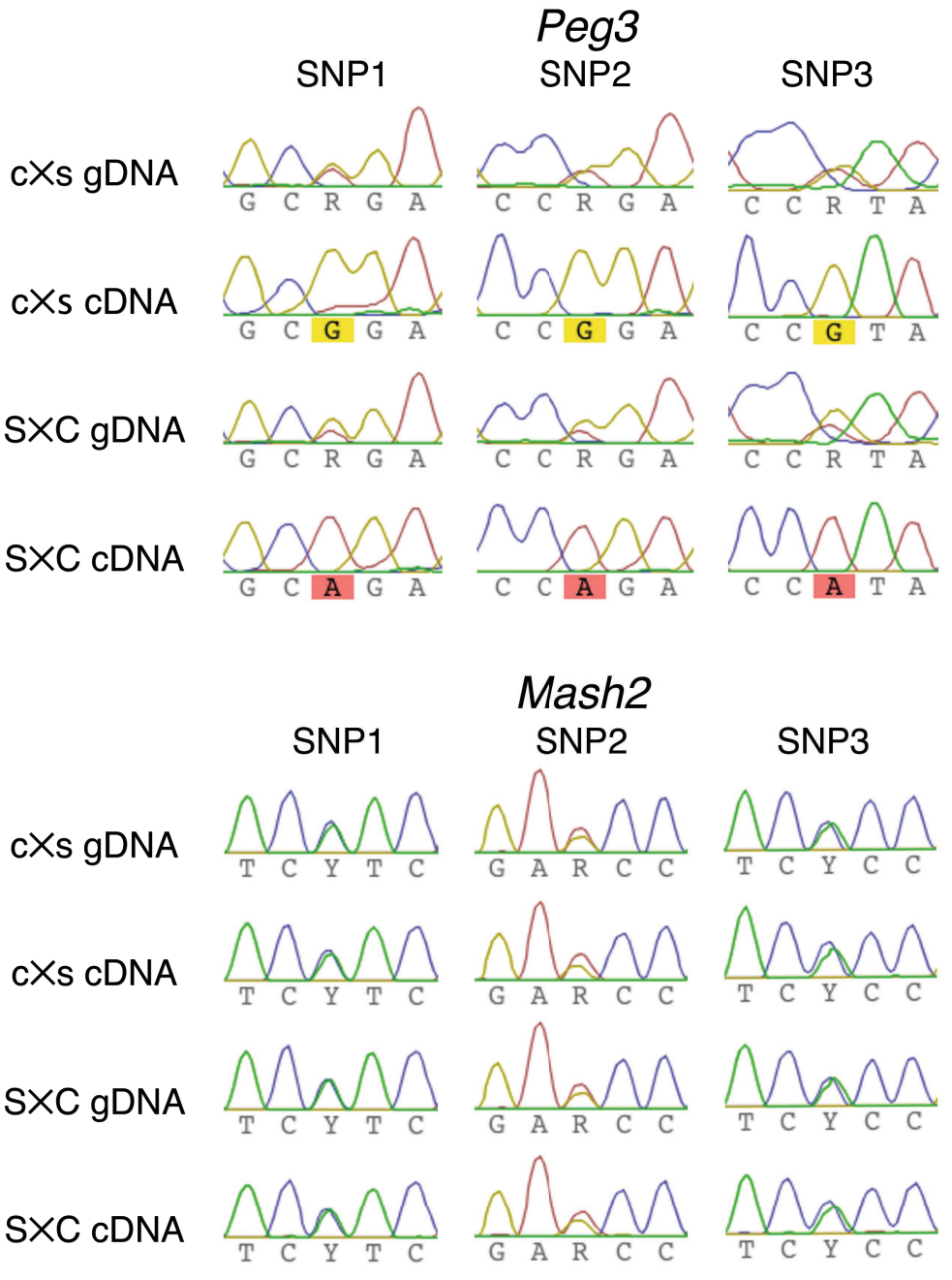
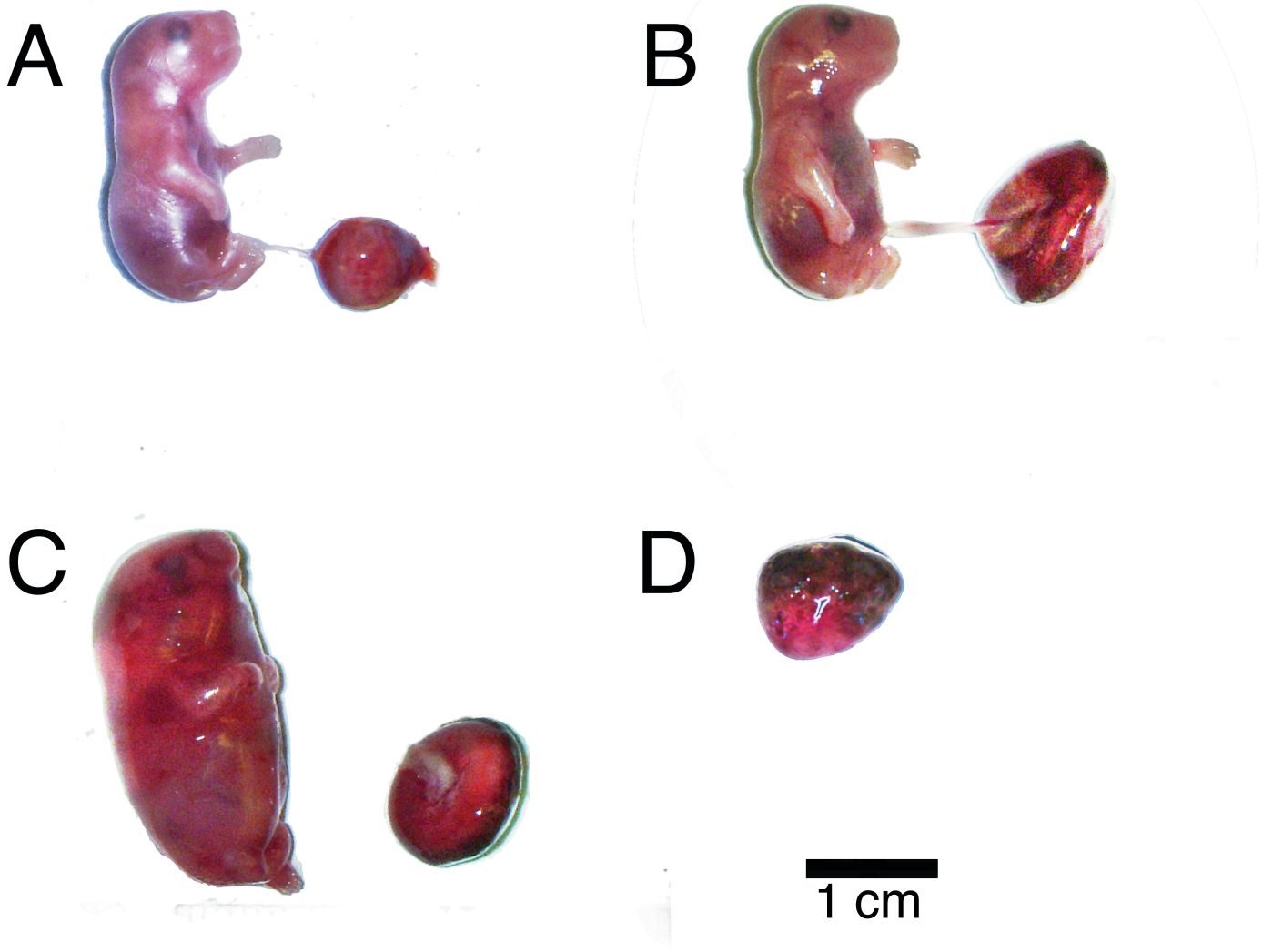
Supplemental Figure 1



Supplemental Figure 1: Examples of a gene that is properly imprinted in reciprocal hybrids (*Peg3*, top) and one that shows biallelic expression in hybrids (*Mash2,* bottom). Genomic DNA (gDNA) and complement DNA (cDNA) from the same individiual demonstrate heterozygosity at three fixed differences in the gDNA sequences for both of these genes. In contrast, when cDNA is sequenced, these heterozygous postitions show imprinted expression of *Peg3* and biallelic expression of *Mash2* .

Supplemental Figure 2



Supplemental Figure 2: (A) Normal *P. campbelli* offspring with average sized placenta. (B) Overgrown S×C offspring with an enlarged placenta. (C) Overgrown S×C offspring with severe edema (swelling) of the body and an enlarged placenta. (D) Overgrown S×C molar conceptus. All images are to scale.

Table S1: Mammalian crosses that show abnormal growth effects

Order	Family	Parent 1	Parent 2	1x2	2x1	Reference	Silent Nucleotide Divergence (Dxy) at cyt *b* (K2P corrected)	GenBank sequences used to estimate Dxy	Quote
Artiodactyla	Bovidae	*Ammotragus lervia*	*Capra hircus*	NA	Small	Gray (1972) #382	0.1244	AF034731.1, AB044308.1	"full-term hybrid kids… [were] smaller than average full-term goat kids."
Artiodactyla	Bovidae	*Bison bison*	*Bison bonasus*	Large	Large	Gray (1972) #383	0.0773	AF036273.1, Y15005.1	"males in particular show heterosis in respect of body size. … a male hybrid born at Schoenbrunn was as heavy, at 2 years of age, as an adult 5-year-old European Bison."
Artiodactyla	Bovidae	*Bison bison*	*Bos taurus*	Large	Large	Gray (1972) #383	0.0712	AF036273.1, GU249573.1	"The f1 hybrids are long-lived, uniform in type, more docile than bison, and show heterosis. Very heavy losses of both calves and dams have resulted from matings between bison bulls and domestic cows, as the latter invariably secrete excessive amounts of amniotic fluid. The percentages of abortions and stillbirths are particularly high among mlae calves. … In the domestic bull x bison cow cross mortality is relatively low."
Artiodactyla	Bovidae	*Bison bonasus*	*Bos taurus*	Large	Large	Gray (1972) #384	0.0712	GU249573.1, Y15005.1	"The f1 hybrids were hardy and showed heterosis in respect to birth weight, growth rate (especially in the first 6 months of life), disease resistance, strength, and cold tolerance. When the wisent was the dam, the birth weight of the calves was less than when the domestic cow was the dam."
Artiodactyla	Bovidae	*Bos grunniens*	*Bos indicus*	Large	Large	Gray (1972) #389	0.0742	EU807952.1, EF061244.1	"the hybrids often show heterosis in respect to body size"
Artiodactyla	Bovidae	*Bos grunniens*	*Bos taurus*	Large	Large	Gray (1972) #389	0.0757	EU807952.1, GU249573.1	"Opinions differ as to what extent hybrids show heterosis. In general, it seems that they are intermediate in body size when bulls of improved domestic breeds are used, but surpass both parents when sired by bulls of unimproved stock."
Artiodactyla	Bovidae	*Capra hircus*	*Capra caucasica*	Large	NA	Gray (1972) #394	0.0385	AB044308.1, DQ246801.1	"The F1 hybrids reported by Misarev were heavier than either parental species at 4/5 years"
Artiodactyla	Bovidae	*Ovis aries*	*Ovis ammon karelini*	Large	NA	Gray (1972) #446	0.0312	JX567831.1, AJ867276.1	"In general appearance, conformation, and temperment the F1 hybrids tend to resemble the wild species, but they surpass the arkhar in body weight and wool characteristics."
Artiodactyla	Camelidae	*Camelus bactrianus*	*Camelus dromedarius*	Large	Intermediate	Gray (1972) #532	0.1062	AY126625.1, AY126630.1	"The f1 hybrids show heterosis with regard to body measurements, hardiness, endurance, longevity, and certain blood characteristics. The F1 hybrids are large, strong animals equally well adapted for draft and pack work. The cross between the male dromedary and the female bactrian camel is larger than the reciprocal cross at 3 months of age."
Artiodactyla	Cervidae	*Cervus elaphus elaphus*	*Cervus elaphus asiaticus*	Large	NA	Gray (1972) #498	NA	No data for *Cervus elaphus asiaticus*	"[The hybrids] are large animals."
Artiodactyla	Cervidae	*Rangifer tarandus tarandus*	*Rangifer tarandus caribou*	Large	NA	Gray (1972) #530	0.0056	AY726681.1, DQ673135.1	"[the F1 hybrid] is larger than the reindeer at birth (13-16lbs compared with 10-13) and weighs 50-100lbs more when full grown."
Carnivora	Canidae	*Vulpes fulva*	*Alopex lagopus*	Large	NA	Gray (1972) #163	0.1387	JQ003578.1, AY598511.1	"The hybrid surpassed both parental species in growth rate and body length. They are stronger and more vicious than either parent"
Carnivora	Felidae	*Felis catus*	*Felis silvestris*	Large	NA	Gray (1972) #129	0.0042	AB194817.1, EF689045.1	"The young hybrids reported by Peters were rather heavier than domestic cats of the same age"
Carnivora	Felidae	*Felis concolor (Puma concolor)*	*Panthera pardus*	Small	Small	Gray (1972) #131	0.1929	GU175442.1, EF056506.1	"Body length was much less than in either parental species"
Carnivora	Felidae	*Panthera pardus fusca*	*Felis concolor (Puma concolor)*	NA	Small	Gray (1972) #131	0.1929	GU175442.1, EF056506.1	"The hybrid described by Hemmer was a fairly small animal."
Carnivora	Felidae	*Pantera leo*	*Panthera tigris*	Large	Small	Gray (1972) #141	0.1158	JX023542.1, KC879296.1	"The hybrids [Tiger female x Lion male] are often larger than either parental species. According to Reisinger, one male hybrid weighed as much as both parents together. A female backcross (male P. leo x F1) was described as much smaller than a normal lioness"
Carnivora	Felidae	*Pantera onca*	*Panthera pardus*	Large	Intermediate	Gray (1972) #142	0.1376	EF056506.1, GU175435.1	"When barely 9 months of age, the hybrids[female *P. pardus* x male *P. onca*] surpassed their dam in body size. At 1.5 years they were intermediate between sire and dam at height at the withers. [In the reciprocal cross] At 6 months of age, the hybrids were considerably stronger than leopards or jaguars of the same age."
Carnivora	Mustelidae	*Mustela putorius furo*	*Mustela putorius putorius*	Large	NA	Gray (1972) #188	0.0000	AB026103.1, AF057128.1	"The hybrids have a rapid growth rate and appear to be fully fertile."
Carnivora	Ursidae	*Thalactos maritimus (Ursus maritimus)*	*Ursus arctos middendorffi*	Large	Large	Gray (1972) #194	0.0126**	AP012597.1, EU497665.1	"[The f1 hybrids] are large animals of normal viability."
Perissodactyla	Equidae	*Equus asinus*	*Equus grevyi*	Large	Large	Gray (1972) #352	0.0562	JF718884.1, JF718890.1	"the [*E. grevyi* x *E. asinus*] hybrids are superior to either parent in action, conformation and disposistion. The [*E. asinus* x *E. grevyi*] hybrids reported by Rzasnicki grew rapidly, and at 2 years of age were larger than their dam."
Perissodactyla	Equidae	*Equus asinus*	*Equus hemionus onager*	Large	NA	Gray (1972) #352	0.0517	JF718884.1, JF718887.1	"the hybrids are said to be larger and of better appearance than mules or asses."
Perissodactyla	Equidae	*Equus asinus*	*Equus caballus*	Large	Small	Allen (1969), Allen (1993), Gray (1972) #352	0.0773	JF718884.1, KC968811.1	Donkeys carrying hybrids show enlarged endometrial cups compared to horses carrying hybrids.
Perissodactyla	Equidae	*Equus burchelli antiquorum*	*Equus przewalskii*	Large	NA	Gray (1972) #359	0.0924	JF718888.1, JF718883.1	"The male [hybrid] described by Gunali showed heterosis in body measurements"
Perissodactyla	Equidae	*Equus caballus*	*Equus hemonius khur*	NA	Small	Gray (1972) #362	0.0847	JF718887.1, KC968811.1	"the hybrid was smaller than it's dam"
Perissodactyla	Equidae	*Equus zebra*	*Equus caballus*	Large	NA	Gray (1972) #362	0.0848	KC968811.1, JF718889.1	"at one year of age [the hybrid] was taller than either parent"
Primate	Cercopithecidae	*Macaca radiata*	*Macaca sinica*	NA	Small	Gray (1972) #63	NA	No data for *Macaca sinica*	"One hybrid was rather small at birth"
Primate	Cercopithecidae	*Macaca silenus*	*macaca nemestrina*	NA	Small	Gray (1972) #61	0.1309	AF350404.1, EU204975.1	"The hybrids were all under-sized and reared artificially in a children's clinic."
Primate	Lemuridae	*Lemur albifrons (Eulemur fulvus albifrons)*	*Lemur macaco (Eulemur macacao)*	Large	NA	Gray (1972) #116	0.1003*	AF175856.1, AF175849.1	"Hybrids produced at the Hamburg Zoo were large, strong animals…"
Rodentia	Caviidae	*Cavia porcellus*	*Cavia aperea*	Large	NA	Gray (1972) #330	0.0909	HM447187.1, GU136754.1	"…no young are born at the first conception. Either the large hybrid fetuses are reabsorbed or the dam dies at parturition.Hybrids born at subsequent parturitions frequently survive. They have a high birth weight, show rapid growth and are fertile in both sexes."
Rodentia	Caviidae	*Cavia porcellus*	*Cavia fulgida*	Large	Large	Gray (1972) #332	0.0934	HM447187.1, GU136737.1	"F1 hybrids of both sexes are remarkable vigorous, and their early growth rate is rapid. According to Detlefsen, male hybrids are larger than *C. porcellus*, but according to Ubisch and Mello, the hybrids are later surpassed in weight by the domestic guinnea pig."
Rodentia	Cricetidae	*Clethrionomys rutilus*	*Clethrionomys glareolus glareolus*	Large	NA	Gray (1972) #244	0.0818	AB031581.1, DQ472348.1	"F1 hybrids reported by Zimmermann showed hybrid vigour in pre- and postnatal development…"
Rodentia	Cricetidae	*Meriones tristrami*	*Meriones libycus*	Large	NA	Gray (1972) #249	0.1509*	JQ687401.1, JQ927412.1	"A male and female hybrid obtained in Teheran were particularly large and vigorous animals."
Rodentia	Cricetidae	*Mesocricetus auratus*	*Mesocricetus newtoni*	Large	NA	Gray (1972) #254	0.1168	AB290351.1, AJ973381.1	"Litter size was much smaller than in the parentla species, but the hybrids showed heterosis in respect of growth rate and body weight."
Rodentia	Cricetidae	*Peromyscus interparietalis*	*Peromyscus eremicus*	Large	NA	Gray (1972) #273	NA	No data for *Peromyscus interparietalis*	"The f1 hybrids showed heterosis"
Rodentia	Cricetidae	*Peromyscus leucocephalus*	*Peromyscus maniculatus blandus*	Large	Small	Gray (1972) #278	NA	No data for *Peromyscus leucocephalus*	"Reciprocal crosses are possible, but difficulties frequently arise at parturition it the smaller *P. leucocephalus* is the female parent. The placenta of dead [hybrids when *P. lecuocephalus* is the mother] were disproportionately large.
Rodentia	Cricetidae	*Peromyscus polionotus*	*Peromyscus maniculatus*	Large	Small	Dawson (1965), Gray (1972) #281	0.0399	EF423875.1, DQ385827.1	"…There is high incidence of maternal foetal death in the second half of pregnancy, and the *P. polionotus* females frequently die at parturition owing to the unusually large size of the hybrid foetuses. The smaller maternal species (*P. polionotus*) bears the larger hybrids and the larger maternal species (*P. maniculatus)* bears the smaller hybrids."
Rodentia	Cricetidae	*Phodopus sungorus*	*Phodopus campbelli*	Large	Intermediate/Small	Sokolov (1993)/this study	0.0371	KF673394.1, KF673395.1	P.c. x P.s. hybrids weigh 29g as do the parents, while P.s. x P.c. hybrids weigh 55g - Table 2, row 2 in Sokolov (1993) is body weights (in russian)
Rodentia	Muridae	*Acomys dimidiatus*	*Acomys minous*	Large	Small	Gray (1972) #299	0.0838	AJ233959.1, GU046553.1	"The hybrids weighed less at birth and showed less rapid growth than the parental species. [in the reciprocal cross] the large size of the hybrid embryos tended to result in deficiencies at or before parturition. The post-natal growth of the hybrids was more rapid than in the parental species."
Rodentia	Muridae	*Mus spretus*	*Mus musculus*	Large	Small	Zechner (1996)	0.0963	AB033700.1, AC_000026.1	"increased placental size occurred in a (*spr* x *mus*) cross… The opposite phenotype, decreased placental size, was observed in (*mus* x *spr*) and (*mus* x *mac*) crosses…"
Rodentia	Muridae	*Mus macidonicus*	*Mus musculus*	Large	Small	Zechner (1996)	0.0686	AY057808.1, AC_000026.1	"increased placental size occurred in a (*spr* x *mus*) cross… The opposite phenotype, decreased placental size, was observed in (*mus* x *spr*) and (*mus* x *mac*) crosses… The occurrence of abnormally sized placenta weight in the *mac* crosses followed exactly the same pattern as the spr crosses"
Rodentia	Muridae	*Mus specilegus*	*Mus musculus*	Large	NA	Zechner (1996)	NA	No data for *Mus specilegus*	"When the (*mus* x *spi*) F1 females were backcrossed with *mus* males, enlarged placentas were again observed"

Note: many taxanomic names have changed since Gray published in 1972. Here we report the same names as Grey (1972) with current names in parentheses

* To calculate Dxy, we aligned all sequences and trimmed the alignment to the 718 bases shared across most of the species. The single asterisk (*) indicates species pairs that had fewer than 718 bases in this trimmed alignment and indicates that these may not be directly comparable to the others.

** Low genetic divergence between polar bears and grizzly bears represents recent mitochondrial introgression and may not be indicative of the genome-wide divergence (Miller et al., 2012).

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Table S2: PCR Primer Sequences and Reaction Conditions

Primer Name	Sequence 5` to 3`	Melting Temp (Tm)	GenBank accession numbers or USCS gene IDs/genome builds used to design these primer pairs
CytB Forward	CCWGCCCCATCAAAYATYTC	60	
CytB Reverse	ACTGGTTGNCCTCCRATTCA	60	UCSC: uc009kob.1_mm9, rn4
Grb10 Forward	GCCTTCAGGAGGAAGACCA	55	
Grb10 Reverse	CATGGAACCARTGCTGNTC	55	UCSC: NM_001001555_hg18, mm9, rn4, cavPor2
H19 Forward	GACATGGTCCGGTGTGAYG	55	
H19 Reverse	CTGGTGRGGAGGGGCAAA	55	UCSC: uc009kob.1_mm9, hg19, rn4
Igf2 Forward	TGGGGAAGTCGATGTTGG	55	
Igf2 Reverse	CGYTTGGCCTCTCTGAACKC	55	UCSC: uc009kod.1_mm9, hg19, rn4, cavPor3
Igf2r Forward	ACCACGAGTGGGGCTTCT	59	
Igf2r Reverse	GCCACCAGGAGNAGRCTGAG	59	UCSC: uc008aky.1_mm9, hg18, rn4, cavPor2
Mash2 Forward	GAGCGCAACCGCGTRAAG	57	
Mash2 Reverse	TCAGTAGCCCCCTAACCARCTG	57	UCSC: uc009koj.1_mm9, hg18, rn4, cavPor2
Mest Forward	GAGRGAGTGGTGGGTCCARG	56	
Mest Reverse	AAGGAGTTGATGAAGCCCATA	56	UCSC: uc009bfu.1_mm9, hg18, cavPor2
Peg3 Forward	TGTGGACAGGCTTCATTCA	55	
Peg3 Reverse	TGTGAGAATTCTGGTGTCTGG	55	UCSC: NM_001146186_mm9, hg18, rn4, cavPor2
Snrpn Forward	TGTGGGTAAGAGTAGCAAGATGC	55	
Snrpn Reverse	GTCTTGGTGGRCGCATTC	55	UCSC: NM_022807_mm9, rn4
Zfx Forward*	CAAAWCATGCAAGGRTAGAC	60	
Zfx Reverse*	AGACCTGATTCCAGGCAGTACCA	60	GenBank: X75172.1, X75171.1, NM_001044386.1, AY012058.1, M74776.1, AY012055.1
*Grb10*_qpcr_Gen_F	CAGGTGAAGGAAGTTGGAAG	60	
*Grb10*_qpcr_Gen_R	GGACTTTGTCCACGAAGGAA	60	GenBank: JX217835.1, JX217834.1
*H19*_qpcr_F1	TGGTCTCTCAAGCAAAGAA	60	
*H19*_qpcr_R1	CGTCATCTCCCTCCTGTCTT	60	GenBank: JX217837.1, JX217836.1
*Igf2*_qpcr_F1	GAGGCATCGTGGAAGAGTG	60	
*Igf2*_qpc_R1	ACACGTCCCTCTCGGACTT	60	GenBank: JX217838.1, JX217839.1
*Igf2r*_qpcr_F2	AATGACCAGCACTTCAGCAG	60	
*Igf2r*_qpcr_R2	TGGAAGAAGATGGTGGTAGA	60	GenBank: JX 217841.1, JX217840.1
*Mash2*_qpcr_F2	CGTTATCTCCTCCGCCAGT	60	
*Mash2*_qpcr_R2	CACCGGACTCAGCTCTCC	60	GenBank: JX217843.1, JX217842.1
*Mest*_qpcr_F1	GCTTTGGCTTCAGTGACAAA	60	
*Mest*_qpcr_R1	TGATTCTGCGGTTCTGTAGC	60	GenBank: JX217845.1, JX217844.1
*Peg3*_qpcr_F1	CAGATGGAGAAGCTGCTGAG	60	
*Peg3*_qpcr_R2	CTTTTCTGGGTCTTCGATCC	60	GenBank: JX217847.1, JX217846.1
*Snrpn*_qpcr_F1	GGAGGGTCCACCTCCTAAAG	60	
*Snrpn*_qpcr_R1	GGACAGGACCTGCTAATCCA	60	GenBank: JX217849.1, JX217848.1
*Ywhaz*_qpcr_F1	GCCTGCTCTCTTGCAAAAAC	60	
*Ywhaz*_qpcr_R2	ATTTTCCCCTCCTTCTCCTG	60	CHO-K1 (GCA_000223135.1)

PCR reaction conditions: 2min at 94c, 30x(15sec at 94c, 15sec at Tm, 60sec at 72c), 60sec at 72c, hold at 10c
qPCR reaction conditions: 10min at 95c, 40x(30sec at 95c, 15sec at Tm, 15sec at 72c), 1min at 95c, 30sec at 55c, 30sec at 95c

*This primer pair is similar to LGL331 and LGL335 from Shaw (2003) but have some slight modifications that result in them not amplifying *Zfy* in hamsters.
We have therefore choosen to name them differently despite their similarities and common origin.

Shaw, C. N., P. J. Wilson, and B. N. White. 2003. A reliable molecular method of gender determination for mammals. J. Mammal. 84:123–128.