB3	ENSMUSG00000018166	-0.556119327

2159	Fam210a	ENSMUSG00000038121	-0.557004182
2160	Bckdk	ENSMUSG00000030802	-0.55719579
2161	Apex2	ENSMUSG00000025269	-0.557329763
2162	Tmem204	ENSMUSG00000024168	-0.558046951
2163	Pde7a	ENSMUSG00000069094	-0.558104739
2164	Hmgb3	ENSMUSG00000015217	-0.558279602
2165	Obsl1	ENSMUSG00000026211	-0.558335378
2166	Mcrip2	ENSMUSG00000025732	-0.55983515
2167	Map4k2	ENSMUSG00000024948	-0.560285933
2168	3110002H16Rik	ENSMUSG00000024410	-0.560602784
2169	Abraxas1	ENSMUSG00000035234	-0.56062947
2170	Prps2	ENSMUSG00000025742	-0.561116802
2171	Ramp2	ENSMUSG00000001240	-0.561222965
2172	Tmcc3	ENSMUSG00000020023	-0.561740632
2173	Slc5a6	ENSMUSG00000006641	-0.561791351
2174	Uqcrc1	ENSMUSG00000025651	-0.561881474
2175	Rhbdl3	ENSMUSG00000017692	-0.56280333
2176	Exoc6	ENSMUSG00000053799	-0.56291617
2177	Crybg1	ENSMUSG00000019866	-0.563655961
2178	Klf15	ENSMUSG00000030087	-0.56372324
2179	Pmvk	ENSMUSG00000027952	-0.563989817
2180	Isca2	ENSMUSG00000021241	-0.564015297
2181	Eci2	ENSMUSG00000021417	-0.564589924
2182	Gm28661	ENSMUSG000000102070	-0.565481503
2183	Cavin2	ENSMUSG00000045954	-0.566371611
2184	Tspan13	ENSMUSG00000020577	-0.566547921
2185	Scrn3	ENSMUSG00000008226	-0.566693655
2186	Plcl2	ENSMUSG00000038910	-0.566896721
2187	St6gal1	ENSMUSG00000022885	-0.566897048
2188	Mtrf1	ENSMUSG00000022022	-0.567046144
2189	Fem1a	ENSMUSG00000043683	-0.567077453
2190	Klh7	ENSMUSG00000028986	-0.567231486
2191	Sh3glb2	ENSMUSG00000026860	-0.567374889
2192	Ppp1r9a	ENSMUSG00000032827	-0.567836766
2193	Med12l	ENSMUSG00000056476	-0.567943216
2194	Plcg1	ENSMUSG00000016933	-0.568154692
2195	Tfpt	ENSMUSG00000006335	-0.568414535
2196	Smim5	ENSMUSG00000048442	-0.569743728
2197	Fam160a1	ENSMUSG00000051000	-0.569891918
2198	Gm12251	ENSMUSG000000084384	-0.569923703
2199	Rmdn1	ENSMUSG00000028229	-0.570146864
2200	Tmem100	ENSMUSG00000069763	-0.57030649
2201	Eif4e3	ENSMUSG00000093661	-0.570598574
2202	Crebl2	ENSMUSG00000032652	-0.571324361
2203	Myoz2	ENSMUSG00000028116	-0.571557304
2204	Sdha	ENSMUSG00000021577	-0.571637663
2205	Arhgef28	ENSMUSG00000021662	-0.572618452

2206	Ralgapa2	ENSMUSG00000037110	-0.572716448
2207	Med16	ENSMUSG00000013833	-0.572768246
2208	Agap2	ENSMUSG00000025422	-0.574123746
2209	Atpaf1	ENSMUSG00000028710	-0.574359824
2210	Tmem94	ENSMUSG00000020747	-0.574475469
2211	Psap	ENSMUSG00000004207	-0.575391273
2212	2510002D24Rik	ENSMUSG00000071632	-0.575631521
2213	Ndufs1	ENSMUSG00000025968	-0.575750009
2214	Dcaf8	ENSMUSG00000026554	-0.575800509
2215	Adck1	ENSMUSG00000021044	-0.576037786
2216	Ndufs8	ENSMUSG000000059734	-0.576385352
2217	Hsd17b4	ENSMUSG00000024507	-0.576874791
2218	Cracr2b	ENSMUSG00000048200	-0.57753154
2219	Casc4	ENSMUSG00000060227	-0.577820992
2220	Cidea	ENSMUSG00000024526	-0.577898261
2221	Cuedc2	ENSMUSG00000036748	-0.577917614
2222	Dgka	ENSMUSG00000025357	-0.578016322
2223	Eml2	ENSMUSG00000040811	-0.579085629
2224	Fzd4	ENSMUSG00000049791	-0.58034979
2225	Senp7	ENSMUSG00000052917	-0.580575406
2226	Zfp839	ENSMUSG00000021271	-0.580707371
2227	Cdnf	ENSMUSG00000039496	-0.580774473
2228	Abca5	ENSMUSG00000018800	-0.580794466
2229	Letm1	ENSMUSG00000005299	-0.582496029
2230	Prdx5	ENSMUSG00000024953	-0.582553782
2231	Pick1	ENSMUSG00000068206	-0.583476211
2232	Daam1	ENSMUSG00000034574	-0.583523287
2233	Noa1	ENSMUSG00000036285	-0.583668444
2234	Ndufa3	ENSMUSG00000035674	-0.583810545
2235	Pdk1	ENSMUSG00000006494	-0.583994104
2236	Ttc32	ENSMUSG00000066637	-0.584212965
2237	Isoc1	ENSMUSG00000024601	-0.584740117
2238	Hmcn1	ENSMUSG00000066842	-0.584744669
2239	Asah2	ENSMUSG00000024887	-0.586012324
2240	P3h4	ENSMUSG00000006931	-0.586113055
2241	Rmdn2	ENSMUSG00000036368	-0.586367244
2242	Coq5	ENSMUSG00000041733	-0.586455553
2243	Hfe2	ENSMUSG00000038403	-0.586491918
2244	Myom1	ENSMUSG00000024049	-0.586607712
2245	Grb2	ENSMUSG00000059923	-0.586806076
2246	Tspan7	ENSMUSG00000058254	-0.587006651
2247	Pygm	ENSMUSG00000032648	-0.587081629
2248	Itm2b	ENSMUSG00000022108	-0.587609213
2249	Fgf16	ENSMUSG00000031230	-0.588741421
2250	Ptcd3	ENSMUSG00000063884	-0.589003643
2251	Fan1	ENSMUSG00000033458	-0.589569881
2252	Cmss1	ENSMUSG00000022748	-0.589886955

2253	Tnfaip8	ENSMUSG00000062210	-0.590070892
2254	Endog	ENSMUSG00000015337	-0.59016548
2255	Lrrc10	ENSMUSG00000060187	-0.591215565
2256	Homer2	ENSMUSG00000025813	-0.591816045
2257	Ulk1	ENSMUSG00000029512	-0.592098279
2258	Ganc	ENSMUSG00000062646	-0.592254547
2259	Meaf6	ENSMUSG00000028863	-0.592485427
2260	Fam173a	ENSMUSG00000057411	-0.592574731
2261	Chd1l	ENSMUSG00000028089	-0.593081602
2262	Ntn1	ENSMUSG00000020902	-0.593110744
2263	Atp2a3	ENSMUSG00000020788	-0.593955013
2264	Htra1	ENSMUSG00000006205	-0.593997408
2265	Cdh5	ENSMUSG00000031871	-0.594006866
2266	Def8	ENSMUSG00000001482	-0.594596081
2267	Akr7a5	ENSMUSG00000028743	-0.594801181
2268	Mylip	ENSMUSG00000038175	-0.594942876
2269	Egf	ENSMUSG00000028017	-0.59603806
2270	Ctsf	ENSMUSG00000083282	-0.597437482
2271	Paxx	ENSMUSG00000047617	-0.59802881
2272	Entpd5	ENSMUSG00000021236	-0.598319679
2273	Acyp2	ENSMUSG00000060923	-0.598495265
2274	Pstk	ENSMUSG00000063179	-0.599137909
2275	Myo10	ENSMUSG00000022272	-0.599210605
2276	Pgm5	ENSMUSG00000041731	-0.599438032
2277	F3	ENSMUSG00000028128	-0.599512712
2278	Cyb5rl	ENSMUSG00000028621	-0.599536517
2279	Ppfia1	ENSMUSG00000037519	-0.599879028
2280	Gm28439	ENSMUSG00000100131	-0.599879451
2281	Idua	ENSMUSG00000033540	-0.600712467
2282	Gstt1	ENSMUSG00000001663	-0.600987363
2283	Tcn2	ENSMUSG00000020432	-0.601166101
2284	Mrpl34	ENSMUSG00000034880	-0.601461864
2285	Osgep1	ENSMUSG00000026096	-0.602161945
2286	Ap4s1	ENSMUSG00000020955	-0.602362898
2287	Rnf166	ENSMUSG00000014470	-0.602610184
2288	Adamts5	ENSMUSG00000022894	-0.60265657
2289	Atp5a1	ENSMUSG00000025428	-0.602738117
2290	Tatdn3	ENSMUSG00000026632	-0.603268224
2291	Adamtsl4	ENSMUSG00000015850	-0.603337818
2292	Il15ra	ENSMUSG00000023206	-0.603535482
2293	Plekhb2	ENSMUSG00000026123	-0.603670394
2294	4430402118Rik	ENSMUSG00000064202	-0.603740712
2295	Ap5s1	ENSMUSG00000068264	-0.60393339
2296	1700020114Rik	ENSMUSG00000085438	-0.604931782
2297	Tmem140	ENSMUSG00000057137	-0.605726069
2298	Bsg	ENSMUSG00000023175	-0.606022379
2299	Serpinb6b	ENSMUSG00000042842	-0.606956036

2300	mt-Nd4	ENSMUSG00000064363	-0.607146132
2301	Zfp366	ENSMUSG00000050919	-0.607612805
2302	Bche	ENSMUSG00000027792	-0.607984338
2303	Abcc9	ENSMUSG00000030249	-0.609656213
2304	Pdlim4	ENSMUSG00000020388	-0.609723532
2305	Trpc3	ENSMUSG00000027716	-0.610083618
2306	Dcakd	ENSMUSG00000020935	-0.610873386
2307	Gm5421	ENSMUSG00000097245	-0.611967223
2308	Aldh2	ENSMUSG00000029455	-0.612687306
2309	Plekhh2	ENSMUSG00000040852	-0.61281517
2310	Rab6b	ENSMUSG00000032549	-0.612858467
2311	Ndufs2	ENSMUSG00000013593	-0.613461601
2312	Stom	ENSMUSG00000026880	-0.613972711
2313	Atg10	ENSMUSG00000021619	-0.614399769
2314	Abtb1	ENSMUSG00000030083	-0.614970715
2315	Ccdc85a	ENSMUSG00000032878	-0.615257439
2316	Fbxo31	ENSMUSG00000052934	-0.615300647
2317	0610012G03Rik	ENSMUSG00000107002	-0.615565015
2318	Ptpnb	ENSMUSG00000020154	-0.616193965
2319	Mrpl39	ENSMUSG00000022889	-0.61628961
2320	Spry2	ENSMUSG00000022114	-0.616383611
2321	Svil	ENSMUSG00000024236	-0.616632983
2322	Mid1ip1	ENSMUSG00000008035	-0.616668051
2323	S100a1	ENSMUSG00000044080	-0.617875878
2324	Pex19	ENSMUSG00000003464	-0.617916784
2325	Rassf9	ENSMUSG00000044921	-0.618119449
2326	Mpst	ENSMUSG00000071711	-0.618843196
2327	Apeh	ENSMUSG00000032590	-0.619613962
2328	Lifr	ENSMUSG00000054263	-0.620152251
2329	She	ENSMUSG00000046280	-0.62041167
2330	Alkbh7	ENSMUSG00000002661	-0.620494678
2331	Ano8	ENSMUSG00000034863	-0.621697864
2332	Spaar	ENSMUSG00000028475	-0.621707606
2333	Ppm1k	ENSMUSG00000037826	-0.622250599
2334	Abca1	ENSMUSG00000015243	-0.622252325
2335	Ndufaf1	ENSMUSG00000027305	-0.622352726
2336	Lims2	ENSMUSG00000024395	-0.622817177
2337	Fitm2	ENSMUSG00000048486	-0.623061042
2338	Ccnd2	ENSMUSG00000000184	-0.623132618
2339	Gramd1b	ENSMUSG00000040111	-0.623378429
2340	Echdc2	ENSMUSG00000028601	-0.623697108
2341	Fgfr3	ENSMUSG00000054252	-0.623769904
2342	Nfia	ENSMUSG00000028565	-0.62405673
2343	Mcf2l	ENSMUSG00000031442	-0.624077836
2344	Caprin2	ENSMUSG00000030309	-0.624218285
2345	Patz1	ENSMUSG00000020453	-0.624465891
2346	Trim54	ENSMUSG00000062077	-0.624508715

2347	Ddo	ENSMUSG00000063428	-0.624617482
2348	Mreg	ENSMUSG00000039395	-0.624643211
2349	Cyp2j6	ENSMUSG00000052914	-0.625129429
2350	Nlrp10	ENSMUSG00000049709	-0.625685649
2351	1810011O10Rik	ENSMUSG00000056313	-0.626632491
2352	Zbtb14	ENSMUSG00000049672	-0.627700018
2353	Nat6	ENSMUSG00000079334	-0.627833495
2354	D10Jhu81e	ENSMUSG00000053329	-0.628350448
2355	mt-Cytb	ENSMUSG00000064370	-0.628752121
2356	Aldh1a1	ENSMUSG00000053279	-0.628773356
2357	Mef2c	ENSMUSG00000005583	-0.628791461
2358	Ubr2	ENSMUSG00000023977	-0.629311076
2359	Mccc2	ENSMUSG00000021646	-0.629376737
2360	Lymr9	ENSMUSG00000072640	-0.629556868
2361	Paqr4	ENSMUSG00000023909	-0.629559624
2362	mt-Nd1	ENSMUSG00000064341	-0.630145356
2363	Epdr1	ENSMUSG00000002808	-0.630371804
2364	Klhl23	ENSMUSG00000042155	-0.630506842
2365	Ankrd9	ENSMUSG00000037904	-0.631064184
2366	Serhl	ENSMUSG00000058586	-0.632630944
2367	Sik3	ENSMUSG00000034135	-0.63313064
2368	Adap2	ENSMUSG00000020709	-0.633161682
2369	Kbtbd4	ENSMUSG00000005505	-0.633572073
2370	Tmem182	ENSMUSG00000079588	-0.634084925
2371	Sept4	ENSMUSG00000020486	-0.635144146
2372	Ago4	ENSMUSG00000042500	-0.635268589
2373	Sept6	ENSMUSG00000050379	-0.636250937
2374	Usp11	ENSMUSG00000031066	-0.636641924
2375	Rmnd1	ENSMUSG00000019763	-0.637072454
2376	Clybl	ENSMUSG00000025545	-0.63707277
2377	Gm38077	ENSMUSG00000104344	-0.637203272
2378	Tmem106b	ENSMUSG00000029571	-0.637667576
2379	Jag2	ENSMUSG00000002799	-0.637868338
2380	Tppp	ENSMUSG00000021573	-0.63801285
2381	Kif26a	ENSMUSG00000021294	-0.638531653
2382	Hook1	ENSMUSG00000028572	-0.639098288
2383	Gm16793	ENSMUSG000000097357	-0.639319523
2384	Trim7	ENSMUSG00000040350	-0.639329032
2385	C1qtnf9	ENSMUSG00000071347	-0.639813758
2386	mt-Co3	ENSMUSG00000064358	-0.641376731
2387	Epb41l3	ENSMUSG00000024044	-0.642210748
2388	Rtn2	ENSMUSG00000030401	-0.642445364
2389	Rasgrp3	ENSMUSG00000071042	-0.642462539
2390	Kdr	ENSMUSG00000062960	-0.642972503
2391	Gtf2i	ENSMUSG00000060261	-0.643498132
2392	Lipe	ENSMUSG00000003123	-0.643876897
2393	Slc12a7	ENSMUSG00000017756	-0.64447967

2394	Lynx1	ENSMUSG00000022594	-0.644516872
2395	Plcd3	ENSMUSG00000020937	-0.646104366
2396	Rarg	ENSMUSG00000001288	-0.647628281
2397	Tie1	ENSMUSG000000033191	-0.648217139
2398	Nr3c2	ENSMUSG000000031618	-0.648454653
2399	Cox7a1	ENSMUSG000000074218	-0.649466383
2400	Ndufs3	ENSMUSG00000005510	-0.649718153
2401	Myct1	ENSMUSG000000046916	-0.649835555
2402	Gm31663	ENSMUSG000000108994	-0.649902664
2403	Taco1	ENSMUSG00000001983	-0.650514111
2404	Mfn1	ENSMUSG000000027668	-0.650535153
2405	Inpp5e	ENSMUSG000000026925	-0.651807893
2406	Aqp1	ENSMUSG000000004655	-0.65383584
2407	Tmem135	ENSMUSG000000039428	-0.654776452
2408	Atp8a1	ENSMUSG000000037685	-0.65619606
2409	Cdkl2	ENSMUSG000000029403	-0.656212769
2410	Zfp799	ENSMUSG000000095253	-0.656354874
2411	Ipp	ENSMUSG000000028696	-0.656760507
2412	Sync	ENSMUSG000000001333	-0.657297551
2413	Adgrl3	ENSMUSG000000037605	-0.657299757
2414	Cdh23	ENSMUSG000000012819	-0.658134068
2415	Pank4	ENSMUSG000000029056	-0.658245758
2416	Siae	ENSMUSG000000001942	-0.658763801
2417	Slc28a2	ENSMUSG000000027219	-0.659977879
2418	Amacr	ENSMUSG000000022244	-0.660230382
2419	Zmym3	ENSMUSG000000031310	-0.660525683
2420	Svip	ENSMUSG000000074093	-0.66063352
2421	Idh1	ENSMUSG000000025950	-0.660666564
2422	Atp5j	ENSMUSG000000022890	-0.660910403
2423	Gstm1	ENSMUSG000000058135	-0.661135102
2424	Sreb1	ENSMUSG000000020538	-0.661346976
2425	Pcca	ENSMUSG000000041650	-0.66137414
2426	Pex7	ENSMUSG000000020003	-0.661484054
2427	Fdft1	ENSMUSG000000021273	-0.662377568
2428	Tuba8	ENSMUSG000000030137	-0.663266428
2429	Zfp606	ENSMUSG000000030386	-0.66386637
2430	Mgme1	ENSMUSG000000027424	-0.664391236
2431	Elmod3	ENSMUSG000000056698	-0.664545769
2432	Peg13	ENSMUSG000000106847	-0.664975567
2433	Fam213b	ENSMUSG000000029059	-0.665499246
2434	Acsl6	ENSMUSG000000020333	-0.665987077
2435	Zfp251	ENSMUSG000000022526	-0.666116511
2436	Eepd1	ENSMUSG000000036611	-0.66616001
2437	6820402A03Rik	ENSMUSG000000103706	-0.666189114
2438	Thsd7a	ENSMUSG000000032625	-0.667371186
2439	Ptcd1	ENSMUSG000000029624	-0.667993676
2440	Fgf1	ENSMUSG000000036585	-0.668086446

2441	Slc50a1	ENSMUSG00000027953	-0.668118588
2442	Hic1	ENSMUSG00000043099	-0.668568445
2443	Slc22a5	ENSMUSG00000018900	-0.669515278
2444	Dtd1	ENSMUSG00000027430	-0.66974829
2445	Rai2	ENSMUSG00000043518	-0.670077188
2446	Asb13	ENSMUSG00000033781	-0.670132981
2447	Oxct1	ENSMUSG00000022186	-0.670579592
2448	Kcnn1	ENSMUSG00000002908	-0.670870269
2449	Acox1	ENSMUSG00000020777	-0.671789499
2450	Bmf	ENSMUSG00000040093	-0.674441763
2451	Nudt6	ENSMUSG00000050174	-0.675516526
2452	Sult1a1	ENSMUSG00000030711	-0.675957038
2453	Epas1	ENSMUSG00000024140	-0.676261663
2454	Hic2	ENSMUSG00000050240	-0.677667271
2455	Sec31b	ENSMUSG00000051984	-0.6777256
2456	Gfra1	ENSMUSG00000025089	-0.678475203
2457	Slc25a10	ENSMUSG00000025792	-0.678907296
2458	Gm17281	ENSMUSG00000097317	-0.678984092
2459	Selenop	ENSMUSG00000064373	-0.678988602
2460	Kcnn2	ENSMUSG00000054477	-0.680432324
2461	Kcnj12	ENSMUSG00000042529	-0.680890738
2462	Ppara	ENSMUSG00000022383	-0.681160384
2463	Gpihbp1	ENSMUSG00000022579	-0.68161438
2464	Oplah	ENSMUSG00000022562	-0.681680568
2465	Slc25a22	ENSMUSG00000019082	-0.681770585
2466	Phf24	ENSMUSG00000036062	-0.682006711
2467	Egln1	ENSMUSG00000031987	-0.682408344
2468	Aco2	ENSMUSG00000022477	-0.682804439
2469	Dusp1	ENSMUSG00000024190	-0.683248224
2470	Tnnt2	ENSMUSG00000026414	-0.683636278
2471	Ptcd2	ENSMUSG00000021650	-0.683857648
2472	Zfp970	ENSMUSG00000078866	-0.683984587
2473	Peli2	ENSMUSG00000021846	-0.684062819
2474	Gmnn	ENSMUSG00000006715	-0.684189806
2475	Hs1bp3	ENSMUSG00000020605	-0.684333926
2476	8430408G22Rik	ENSMUSG00000048489	-0.68433734
2477	Rilpl1	ENSMUSG00000029392	-0.685770771
2478	D2hgdh	ENSMUSG00000073609	-0.685801449
2479	Ppa2	ENSMUSG00000028013	-0.686441494
2480	Klh31	ENSMUSG00000044938	-0.687197946
2481	Cd300lg	ENSMUSG00000017309	-0.687664327
2482	Gpr27	ENSMUSG00000072875	-0.68854531
2483	Prox1	ENSMUSG00000010175	-0.689321937
2484	Gm44250	ENSMUSG000000107881	-0.689499761
2485	Nmnat1	ENSMUSG00000028992	-0.689589093
2486	Jarid2	ENSMUSG00000038518	-0.690179959
2487	Ankrd29	ENSMUSG00000057766	-0.690868464

2488	Pde8b	ENSMUSG00000021684	-0.690871512
2489	Tecr	ENSMUSG00000031708	-0.691207984
2490	Eci1	ENSMUSG00000024132	-0.692564361
2491	Sdhaf4	ENSMUSG00000026154	-0.692825001
2492	Pcdh12	ENSMUSG00000024440	-0.693594884
2493	Maob	ENSMUSG00000040147	-0.693863012
2494	Wfdc1	ENSMUSG00000023336	-0.694147029
2495	Tmem38a	ENSMUSG00000031791	-0.694190603
2496	Spsb1	ENSMUSG00000039911	-0.694889534
2497	Pcyox1	ENSMUSG00000029998	-0.69499799
2498	Zswim7	ENSMUSG00000014243	-0.695351856
2499	Ushbp1	ENSMUSG00000034911	-0.695806688
2500	Rnls	ENSMUSG00000071573	-0.695821433
2501	Ablim1	ENSMUSG00000025085	-0.696309985
2502	Zfp827	ENSMUSG00000071064	-0.696502693
2503	Ndufab1	ENSMUSG00000030869	-0.696551859
2504	Lrp5	ENSMUSG00000024913	-0.696833664
2505	Ttc30b	ENSMUSG00000075273	-0.698535004
2506	Aldh7a1	ENSMUSG00000053644	-0.698640225
2507	Kcnj8	ENSMUSG00000030247	-0.699171701
2508	Rasl10b	ENSMUSG00000020684	-0.700393113
2509	Paox	ENSMUSG00000025464	-0.701810542
2510	Plin4	ENSMUSG00000002831	-0.701917575
2511	C1qtnf12	ENSMUSG00000023571	-0.703793243
2512	Tmem44	ENSMUSG00000022537	-0.704467409
2513	Gzmm	ENSMUSG00000054206	-0.704623032
2514	Gm10718	ENSMUSG00000095186	-0.705433862
2515	Syt7	ENSMUSG00000024743	-0.705823927
2516	Tfdp2	ENSMUSG00000032411	-0.706039368
2517	Scn4b	ENSMUSG00000046480	-0.706379455
2518	Pcdhga2	ENSMUSG00000103332	-0.707522986
2519	Gprc5c	ENSMUSG00000051043	-0.707719097
2520	mt-Nd3	ENSMUSG00000064360	-0.709349661
2521	Echs1	ENSMUSG00000025465	-0.709980846
2522	Cirbp	ENSMUSG00000045193	-0.71033307
2523	Zadh2	ENSMUSG00000049090	-0.710512304
2524	Gstm2	ENSMUSG00000040562	-0.710708992
2525	Efcab2	ENSMUSG00000026495	-0.712042064
2526	Camk2n1	ENSMUSG00000046447	-0.712152072
2527	Zfp30	ENSMUSG00000047473	-0.712641271
2528	Apln	ENSMUSG00000037010	-0.713655903
2529	Ppip5k2	ENSMUSG00000040648	-0.714230872
2530	C130074G19Rik	ENSMUSG00000039349	-0.714306655
2531	Slc25a13	ENSMUSG00000015112	-0.714569207
2532	Fabp4	ENSMUSG00000062515	-0.714831442
2533	Gm14261	ENSMUSG00000085322	-0.714895226
2534	Rgs4	ENSMUSG00000038530	-0.715066249

2535	Crat	ENSMUSG00000026853	-0.716422069
2536	Adgrf5	ENSMUSG00000056492	-0.717033467
2537	Coq3	ENSMUSG00000028247	-0.717122404
2538	Cox8b	ENSMUSG00000025488	-0.717363717
2539	Scamp5	ENSMUSG00000040722	-0.718445314
2540	Alad	ENSMUSG00000028393	-0.718929217
2541	Mrps34	ENSMUSG00000038880	-0.719143077
2542	Aldh5a1	ENSMUSG00000035936	-0.720139965
2543	mt-Tt	ENSMUSG00000064371	-0.720428493
2544	Sgcb	ENSMUSG00000029156	-0.720594515
2545	Pomgnt2	ENSMUSG00000066235	-0.720795206
2546	Btbd3	ENSMUSG00000062098	-0.720862004
2547	Acbd4	ENSMUSG00000056938	-0.720929778
2548	1010001N08Rik	ENSMUSG00000097222	-0.72110946
2549	Fuz	ENSMUSG00000011658	-0.72122837
2550	Suox	ENSMUSG00000049858	-0.722112765
2551	Bbs10	ENSMUSG00000035759	-0.722258322
2552	Erlec1	ENSMUSG00000020311	-0.72239425
2553	Mrpl14	ENSMUSG00000023939	-0.722528921
2554	Dll4	ENSMUSG00000027314	-0.722648159
2555	Card10	ENSMUSG00000033170	-0.723010669
2556	Gm10925	ENSMUSG00000100862	-0.7230275
2557	Tmem110	ENSMUSG00000006526	-0.724584545
2558	Clasp2	ENSMUSG00000033392	-0.725169753
2559	Smarca2	ENSMUSG00000024921	-0.726387329
2560	Ptgr2	ENSMUSG00000072946	-0.726456441
2561	Mgll	ENSMUSG00000033174	-0.726791001
2562	Podxl2	ENSMUSG00000033152	-0.727560053
2563	Chmp4c	ENSMUSG00000027536	-0.729854121
2564	Pnpla7	ENSMUSG00000036833	-0.730157453
2565	D830050J10Rik	ENSMUSG00000107994	-0.73086899
2566	Nudt16l1	ENSMUSG00000022516	-0.731272383
2567	Macrod1	ENSMUSG00000036278	-0.731557102
2568	Glt28d2	ENSMUSG00000031286	-0.732389934
2569	Pyurf	ENSMUSG00000043162	-0.733408675
2570	Abat	ENSMUSG00000057880	-0.73374244
2571	Rasgrp2	ENSMUSG00000032946	-0.733785494
2572	Fam78a	ENSMUSG00000050592	-0.733794225
2573	Vtn	ENSMUSG00000017344	-0.734844016
2574	Dok7	ENSMUSG00000044716	-0.734943827
2575	Dsg2	ENSMUSG00000044393	-0.735091546
2576	Srpk3	ENSMUSG00000002007	-0.735234808
2577	Bckdhb	ENSMUSG00000032263	-0.735293564
2578	Ndufs7	ENSMUSG00000020153	-0.735962895
2579	Mrps35	ENSMUSG00000040112	-0.736204656
2580	Mcee	ENSMUSG00000033429	-0.736440019
2581	Pkdrej	ENSMUSG00000052496	-0.737349874

2582	Abcd3	ENSMUSG00000028127	-0.737834501
2583	Mpv17	ENSMUSG00000107283	-0.738197926
2584	Fyco1	ENSMUSG00000025241	-0.738549394
2585	Map3k5	ENSMUSG00000071369	-0.738753061
2586	Tmem143	ENSMUSG00000002781	-0.738986725
2587	Hspb3	ENSMUSG00000051456	-0.739118305
2588	Cep112	ENSMUSG00000020728	-0.73932413
2589	Myh6	ENSMUSG00000040752	-0.739876607
2590	Snrk	ENSMUSG00000038145	-0.739884033
2591	mt-Atp6	ENSMUSG00000064357	-0.740257904
2592	Cnst	ENSMUSG00000038949	-0.740503336
2593	Npc1	ENSMUSG00000024413	-0.741679415
2594	Crocc	ENSMUSG00000040860	-0.743405824
2595	Cdk5rap1	ENSMUSG00000027487	-0.743471282
2596	Vldlr	ENSMUSG00000024924	-0.743540465
2597	Trabd2b	ENSMUSG00000070867	-0.744158503
2598	Cpeb3	ENSMUSG00000039652	-0.74449319
2599	Prpf19	ENSMUSG00000024735	-0.744666247
2600	Mettl7a1	ENSMUSG00000054619	-0.744932601
2601	Camk2b	ENSMUSG00000057897	-0.745125641
2602	Slc9a3r2	ENSMUSG00000002504	-0.745387429
2603	Rpl3l	ENSMUSG00000002500	-0.745427334
2604	Nmnat3	ENSMUSG00000032456	-0.745655725
2605	Ric8b	ENSMUSG00000035620	-0.746236414
2606	Dcaf4	ENSMUSG00000021222	-0.746482309
2607	Cenpp	ENSMUSG00000021391	-0.746913297
2608	Akap7	ENSMUSG00000039166	-0.747518484
2609	Slc25a11	ENSMUSG00000014606	-0.748978497
2610	Tmc7	ENSMUSG00000042246	-0.749229475
2611	0610009O20Rik	ENSMUSG00000024442	-0.750003149
2612	Cd36	ENSMUSG00000002944	-0.750182522
2613	Prag1	ENSMUSG00000050271	-0.750503491
2614	Sox18	ENSMUSG00000046470	-0.751310502
2615	BC026585	ENSMUSG00000033488	-0.751508003
2616	Lppos	ENSMUSG00000097867	-0.751539192
2617	Vwa7	ENSMUSG00000007030	-0.751719346
2618	Smpd2	ENSMUSG00000019822	-0.753299005
2619	Cc2d2a	ENSMUSG00000039765	-0.754129807
2620	BC029722	ENSMUSG00000074649	-0.754307684
2621	Mgst3	ENSMUSG00000026688	-0.754382609
2622	Abcb4	ENSMUSG00000042476	-0.755115237
2623	Casp6	ENSMUSG00000027997	-0.755830956
2624	Smim26	ENSMUSG00000074754	-0.756716004
2625	Gm9755	ENSMUSG00000030735	-0.757322821
2626	Art3	ENSMUSG00000034842	-0.758317218
2627	Auh	ENSMUSG00000021460	-0.758686888
2628	Acat1	ENSMUSG00000032047	-0.759665863

2629	Bend5	ENSMUSG00000028545	-0.759702467
2630	Eml1	ENSMUSG00000058070	-0.760603288
2631	Ivns1abp	ENSMUSG00000023150	-0.760832473
2632	Angpt1	ENSMUSG00000022309	-0.760950223
2633	Zrsr1	ENSMUSG00000044068	-0.760977265
2634	Emc9	ENSMUSG00000022217	-0.761720075
2635	Gm43305	ENSMUSG00000105703	-0.762403486
2636	Klhl32	ENSMUSG00000040387	-0.763651741
2637	Ebpl	ENSMUSG00000021928	-0.763956553
2638	Ak3	ENSMUSG00000024782	-0.766155859
2639	Toporsos	ENSMUSG00000028407	-0.766982618
2640	Gm4459	ENSMUSG00000083626	-0.767074824
2641	Pank1	ENSMUSG00000033610	-0.768053611
2642	Sirt4	ENSMUSG00000029524	-0.768977383
2643	Galc	ENSMUSG00000021003	-0.769507757
2644	Pecr	ENSMUSG00000026189	-0.771947853
2645	Aqp7	ENSMUSG00000028427	-0.772127676
2646	Lyl1	ENSMUSG00000034041	-0.772349084
2647	Gm26722	ENSMUSG00000096944	-0.774085326
2648	Nim1k	ENSMUSG00000095930	-0.774826347
2649	Acot13	ENSMUSG00000006717	-0.7769661
2650	Tusc5	ENSMUSG00000046275	-0.777305481
2651	Pex10	ENSMUSG00000029047	-0.778109738
2652	Smtn	ENSMUSG00000020439	-0.778327266
2653	Nexn	ENSMUSG00000039103	-0.779078102
2654	Papln	ENSMUSG00000021223	-0.779079331
2655	Fam214a	ENSMUSG00000034858	-0.779212284
2656	Rapsn	ENSMUSG00000002104	-0.779222722
2657	mt-Co2	ENSMUSG00000064354	-0.780598223
2658	Abhd14b	ENSMUSG00000042073	-0.781088212
2659	Higd1b	ENSMUSG00000020928	-0.781877654
2660	Thbs2	ENSMUSG00000023885	-0.782058174
2661	Bmp6	ENSMUSG00000039004	-0.783248168
2662	Frmd5	ENSMUSG00000027238	-0.783529131
2663	Rph3al	ENSMUSG00000020847	-0.784036647
2664	Atp6v0e2	ENSMUSG00000039347	-0.784164147
2665	Sirt5	ENSMUSG00000054021	-0.784197866
2666	Rdm1	ENSMUSG00000010362	-0.786074333
2667	Mrgprh	ENSMUSG00000059408	-0.786172689
2668	Acsf3	ENSMUSG00000015016	-0.786485066
2669	Pitpnc1	ENSMUSG00000040430	-0.786572263
2670	Accs	ENSMUSG00000040272	-0.786864465
2671	Colgalt2	ENSMUSG00000032649	-0.787138541
2672	Rab3d	ENSMUSG00000019066	-0.787763935
2673	Zfp810	ENSMUSG00000066829	-0.789687721
2674	Hey1	ENSMUSG00000040289	-0.789793461
2675	Gaa	ENSMUSG00000025579	-0.790272838

2676	Pcbd2	ENSMUSG00000021496	-0.790535796
2677	Myl3	ENSMUSG00000059741	-0.790557316
2678	Gpr22	ENSMUSG00000044067	-0.792684389
2679	Eid2b	ENSMUSG00000070705	-0.792885269
2680	Sirt3	ENSMUSG00000025486	-0.79503448
2681	Ddt	ENSMUSG00000001666	-0.79557787
2682	Gpr155	ENSMUSG00000041762	-0.796807259
2683	Sbk1	ENSMUSG00000042978	-0.798013751
2684	Fkbp4	ENSMUSG00000030357	-0.798484943
2685	Hdac9	ENSMUSG00000004698	-0.799487498
2686	Pnpla2	ENSMUSG00000025509	-0.801503481
2687	Rapgef4	ENSMUSG00000049044	-0.801816016
2688	Mxi1	ENSMUSG00000025025	-0.801926641
2689	Aldh9a1	ENSMUSG00000026687	-0.802127631
2690	Klhdc8a	ENSMUSG00000042115	-0.802567579
2691	Tcp11l2	ENSMUSG00000020034	-0.802610081
2692	Ndufa4l2	ENSMUSG00000040280	-0.802746486
2693	Nit2	ENSMUSG00000022751	-0.803530229
2694	Sox7	ENSMUSG00000063060	-0.80473381
2695	Arrdc2	ENSMUSG00000002910	-0.805654879
2696	Abcb1a	ENSMUSG00000040584	-0.805927726
2697	Gpd1	ENSMUSG00000023019	-0.805964347
2698	Actc1	ENSMUSG00000068614	-0.806328421
2699	Gpam	ENSMUSG00000024978	-0.806391322
2700	Smarcd1	ENSMUSG00000023018	-0.806595261
2701	Pcyt2	ENSMUSG00000025137	-0.806699774
2702	Pla2g4e	ENSMUSG00000050211	-0.807634698
2703	Slc2a12	ENSMUSG00000037490	-0.807807441
2704	Rbm38	ENSMUSG00000027510	-0.80785213
2705	Lrrc24	ENSMUSG00000033707	-0.808542049
2706	Esrrg	ENSMUSG00000026610	-0.808884554
2707	Dbt	ENSMUSG00000000340	-0.810246503
2708	Dhrs7c	ENSMUSG00000033044	-0.810946823
2709	Cbx7	ENSMUSG00000053411	-0.811664032
2710	Adhfe1	ENSMUSG00000025911	-0.811684459
2711	Hcn2	ENSMUSG00000020331	-0.812255728
2712	Tnnc1	ENSMUSG00000091898	-0.812425737
2713	Tril	ENSMUSG00000043496	-0.81326399
2714	Anks1	ENSMUSG00000024219	-0.813784277
2715	mt-Nd2	ENSMUSG00000064345	-0.813827546
2716	Mybpc3	ENSMUSG00000002100	-0.813980241
2717	Iqcc	ENSMUSG00000040795	-0.814297055
2718	D3Ertd751e	ENSMUSG00000025766	-0.814693226
2719	Etfrf1	ENSMUSG00000040370	-0.815309925
2720	Snhg14	ENSMUSG00000100826	-0.815703021
2721	Tufm	ENSMUSG00000073838	-0.816183515
2722	Scarna17	ENSMUSG00000088689	-0.817632297

2723	Yipf7	ENSMUSG00000029158	-0.818532027
2724	Ehhadh	ENSMUSG00000022853	-0.818900418
2725	Mccc1	ENSMUSG00000027709	-0.819068716
2726	Me3	ENSMUSG00000030621	-0.819125088
2727	BB218582	ENSMUSG00000085218	-0.819953002
2728	Nr1d2	ENSMUSG00000021775	-0.821140955
2729	Thnsl2	ENSMUSG00000054474	-0.821497746
2730	Anapc13	ENSMUSG00000035048	-0.821614294
2731	Vwa3a	ENSMUSG00000030889	-0.822289545
2732	Gpr160	ENSMUSG00000037661	-0.822349811
2733	Tmem150a	ENSMUSG00000055912	-0.82371951
2734	Cdc42bpg	ENSMUSG00000024769	-0.823879398
2735	Kbtbd3	ENSMUSG00000025893	-0.82396994
2736	Gstp-ps	ENSMUSG00000103653	-0.82464889
2737	Celsr2	ENSMUSG00000068740	-0.825309075
2738	Fndc5	ENSMUSG00000001334	-0.825589261
2739	Klh3	ENSMUSG00000014164	-0.827093792
2740	Tst	ENSMUSG00000044986	-0.82730391
2741	Gm13479	ENSMUSG00000085591	-0.82744395
2742	Gm13910	ENSMUSG00000063684	-0.82746306
2743	Rhot2	ENSMUSG00000025733	-0.827671361
2744	Acad10	ENSMUSG00000029456	-0.82818379
2745	Gm10602	ENSMUSG00000073985	-0.828270475
2746	Ttc7	ENSMUSG00000036918	-0.828897734
2747	Prr33	ENSMUSG00000043795	-0.829301308
2748	Gm6652	ENSMUSG00000099858	-0.830246173
2749	Prickle3	ENSMUSG00000031145	-0.83071083
2750	Adra1a	ENSMUSG00000045875	-0.831774568
2751	Acyp1	ENSMUSG00000008822	-0.832521689
2752	2310061I04Rik	ENSMUSG00000050705	-0.833151162
2753	Trmt5	ENSMUSG00000034442	-0.833888524
2754	Ifngr2	ENSMUSG00000022965	-0.834340193
2755	Tha1	ENSMUSG00000017713	-0.83437621
2756	Abca6	ENSMUSG00000044749	-0.834427931
2757	Pik3ip1	ENSMUSG00000034614	-0.837890987
2758	Plxnb1	ENSMUSG00000053646	-0.838896607
2759	Ank1	ENSMUSG00000031543	-0.838927183
2760	Slc26a10	ENSMUSG00000040441	-0.841428669
2761	Car14	ENSMUSG00000038526	-0.84270873
2762	Asb2	ENSMUSG00000021200	-0.843163445
2763	Hrc	ENSMUSG00000038239	-0.84317812
2764	Ighg2c	ENSMUSG00000076612	-0.843523497
2765	Cadm4	ENSMUSG00000054793	-0.844054594
2766	Grb14	ENSMUSG00000026888	-0.845131643
2767	Igsf1	ENSMUSG00000031111	-0.847008554
2768	Ednra	ENSMUSG00000031616	-0.847527316
2769	Dpep1	ENSMUSG00000019278	-0.848259822

2770	Cbr1	ENSMUSG00000051483	-0.848641508
2771	C1qtnf2	ENSMUSG00000046491	-0.848993175
2772	Zfand1	ENSMUSG00000039795	-0.849621801
2773	Nipsnap2	ENSMUSG00000029432	-0.850592243
2774	Fgf13	ENSMUSG00000031137	-0.852006682
2775	Gdpd1	ENSMUSG00000061666	-0.852430106
2776	Lmod3	ENSMUSG00000044086	-0.853231516
2777	Rtn4ip1	ENSMUSG00000019864	-0.853236041
2778	Cyp2d22	ENSMUSG00000061740	-0.853430381
2779	Sord	ENSMUSG00000027227	-0.853819145
2780	Hemk1	ENSMUSG00000032579	-0.85500593
2781	Asb11	ENSMUSG00000031382	-0.85598189
2782	Sdr39u1	ENSMUSG00000022223	-0.858542837
2783	Epm2a	ENSMUSG00000055493	-0.858822742
2784	Mettl26	ENSMUSG00000025731	-0.859351403
2785	Nlr1	ENSMUSG00000032109	-0.859781875
2786	C230035116Rik	ENSMUSG00000085024	-0.860477821
2787	Tstd3	ENSMUSG00000028251	-0.863467016
2788	Acads	ENSMUSG00000029545	-0.86371654
2789	Gm23119	ENSMUSG00000089235	-0.864298007
2790	Hadhb	ENSMUSG00000059447	-0.866526662
2791	Khk	ENSMUSG00000029162	-0.866706147
2792	Slc36a2	ENSMUSG00000020264	-0.867425477
2793	Smad9	ENSMUSG00000027796	-0.868440949
2794	Mrpl49	ENSMUSG00000007338	-0.87036318
2795	Hrasls	ENSMUSG00000022525	-0.870946666
2796	Hspa12a	ENSMUSG00000025092	-0.872139853
2797	Ttc21b	ENSMUSG00000034848	-0.872494533
2798	Dusp7	ENSMUSG00000053716	-0.873463094
2799	Pfkfb2	ENSMUSG00000026409	-0.87394991
2800	Sh3rf2	ENSMUSG00000057719	-0.874447577
2801	Etl4	ENSMUSG00000036617	-0.874576246
2802	Fbxo21	ENSMUSG00000032898	-0.875205056
2803	Hdhd5	ENSMUSG00000058979	-0.875542455
2804	Pcsk6	ENSMUSG00000030513	-0.87580471
2805	Usp2	ENSMUSG00000032010	-0.876552288
2806	Asb15	ENSMUSG00000029685	-0.876727824
2807	mt-Nd4l	ENSMUSG00000065947	-0.877120689
2808	Gm38393	ENSMUSG00000000948	-0.87730952
2809	Gm10800	ENSMUSG00000075014	-0.877731619
2810	Kcnip2	ENSMUSG00000025221	-0.877865721
2811	Tango2	ENSMUSG00000013539	-0.878500417
2812	Asb5	ENSMUSG00000031519	-0.879472511
2813	Myo5c	ENSMUSG00000033590	-0.880184446
2814	Ankrd24	ENSMUSG00000054708	-0.880483077
2815	Phyh	ENSMUSG00000026664	-0.881156947
2816	Prickle1	ENSMUSG00000036158	-0.881386132

2817	Ak1	ENSMUSG00000026817	-0.882281303
2818	Igfbp6	ENSMUSG00000023046	-0.884497076
2819	Grhpr	ENSMUSG00000035637	-0.887265881
2820	Mmp15	ENSMUSG00000031790	-0.887919234
2821	Rhobtb2	ENSMUSG00000022075	-0.888230243
2822	Txlnb	ENSMUSG00000039891	-0.88964442
2823	Timp4	ENSMUSG00000030317	-0.890229159
2824	Hopx	ENSMUSG00000059325	-0.892712081
2825	Ppif	ENSMUSG00000021868	-0.892765578
2826	Setd6	ENSMUSG00000031671	-0.892962604
2827	Cdk18	ENSMUSG00000026437	-0.893020603
2828	Per3	ENSMUSG00000028957	-0.895496834
2829	4921531C22Rik	ENSMUSG00000085704	-0.896194187
2830	Mfap3l	ENSMUSG00000031647	-0.896692221
2831	Scrn2	ENSMUSG00000020877	-0.897492124
2832	Acadm	ENSMUSG00000062908	-0.897791284
2833	Lrrc2	ENSMUSG00000032495	-0.901393006
2834	Bcl7a	ENSMUSG00000029438	-0.901748448
2835	Lurap1l	ENSMUSG00000048706	-0.902321076
2836	Cpt1a	ENSMUSG00000024900	-0.902417988
2837	Coq9	ENSMUSG00000031782	-0.903588172
2838	Gal3st3	ENSMUSG00000047658	-0.904559582
2839	Lrrc39	ENSMUSG00000027961	-0.904675463
2840	Gm44220	ENSMUSG000000107655	-0.907405613
2841	Gpsm1	ENSMUSG00000026930	-0.908202152
2842	Lpl	ENSMUSG00000015568	-0.908351401
2843	Dand5	ENSMUSG00000053226	-0.908622822
2844	Stmn2	ENSMUSG00000027500	-0.909480017
2845	Hsd17b11	ENSMUSG00000029311	-0.909819393
2846	Gm10461	ENSMUSG000000107277	-0.909824707
2847	Colec11	ENSMUSG00000036655	-0.91027753
2848	Higd2a	ENSMUSG00000025868	-0.911223979
2849	Pde4c	ENSMUSG00000031842	-0.911589434
2850	Nudt14	ENSMUSG00000002804	-0.911669047
2851	Inca1	ENSMUSG00000057054	-0.913738658
2852	Plet1os	ENSMUSG000000101304	-0.915336161
2853	Hlf	ENSMUSG00000003949	-0.915557847
2854	Slc40a1	ENSMUSG00000025993	-0.918664253
2855	Cpt1b	ENSMUSG00000078937	-0.919775589
2856	Mme	ENSMUSG00000027820	-0.922523877
2857	Jam2	ENSMUSG00000053062	-0.923211756
2858	Gsta4	ENSMUSG00000032348	-0.925528534
2859	Rnf144b	ENSMUSG00000038068	-0.927869013
2860	Etfa	ENSMUSG00000032314	-0.928447357
2861	Fam213a	ENSMUSG00000021792	-0.930009747
2862	mt-Ti	ENSMUSG00000064342	-0.93067733
2863	mt-Nd6	ENSMUSG00000064368	-0.931104975

2864	Gm44386	ENSMUSG00000107689	-0.931894496
2865	Lmo2	ENSMUSG00000032698	-0.932777063
2866	Sobp	ENSMUSG00000038248	-0.933063875
2867	Ldhd	ENSMUSG00000031958	-0.933350141
2868	Atp1b2	ENSMUSG00000041329	-0.934700712
2869	AU021092	ENSMUSG00000051669	-0.937918233
2870	Ckm	ENSMUSG00000030399	-0.93816446
2871	Slc25a33	ENSMUSG00000028982	-0.9402885
2872	Fam228b	ENSMUSG00000050545	-0.940775714
2873	Fam81a	ENSMUSG00000032224	-0.941465985
2874	5430431A17Rik	ENSMUSG00000108322	-0.941737365
2875	Il2ra	ENSMUSG00000026770	-0.942288619
2876	Tarsl2	ENSMUSG00000030515	-0.943537175
2877	4632428C04Rik	ENSMUSG00000097184	-0.945595775
2878	Unc119	ENSMUSG00000002058	-0.949090283
2879	Sv2a	ENSMUSG00000038486	-0.950702636
2880	Acot11	ENSMUSG00000034853	-0.950965714
2881	Tmem71	ENSMUSG00000036944	-0.951169612
2882	Acadvl	ENSMUSG00000018574	-0.951280633
2883	Gm33609	ENSMUSG00000104736	-0.951720598
2884	Gm40457	ENSMUSG00000108626	-0.952372978
2885	Ptpn3	ENSMUSG00000038764	-0.952770283
2886	Art5	ENSMUSG00000070424	-0.953880012
2887	Adi1	ENSMUSG00000020629	-0.954935021
2888	Adamts7	ENSMUSG00000032363	-0.956271344
2889	Slc46a1	ENSMUSG00000020829	-0.956634929
2890	Acad11	ENSMUSG00000090150	-0.957106991
2891	Nampt	ENSMUSG00000020572	-0.957162533
2892	Neil2	ENSMUSG00000035121	-0.957934306
2893	4633401B06Rik	ENSMUSG00000105597	-0.958711109
2894	Zfp791	ENSMUSG00000074194	-0.960926562
2895	Nqo2	ENSMUSG00000046949	-0.962732676
2896	Cyp27a1	ENSMUSG00000026170	-0.963398309
2897	Nat8l	ENSMUSG00000048142	-0.964304504
2898	Sgca	ENSMUSG00000001508	-0.964751244
2899	Tnip3	ENSMUSG00000044162	-0.965612186
2900	Plbd1	ENSMUSG00000030214	-0.969094937
2901	Gm45206	ENSMUSG00000108389	-0.971268422
2902	Lrp3	ENSMUSG00000001802	-0.971712724
2903	Nr0b2	ENSMUSG00000037583	-0.971731496
2904	Ttc38	ENSMUSG00000035944	-0.973692559
2905	Exoc3l4	ENSMUSG00000021280	-0.97422634
2906	Glul	ENSMUSG00000026473	-0.974400932
2907	L3hypdh	ENSMUSG00000019718	-0.974488828
2908	Optn	ENSMUSG00000026672	-0.974648007
2909	Sh3d21	ENSMUSG00000073758	-0.976004393
2910	2310040G24Rik	ENSMUSG00000101655	-0.9776137

2911	Cmbl	ENSMUSG00000022235	-0.978806029
2912	Impa2	ENSMUSG00000024525	-0.979310612
2913	Akr1b10	ENSMUSG00000061758	-0.979513983
2914	Apc2	ENSMUSG00000020135	-0.979782053
2915	Slc22a3	ENSMUSG00000023828	-0.98242249
2916	Hdac11	ENSMUSG00000034245	-0.982675759
2917	Retreg1	ENSMUSG00000022270	-0.983179656
2918	2310039L15Rik	ENSMUSG00000100550	-0.983477268
2919	Btnl9	ENSMUSG00000040283	-0.984495261
2920	Mitf	ENSMUSG00000035158	-0.985274263
2921	Gm43288	ENSMUSG00000106220	-0.986173465
2922	Gm37691	ENSMUSG00000104348	-0.987647578
2923	Nrg2	ENSMUSG00000060275	-0.9878458
2924	Cep128	ENSMUSG00000061533	-0.988840525
2925	Scara5	ENSMUSG00000022032	-0.990524464
2926	Plin3	ENSMUSG00000024197	-0.991344724
2927	Gpr157	ENSMUSG00000047875	-0.991543849
2928	Scn4a	ENSMUSG00000001027	-0.992162729
2929	Mtfp1	ENSMUSG00000004748	-0.992563111
2930	Gm20712	ENSMUSG00000093677	-0.992852849
2931	Cpxm2	ENSMUSG00000030862	-0.995825171
2932	Ankrd35	ENSMUSG00000038354	-0.995973091
2933	Whrn	ENSMUSG00000039137	-0.996383244
2934	Oxld1	ENSMUSG00000039670	-0.996621904
2935	2310069G16Rik	ENSMUSG00000097102	-0.996914287
2936	Gm11899	ENSMUSG00000087399	-0.99920021
2937	Acsl1	ENSMUSG00000018796	-0.999476453
2938	Gm43050	ENSMUSG00000106795	-1.00051903
2939	Osbp2	ENSMUSG00000020435	-1.001347132
2940	Cxx1c	ENSMUSG00000051851	-1.003518841
2941	Fstl4	ENSMUSG00000036264	-1.004906968
2942	Tef	ENSMUSG00000022389	-1.007327474
2943	Zfp133-ps	ENSMUSG00000083674	-1.008262489
2944	Gm7889	ENSMUSG00000099624	-1.010052315
2945	Gm19461	ENSMUSG00000101693	-1.011725335
2946	Adam11	ENSMUSG00000020926	-1.012923867
2947	Gpcpd1	ENSMUSG00000027346	-1.012946203
2948	D630003M21Rik	ENSMUSG00000037813	-1.013110658
2949	Gstt2	ENSMUSG00000033318	-1.013144454
2950	Hadha	ENSMUSG00000025745	-1.013688305
2951	Cux2	ENSMUSG00000042589	-1.013722447
2952	Fmo5	ENSMUSG00000028088	-1.014078015
2953	Pm20d2	ENSMUSG00000054659	-1.014437199
2954	Gnmt	ENSMUSG00000002769	-1.014646858
2955	1110034G24Rik	ENSMUSG00000044991	-1.015035925
2956	Gstp1	ENSMUSG00000060803	-1.015527288
2957	Il10rb	ENSMUSG00000022969	-1.015903371

2958	Vwa8	ENSMUSG00000058997	-1.019871529
2959	9330162012Rik	ENSMUSG00000086448	-1.021000503
2960	Gm10435	ENSMUSG00000072902	-1.021844174
2961	Gm43389	ENSMUSG00000106665	-1.022471531
2962	Gm45203	ENSMUSG00000108494	-1.022852343
2963	Zfp934	ENSMUSG00000074865	-1.022913935
2964	Bri3	ENSMUSG00000047843	-1.023056606
2965	Gm14403	ENSMUSG00000094786	-1.025311153
2966	Gper1	ENSMUSG00000053647	-1.02689718
2967	Cdkn1c	ENSMUSG00000037664	-1.027042013
2968	Fsd2	ENSMUSG00000038663	-1.028381935
2969	Acadl	ENSMUSG00000026003	-1.02937998
2970	Cds1	ENSMUSG00000029330	-1.029440128
2971	Galm	ENSMUSG00000035473	-1.029656305
2972	Mblac2	ENSMUSG00000051098	-1.030427392
2973	Dhdh	ENSMUSG00000011382	-1.031542094
2974	Gm45012	ENSMUSG00000109052	-1.036433992
2975	Gm42568	ENSMUSG00000103703	-1.037766164
2976	Acacb	ENSMUSG00000042010	-1.042600338
2977	Rasl2-9	ENSMUSG00000083649	-1.04519485
2978	Dut	ENSMUSG00000027203	-1.045216758
2979	0610040J01Rik	ENSMUSG00000060512	-1.046029335
2980	Gm5532	ENSMUSG00000073535	-1.046366906
2981	Fam69b	ENSMUSG00000036186	-1.046657605
2982	Mif4gd	ENSMUSG00000020743	-1.048510346
2983	Ggnbp1	ENSMUSG00000048731	-1.048886547
2984	Hsd12	ENSMUSG00000028383	-1.052403212
2985	Tcf15	ENSMUSG00000068079	-1.054316753
2986	Gck	ENSMUSG00000041798	-1.054429563
2987	Nudt7	ENSMUSG00000031767	-1.054560606
2988	Vamp5	ENSMUSG00000073002	-1.055082504
2989	4933431K23Rik	ENSMUSG00000086451	-1.056770752
2990	Tmem266	ENSMUSG00000032313	-1.056874166
2991	Zfp612	ENSMUSG00000044676	-1.058287295
2992	Lbh	ENSMUSG00000024063	-1.062575114
2993	Gm14327	ENSMUSG00000074521	-1.063729109
2994	mt-Tp	ENSMUSG00000064372	-1.064094033
2995	Mlycd	ENSMUSG00000074064	-1.064314435
2996	Klhl38	ENSMUSG00000022357	-1.066499302
2997	Fam229b	ENSMUSG00000051736	-1.06813419
2998	Gm44949	ENSMUSG00000108655	-1.070894839
2999	Ccdc141	ENSMUSG00000044033	-1.071334785
3000	Osbp13	ENSMUSG00000029822	-1.071369944
3001	Asrg11	ENSMUSG00000024654	-1.071606102
3002	Kyat1	ENSMUSG00000039648	-1.072370642
3003	A530013C23Rik	ENSMUSG00000006462	-1.072410593
3004	Myzap	ENSMUSG00000041361	-1.073298516

3005	Nrg1	ENSMUSG00000062991	-1.07430495
3006	Ephx2	ENSMUSG00000022040	-1.076550456
3007	Gstk1	ENSMUSG00000029864	-1.077075901
3008	Naprt	ENSMUSG00000022574	-1.077579958
3009	A430046D13Rik	ENSMUSG00000097353	-1.07782994
3010	Sesn1	ENSMUSG00000038332	-1.078562235
3011	Gm44421	ENSMUSG00000107451	-1.079272861
3012	Amy1	ENSMUSG00000074264	-1.079929831
3013	Ano4	ENSMUSG00000035189	-1.081642566
3014	Fahd2a	ENSMUSG00000027371	-1.081780336
3015	mt-Rnr2	ENSMUSG00000064339	-1.08216366
3016	Lgi1	ENSMUSG00000067242	-1.082756169
3017	Sema3b	ENSMUSG00000057969	-1.083197213
3018	Tcap	ENSMUSG00000007877	-1.083463945
3019	Idh2	ENSMUSG00000030541	-1.084701281
3020	mt-Tw	ENSMUSG00000064346	-1.087442409
3021	Acaa2	ENSMUSG00000036880	-1.088062756
3022	Gm3646	ENSMUSG00000091937	-1.089192401
3023	Ace2	ENSMUSG00000015405	-1.089199488
3024	Hhatl	ENSMUSG00000032523	-1.090321835
3025	Tesc	ENSMUSG00000029359	-1.091053216
3026	Gm20186	ENSMUSG00000106874	-1.092476899
3027	3425401B19Rik	ENSMUSG00000071540	-1.095134825
3028	Pln	ENSMUSG00000038583	-1.095582809
3029	Hs3st5	ENSMUSG00000044499	-1.096291803
3030	Retsat	ENSMUSG00000056666	-1.099116341
3031	Dhrs4	ENSMUSG00000022210	-1.102827166
3032	Dpysl4	ENSMUSG00000025478	-1.102956308
3033	Car4	ENSMUSG00000000805	-1.104007528
3034	Mb	ENSMUSG00000018893	-1.105490432
3035	Selenbp1	ENSMUSG00000068874	-1.108493119
3036	Fbxo44	ENSMUSG00000029001	-1.109371327
3037	Pfkm	ENSMUSG00000033065	-1.109724719
3038	Peli3	ENSMUSG00000024901	-1.110707862
3039	6430573F11Rik	ENSMUSG00000039620	-1.113472696
3040	Celsr1	ENSMUSG00000016028	-1.113678402
3041	Fblim1	ENSMUSG00000006219	-1.114194993
3042	Klhdc1	ENSMUSG00000051890	-1.115614331
3043	Accs1	ENSMUSG00000027452	-1.116309317
3044	Dgat2	ENSMUSG00000030747	-1.116341081
3045	Bckdha	ENSMUSG00000060376	-1.117683661
3046	Rxrg	ENSMUSG00000015843	-1.118586113
3047	Myot	ENSMUSG00000024471	-1.119671173
3048	Dbp	ENSMUSG00000059824	-1.120104998
3049	Bcl11a	ENSMUSG00000000861	-1.120801394
3050	1700123M08Rik	ENSMUSG00000085614	-1.126677328
3051	Cd59b	ENSMUSG00000068686	-1.127338543

3052	Slc27a1	ENSMUSG00000031808	-1.128374228
3053	Etfdh	ENSMUSG00000027809	-1.129099485
3054	Itgb1bp2	ENSMUSG00000031312	-1.129564361
3055	Hnmt	ENSMUSG00000026986	-1.129850214
3056	Msrp2	ENSMUSG00000023094	-1.130511119
3057	Adra2b	ENSMUSG00000058620	-1.130953137
3058	Gm15543	ENSMUSG00000086863	-1.131607026
3059	Carmil3	ENSMUSG00000022211	-1.134805775
3060	Pnmal2	ENSMUSG00000070802	-1.137119937
3061	Bcl11b	ENSMUSG00000048251	-1.137896146
3062	Prodh	ENSMUSG00000003526	-1.139746748
3063	Atcayos	ENSMUSG00000085779	-1.141887338
3064	Gm42418	ENSMUSG00000098178	-1.143004231
3065	Slc25a42	ENSMUSG00000002346	-1.143080285
3066	Gm31105	ENSMUSG00000109587	-1.143691648
3067	Lsmem1	ENSMUSG00000071342	-1.145498353
3068	Wnk2	ENSMUSG00000037989	-1.145530672
3069	Asb10	ENSMUSG00000038204	-1.145735722
3070	Ppargc1a	ENSMUSG00000029167	-1.147367226
3071	Grm1	ENSMUSG00000019828	-1.148561434
3072	Map2k6	ENSMUSG00000020623	-1.148884904
3073	Gpt	ENSMUSG00000022546	-1.149324244
3074	Spata33	ENSMUSG00000048478	-1.151483501
3075	Irx4	ENSMUSG00000021604	-1.151963632
3076	Gm37829	ENSMUSG00000104453	-1.153922176
3077	Art4	ENSMUSG00000030217	-1.155633092
3078	Ciart	ENSMUSG00000038550	-1.156445194
3079	Acsf2	ENSMUSG00000076435	-1.159362105
3080	Tcea3	ENSMUSG00000001604	-1.160441522
3081	Grhl2	ENSMUSG00000022286	-1.161023386
3082	Art1	ENSMUSG00000030996	-1.161026363
3083	Mir133a-1hg	ENSMUSG000000095438	-1.161070715
3084	Hadh	ENSMUSG00000027984	-1.1647778
3085	Gpld1	ENSMUSG00000021340	-1.16508171
3086	Lmod2	ENSMUSG00000029683	-1.166283518
3087	Ripply3	ENSMUSG00000022941	-1.168470374
3088	Clcn1	ENSMUSG00000029862	-1.16859351
3089	D830039M14Rik	ENSMUSG00000043126	-1.170441555
3090	Decr1	ENSMUSG00000028223	-1.170808345
3091	G0s2	ENSMUSG00000009633	-1.173743664
3092	Pex11a	ENSMUSG00000030545	-1.174261513
3093	Fam131a	ENSMUSG00000050821	-1.177724473
3094	Adss1	ENSMUSG00000011148	-1.178539024
3095	Masp1	ENSMUSG00000022887	-1.181926604
3096	Ubxn10	ENSMUSG00000043621	-1.183131487
3097	Prr29	ENSMUSG00000009210	-1.183153469
3098	Fgf9	ENSMUSG00000021974	-1.183912651

3099	Perm1	ENSMUSG00000078486	-1.184081299
3100	Gpat3	ENSMUSG00000029314	-1.184513647
3101	Atp1a2	ENSMUSG00000007097	-1.18603222
3102	Txnip	ENSMUSG00000038393	-1.1903996
3103	Ctf1	ENSMUSG00000042340	-1.190788769
3104	Gm5514	ENSMUSG00000045104	-1.190835358
3105	Cutc	ENSMUSG00000025193	-1.191014933
3106	Dhtkd1	ENSMUSG00000025815	-1.193470072
3107	Lonrf2	ENSMUSG00000048814	-1.194049943
3108	Abhd18	ENSMUSG00000037818	-1.194127651
3109	Coro6	ENSMUSG00000020836	-1.194972633
3110	Pdzd3	ENSMUSG00000032105	-1.197816904
3111	Tbc1d10c	ENSMUSG00000040247	-1.19855164
3112	Tmem150c	ENSMUSG00000050640	-1.199658439
3113	Dnah7b	ENSMUSG00000041144	-1.200674102
3114	Rragb	ENSMUSG00000041658	-1.201058563
3115	Frem2	ENSMUSG00000037016	-1.201861415
3116	Rnf207	ENSMUSG00000058498	-1.204774423
3117	Rbp7	ENSMUSG00000028996	-1.204832761
3118	Slc7a4	ENSMUSG00000022756	-1.205300042
3119	Gm9903	ENSMUSG00000097271	-1.209571345
3120	CN725425	ENSMUSG00000078932	-1.21072226
3121	Gm14703	ENSMUSG00000087644	-1.212980197
3122	Kcnj11	ENSMUSG00000096146	-1.215461486
3123	Mterf2	ENSMUSG00000049038	-1.215741322
3124	Lrrc14b	ENSMUSG00000021579	-1.217240755
3125	Kbtbd13	ENSMUSG00000054978	-1.217928373
3126	Asb14	ENSMUSG00000021898	-1.22249016
3127	1700040L02Rik	ENSMUSG00000019945	-1.226527603
3128	A930018M24Rik	ENSMUSG00000091089	-1.22686898
3129	Paqr7	ENSMUSG00000037348	-1.227742628
3130	Efnb3	ENSMUSG00000003934	-1.229266384
3131	Gm45163	ENSMUSG00000109419	-1.230381694
3132	Pfkfb1	ENSMUSG00000025271	-1.231363939
3133	2010107G23Rik	ENSMUSG00000020083	-1.23169514
3134	Rhobtb1	ENSMUSG00000019944	-1.235028161
3135	1810034E14Rik	ENSMUSG00000097101	-1.239581107
3136	mt-Ta	ENSMUSG00000064347	-1.242281225
3137	Ldhb	ENSMUSG00000030246	-1.248140182
3138	Gm2011	ENSMUSG00000107741	-1.249105324
3139	Pkd2l2	ENSMUSG00000014503	-1.250439434
3140	Ces1d	ENSMUSG00000056973	-1.251442559
3141	Gstm6	ENSMUSG00000068762	-1.252661532
3142	Dnajc28	ENSMUSG00000039763	-1.253106073
3143	4930452B06Rik	ENSMUSG00000021747	-1.254686107
3144	Gnb3	ENSMUSG00000023439	-1.255777476
3145	Cst6	ENSMUSG00000024846	-1.2561602

3146	Wipf3	ENSMUSG00000086040	-1.256386079
3147	Mir133a-2	ENSMUSG00000065460	-1.257422183
3148	Pxmp2	ENSMUSG00000029499	-1.257612863
3149	Gm10603	ENSMUSG00000099137	-1.258981936
3150	Gm8113	ENSMUSG00000089901	-1.263247821
3151	Rom1	ENSMUSG00000071648	-1.26486349
3152	Gm4956	ENSMUSG00000025936	-1.265433176
3153	Gm826	ENSMUSG00000074623	-1.265694667
3154	Gm11734	ENSMUSG00000085419	-1.266503712
3155	Lrp1b	ENSMUSG00000049252	-1.266856005
3156	Gm572	ENSMUSG00000070577	-1.268319908
3157	Gm43672	ENSMUSG00000106019	-1.268807853
3158	Rbfox1	ENSMUSG00000008658	-1.269620216
3159	Gm20522	ENSMUSG00000092241	-1.272304916
3160	Kcnk2	ENSMUSG00000037624	-1.273199588
3161	BC037032	ENSMUSG00000087221	-1.282525456
3162	Ech1	ENSMUSG00000053898	-1.285960757
3163	Fabp3-ps1	ENSMUSG00000056366	-1.287005673
3164	Slc46a3	ENSMUSG00000029650	-1.288590264
3165	Glns-ps1	ENSMUSG00000082100	-1.28951477
3166	Alox12	ENSMUSG00000000320	-1.292683326
3167	Plekhh1	ENSMUSG00000060716	-1.294707791
3168	Srrm4	ENSMUSG00000063919	-1.297778461
3169	Arhgef19	ENSMUSG00000028919	-1.306615492
3170	Myom2	ENSMUSG00000031461	-1.307139947
3171	Slc25a20	ENSMUSG00000032602	-1.307349159
3172	Kcnv2	ENSMUSG00000047298	-1.307793653
3173	Sh2d4a	ENSMUSG00000053886	-1.311358263
3174	Csdc2	ENSMUSG00000042109	-1.311590607
3175	Smco1	ENSMUSG00000046345	-1.331318384
3176	Fabp3	ENSMUSG00000028773	-1.335957877
3177	Ptprn	ENSMUSG00000026204	-1.341673166
3178	Map3k21	ENSMUSG00000031853	-1.348702929
3179	Cacna1s	ENSMUSG00000026407	-1.356885022
3180	Krt222	ENSMUSG00000035849	-1.357991658
3181	Acad12	ENSMUSG00000042647	-1.36229579
3182	Mfsd4b1	ENSMUSG00000038522	-1.362817899
3183	Ccrl2	ENSMUSG00000043953	-1.365266828
3184	Magix	ENSMUSG00000031147	-1.366433446
3185	Mir208a	ENSMUSG00000065432	-1.369653349
3186	Mccc1os	ENSMUSG00000086392	-1.373886049
3187	Unc13a	ENSMUSG00000034799	-1.376024873
3188	4930458D05Rik	ENSMUSG00000087611	-1.383346548
3189	Plin5	ENSMUSG00000011305	-1.392322443
3190	Pfn4	ENSMUSG00000020639	-1.394021192
3191	Spata2l	ENSMUSG00000033594	-1.401642039
3192	Plxnb3	ENSMUSG00000031385	-1.402146155

3193	Capn3	ENSMUSG00000079110	-1.402187838
3194	Ptgds	ENSMUSG00000015090	-1.405537765
3195	Cmtm8	ENSMUSG00000041012	-1.405711428
3196	Gfra4	ENSMUSG00000027316	-1.408922551
3197	Nrn1	ENSMUSG00000039114	-1.417394585
3198	E330011O21Rik	ENSMUSG00000109841	-1.424155483
3199	Tmem25	ENSMUSG00000002032	-1.424395886
3200	Gm34302	ENSMUSG00000103476	-1.428462909
3201	Gm10699	ENSMUSG00000074461	-1.430274418
3202	Lrrc52	ENSMUSG00000040485	-1.432298226
3203	Agbl2	ENSMUSG00000040812	-1.439180094
3204	Tmod4	ENSMUSG00000005628	-1.440979157
3205	Lrtm1	ENSMUSG00000045776	-1.452630127
3206	Lgi3	ENSMUSG00000033595	-1.456746041
3207	Foxred2	ENSMUSG00000016552	-1.457388753
3208	Gm12519	ENSMUSG00000085643	-1.459198157
3209	Nmb	ENSMUSG00000025723	-1.459632991
3210	9030612E09Rik	ENSMUSG00000045008	-1.462111853
3211	Ccdc189	ENSMUSG00000057176	-1.466492114
3212	Gm20619	ENSMUSG00000093482	-1.470913864
3213	P2ry1	ENSMUSG00000027765	-1.478547649
3214	Dhrs3	ENSMUSG00000066026	-1.485480146
3215	Rasd2	ENSMUSG00000034472	-1.502500427
3216	Dcaf12l1	ENSMUSG00000045284	-1.50295348
3217	Acy3	ENSMUSG00000024866	-1.505525483
3218	Paqr9	ENSMUSG00000064225	-1.507219972
3219	Kcna7	ENSMUSG00000038201	-1.51962661
3220	Ky	ENSMUSG00000035606	-1.521105304
3221	Cpt2	ENSMUSG00000028607	-1.546700563
3222	Ociad2	ENSMUSG00000029153	-1.54931381
3223	Klhl33	ENSMUSG00000090799	-1.551297275
3224	P2rx6	ENSMUSG00000022758	-1.551666095
3225	Hmgcs2	ENSMUSG00000027875	-1.555810995
3226	Fah	ENSMUSG00000030630	-1.557877241
3227	Tmem196	ENSMUSG00000048004	-1.557902735
3228	Cyp1a1	ENSMUSG00000032315	-1.563510036
3229	Gm5069	ENSMUSG00000055676	-1.583367073
3230	1500026H17Rik	ENSMUSG00000097383	-1.595989867
3231	Poln	ENSMUSG00000045102	-1.605717186
3232	Ttll1	ENSMUSG00000022442	-1.618000571
3233	Lrrc4b	ENSMUSG00000047085	-1.620767358
3234	Pdp2	ENSMUSG00000048371	-1.622674208
3235	Acsm5	ENSMUSG00000030972	-1.623060194
3236	Lix1	ENSMUSG00000047786	-1.650475797
3237	Rtn4r	ENSMUSG00000043811	-1.656677431
3238	Tpd52l1	ENSMUSG00000000296	-1.677962008
3239	Echdc3	ENSMUSG00000039063	-1.680348036

3240	Armc2	ENSMUSG00000071324	-1.689499242
3241	Mylk4	ENSMUSG00000044951	-1.713399449
3242	Esrrb	ENSMUSG00000021255	-1.724388138
3243	Gm20594	ENSMUSG00000096887	-1.729589199
3244	Fn3k	ENSMUSG00000025175	-1.770367777
3245	Pnck	ENSMUSG00000002012	-1.79339723
3246	D7Ert443e	ENSMUSG00000030994	-1.794174424
3247	A530016L24Rik	ENSMUSG00000043122	-1.814446005
3248	Uckl1os	ENSMUSG00000010492	-1.823225698
3249	Nudt17	ENSMUSG00000028100	-1.833632626
3250	Scgb1c1	ENSMUSG00000038801	-1.866522579
3251	Scd4	ENSMUSG00000050195	-1.885374552
3252	Ripor2	ENSMUSG00000036006	-1.906096489
3253	Tmem82	ENSMUSG00000043085	-1.943550535
3254	9430062P05Rik	ENSMUSG00000104263	-1.950562933
3255	Bmp7	ENSMUSG00000008999	-1.951083338
3256	Bdh1	ENSMUSG00000046598	-1.96275389
3257	Igfals	ENSMUSG00000046070	-1.995145669
3258	Ogdhl	ENSMUSG00000021913	-2.024478749
3259	Gm45670	ENSMUSG00000109635	-2.027657599
3260	Fbp2	ENSMUSG00000021456	-2.035397682
3261	Myh7b	ENSMUSG00000074652	-2.05635109
3262	Ucp3	ENSMUSG00000032942	-2.089765907
3263	Gchfr	ENSMUSG00000046814	-2.106077278
3264	Slc25a34	ENSMUSG00000040740	-2.121871686
3265	Snai3	ENSMUSG00000006587	-2.140545121
3266	B430212C06Rik	ENSMUSG00000046415	-2.212029917
3267	Lars2	ENSMUSG00000035202	-2.220350519
3268	Angptl3	ENSMUSG00000028553	-2.261570039
3269	Ano5	ENSMUSG00000055489	-2.265706879
3270	Gm36670	ENSMUSG00000109696	-2.289250624
3271	Clec18a	ENSMUSG00000033633	-2.41653806
3272	Cngb3	ENSMUSG00000056494	-2.495569712
3273	Aldob	ENSMUSG00000028307	-2.533973922
3274	Lgals4	ENSMUSG00000053964	-2.549164923
3275	Acot1	ENSMUSG00000072949	-2.630300791
3276	Pde11a	ENSMUSG00000075270	-2.650558147
3277	Slc15a2	ENSMUSG00000022899	-3.106933705

Table IV: 7-day TAC echocardiographic parameters

	Con Sham (n = 5)	Con+Rheb Sham (n = 5)	ATF6 cKO Sham (n = 5)	ATF6 cKO+Rheb Sham (n = 5)
FS (%)	31.47±4.07	33.63±1.68	28.61±2.54	28.28±1.67
EF (%)	59.40±5.61	63.18±2.30	55.60±4.07	54.94±2.72
LVEDV (μl)	55.61±9.30	56.30±2.97	59.41±3.99	75.90±6.83
LVESV (μl)	23.61±2.83	20.84±2.03	26.91±4.19	34.54±4.42
LVIDD (mm)	3.59±0.24	3.65±0.08	3.73±0.10	4.12±0.16
LVIDS (mm)	2.48±0.27	2.42±0.10	2.67±0.16	2.96±0.15
PWTD (mm)	0.72±0.06	0.68±0.05	0.93±0.08	0.72±0.08
PWTS (mm)	1.03±0.11	1.02±0.06	1.15±0.14	0.94±0.08
AWTD (mm)	0.91±0.07	0.87±0.02	0.92±0.08	0.83±0.03
AWTS (mm)	1.21±0.05	1.16±0.08	1.21±0.08	1.12±0.05
HR (bpm)	488±18.43	516±16.48	464±33.55	504±35.34
HW (mg)	138.60±7.91	134.75±2.55	137.73±3.05	161.60±8.84
BW (g)	26.14±0.97	26.64±0.43	27.13±0.26	28.05±0.65
TL (mm)	19.00±0.37	18.50±0.26	19.67±0.26	22.00±0.37
HW/BW (mg/g)	5.29±0.13	5.07±0.15	5.08±0.13	5.75±0.21
HW/TL (mg/mm)	7.28±0.29	7.29±0.19	7.00±0.07	7.34±0.32

	Con TAC (n = 7)	Con+Rheb TAC (n = 8)	ATF6 cKO TAC (n = 7)	ATF6 cKO+Rheb TAC (n = 8)
FS (%)	29.73±2.25	31.60±1.08	17.71±2.20 ^{1,2}	26.25±1.07
EF (%)	57.77±1.54	60.57±1.54	37.25±4.15 ^{1,2}	52.41±1.88
LVEDV (μl)	46.54±4.61	50.55±2.03	61.26±4.53 ²	52.73±5.77 ¹
LVESV (μl)	19.71±1.81	19.92±1.08	38.91±4.66 ^{1,2}	25.46±3.78 ²
LVIDD (mm)	3.36±0.15	3.49±0.06 ¹	3.77±0.12 ²	3.53±0.16 ¹
LVIDS (mm)	2.36±0.13	2.39±0.05	3.11±0.16 ^{1,2}	2.61±0.15 ¹
PWTD (mm)	1.78±0.12 ¹	1.54±0.08 ¹	1.03±0.04 ²	1.45±0.14 ¹
PWTS (mm)	1.99±0.11 ¹	1.66±0.14 ¹	1.07±0.08 ²	1.68±0.13 ¹
AWTD (mm)	1.28±0.05 ¹	1.23±0.08 ¹	0.91±0.12 ²	1.27±0.13 ¹
AWTS (mm)	1.49±0.09 ¹	1.61±0.06 ¹	1.28±0.13 ²	1.62±0.13 ¹
HR (bpm)	523±9.02	519±13.29	505±13.20	514±22.54
HW (mg)	212.44±3.89 ¹	217.20±14.08 ¹	176.89±7.44 ^{1,2}	232.95±9.99 ^{1,2}
BW (g)	24.34±0.66	23.99±0.51 ¹	25.63±0.47	25.52±0.73 ¹
TL (mm)	19.60±0.40	19.00±0.31	20.86±0.32	20.17±0.44
HW/BW (mg/g)	8.75±0.24 ¹	9.10±0.69 ¹	6.90±0.27 ^{1,2}	9.15±0.39 ¹
HW/TL (mg/mm)	10.86±0.22 ¹	11.39±0.56 ¹	8.50±0.41 ^{1,2}	11.54±0.33 ¹

FS = fractional shortening

EF = ejection fraction

LVEDV = left ventricular end diastolic volume

LVESV = left ventricular end systolic volume

LVIDD = left ventricular inner diameter in diastole

LVIDS = left ventricular inner diameter in systole

PWTD = left ventricular posterior wall thickness in diastole

PWTS = left ventricular posterior wall thickness in systole

AWTD = left ventricular anterior wall thickness in diastole

AWTS = left ventricular anterior wall thickness in systole

HR = heart rate in beats per minute

HW = heart weight

BW = body weight

TL = tibia length

HW/BW = heart weight/body weight

HW/TL = heart weight/tibia length

Statistical analyses used a one-way ANOVA with a Newman-Keuls post-hoc analysis.

¹ = $p \leq 0.05$ different from respective Sham

² = $p \leq 0.05$ different from Con TAC

Table V: TAC time course echocardiographic parameters for Wild-Type mice

	Sham (n = 4)	3-Hours TAC (n = 4)	2-Days TAC (n = 4)	7-Days TAC (n = 4)
FS (%)	30.76±1.69	32.27±1.83	28.32±3.21	25.36±1.85
EF (%)	59.11±2.58	61.40±2.64	54.95±4.98	50.51±3.00 ¹
LVEDV (μl)	55.18±3.16	50.76±3.82	58.16±1.60	62.66±1.32 ¹
LVESV (μl)	22.82±2.74	19.94±2.60	26.38±3.44	30.87±1.67 ¹
LVIDD (mm)	3.62±0.08	3.49±0.11	3.70±0.04	3.82±0.03 ¹
LVIDS (mm)	2.51±0.11	2.37±0.13	2.65±0.14	2.85±0.06 ¹
PWTD (mm)	0.70±0.04	0.78±0.03	0.91±0.12	1.30±0.05 ¹
PWTS (mm)	1.03±0.04	1.12±0.06	1.22±0.09	1.69±0.06 ¹
AWTD (mm)	0.79±0.04	0.93±0.05	1.03±0.05 ¹	1.50±0.04 ¹
AWTS (mm)	1.10±0.04	1.22±0.06	1.25±0.04	1.78±0.05 ¹
HR (bpm)	517±11.32	503±13.78	509±11.75	517±7.18
HW (mg)	121.05±5.23	158.95±4.05 ¹	162.90±3.39 ¹	208.50±10.04 ¹
BW (g)	23.09±0.28	31.00±0.85 ¹	27.94±1.56 ¹	29.06±0.37 ¹
TL (mm)	18.50±0.29	23.50±0.29 ¹	21.50±0.50 ¹	22.75±0.25 ¹
HW/BW (mg/g)	5.24±0.22	5.13±0.06	5.85±0.43	7.19±0.42 ¹
HW/TL (mg/mm)	6.54±0.21	6.76±0.10	7.56±0.51 ¹	9.15±0.35 ¹

FS = fractional shortening

EF = ejection fraction

LVEDV = left ventricular end diastolic volume

LVESV = left ventricular end systolic volume

LVIDD = left ventricular inner diameter in diastole

LVIDS = left ventricular inner diameter in systole

PWTD = left ventricular posterior wall thickness in diastole

PWTS = left ventricular posterior wall thickness in systole

AWTD = left ventricular anterior wall thickness in diastole

AWTS = left ventricular anterior wall thickness in systole

HR = heart rate in beats per minute

HW = heart weight

BW = body weight

TL = tibia length

HW/BW = heart weight/body weight

HW/TL = heart weight/tibia length

Statistical analyses used a one-way ANOVA with a Newman-Keuls post-hoc analysis.

¹ = $p \leq 0.05$ different from Sham

Table VI: 3-hour TAC echocardiographic parameters for Con and ATF6 cKO mice

	Con Sham (n = 5)	ATF6 cKO Sham (n = 4)	Con TAC (n = 5)	ATF6 cKO TAC (n = 4)
FS (%)	34.06±2.95	33.88±3.13	31.91±1.57	31.59±3.66
EF (%)	63.57±3.78	63.18±4.30	60.66±2.26	59.72±5.30
LVEDV (μl)	51.52±3.83	58.55±2.44	61.47±4.92	63.15±5.20
LVESV (μl)	18.28±1.23	21.79±3.28	24.33±2.86	26.21±5.31
LVIDD (mm)	3.51±0.11	3.71±0.07	3.78±0.12	3.82±0.13
LVIDS (mm)	2.30±0.06	2.46±0.15	2.57±0.12	2.63±0.23
PWTD (mm)	0.84±0.08	0.76±0.07	0.72±0.05	0.81±0.06
PWTS (mm)	0.90±0.23	1.16±0.18	1.08±0.05	1.16±0.07
AWTD (mm)	0.86±0.10	0.90±0.09	0.88±0.04	0.93±0.04
AWTS (mm)	1.77±0.16	1.24±0.08	1.21±0.04	1.22±0.04
HR (bpm)	493±19.31	517±10.09	510±10.16	512±14.34
HW (mg)	128.88±5.32	137.30±6.35	148.00±2.16 ¹	152.78±6.37 ¹
BW (g)	24.58±0.88	25.88±1.04	26.58±0.40	28.16±0.65 ¹
TL (mm)	19.40±0.51	19.00±0.41	21.00±0.32	21.75±0.48 ¹
HW/BW (mg/g)	5.24±0.11	5.31±0.16	5.58±0.15	5.42±0.14
HW/TL (mg/mm)	6.65±0.25	7.23±0.23	7.06±0.16	7.02±0.22

FS = fractional shortening

EF = ejection fraction

LVEDV = left ventricular end diastolic volume

LVESV = left ventricular end systolic volume

LVIDD = left ventricular inner diameter in diastole

LVIDS = left ventricular inner diameter in systole

PWTD = left ventricular posterior wall thickness in diastole

PWTS = left ventricular posterior wall thickness in systole

AWTD = left ventricular anterior wall thickness in diastole

AWTS = left ventricular anterior wall thickness in systole

HR = heart rate in beats per minute

HW = heart weight

BW = body weight

TL = tibia length

HW/BW = heart weight/body weight

HW/TL = heart weight/tibia length

Statistical analyses used a one-way ANOVA with a Newman-Keuls post-hoc analysis.

¹ = $p \leq 0.05$ different from respective Sham

² = $p \leq 0.05$ different from Con TAC