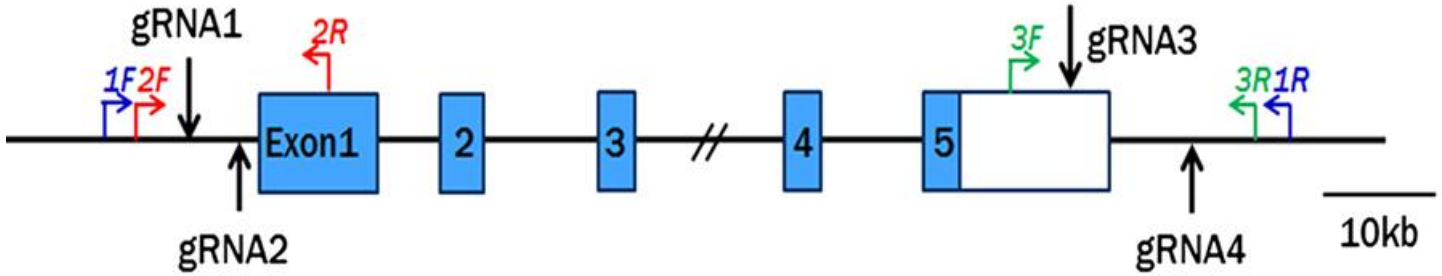
유전자 KO / KI 질병 모델 토끼

단일 염기 변이 질병 모델 토끼

생산•번식용 모델 토끼

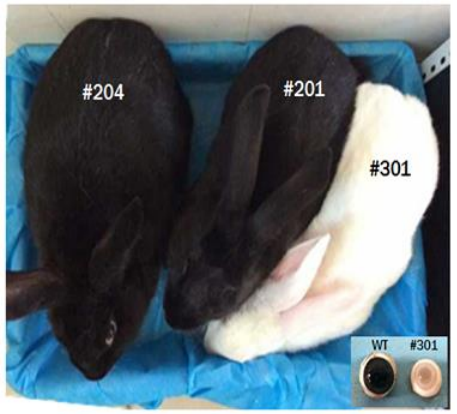
신경계 질환 모델 토끼

TYR 유전자 Knock-out 토끼 — 백색증(알비니즘)





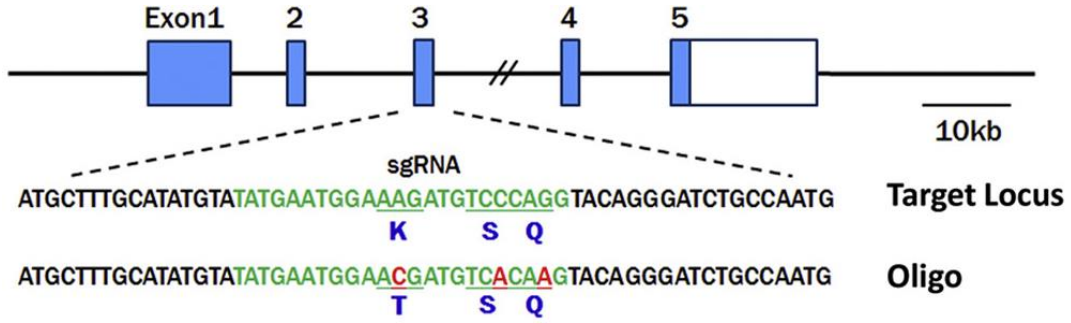
백색증 인간

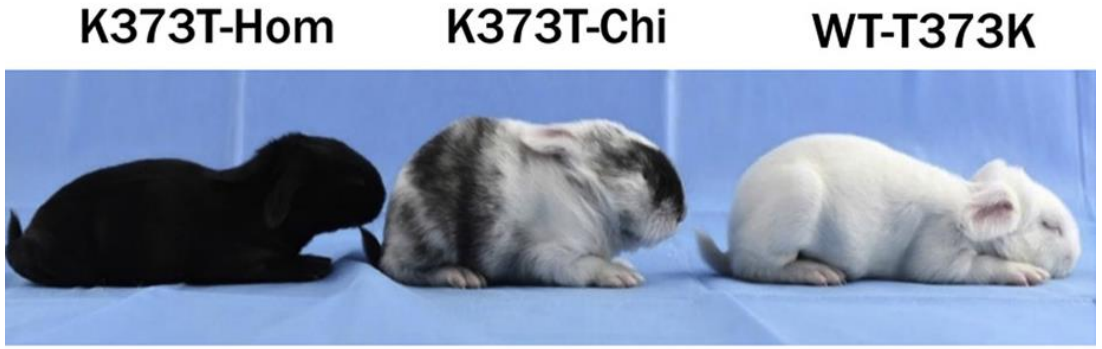


백색증 토끼

토끼에서 **TYR(Tyrosinase) 유전자**를 **KO(Knockout, 유전자 결손)** 시키면 멜라닌 색소 합성이 차단되어 **알비노(Albinism, 백색증)** 현상이 나타납니다.

TYR 유전자 T373K 위치 Knock-in 토끼 — 백색증(알비니즘)





T373K 변이: TYR 유전자의 373번째 아미노산에 변이가 생기면 효소 활성이 사라져 백색증 중에서도 가장 심한 **제1형 눈피부백색증(OCA1)**이 나타납니다.

MSTN 유전자 Knock-out 토끼 — 이중 근육(더블 머슬)

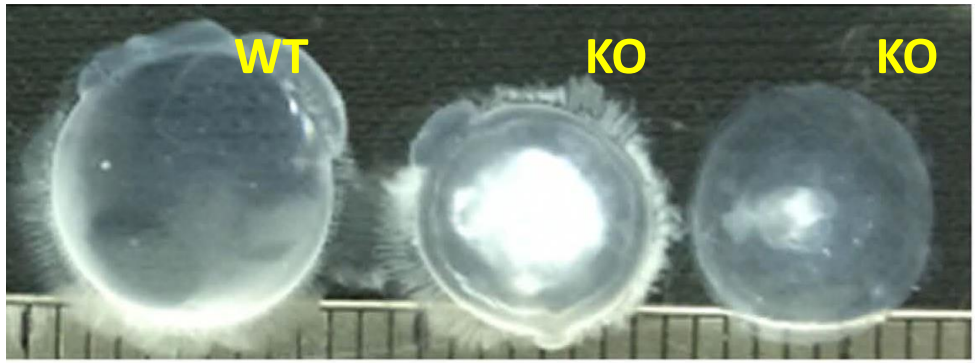
MSTN$^{-/-}$ *MSTN*$^{-/+}$ *WT*



토끼에서 **MSTN(Myostatin) 유전자**를 **KO(Knockout, 유전자 결손)** 시키면 근육 성장을 억제하는 기능이 사라져 근육량이 폭발적으로 증가하는 **'더블 머슬(Double-muscling)'** 표현형이 나타납니다

GJA8 및 CRYAA 유전자 Knock-out 토끼 — 백내장

GJA8 KO

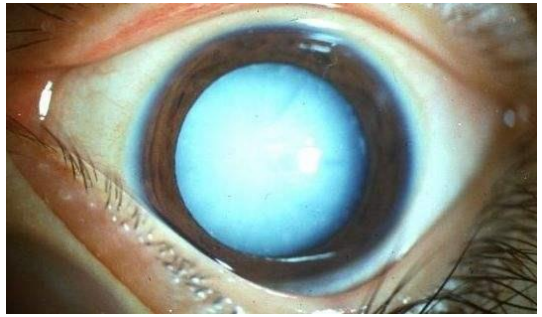




이상적인 안과질환모델

CRYAA KO



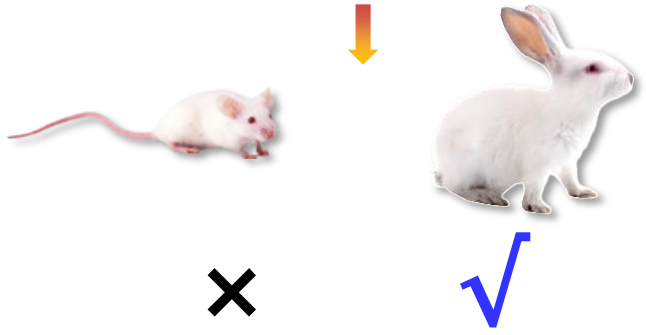


토끼에서 **GJA8** 및 **CRYAA** 유전자를 **KO(Knockout)** 시키면 인간의 **선천성 백내장(Congenital Cataracts)**과 매우 유사한 증상이 나타납니다.

< 백내장, 소안구증, 수정체 위축>

DMP1 유전자 Knock-out 토끼 — 저인산성 구루병

Haversian canals & Osteon

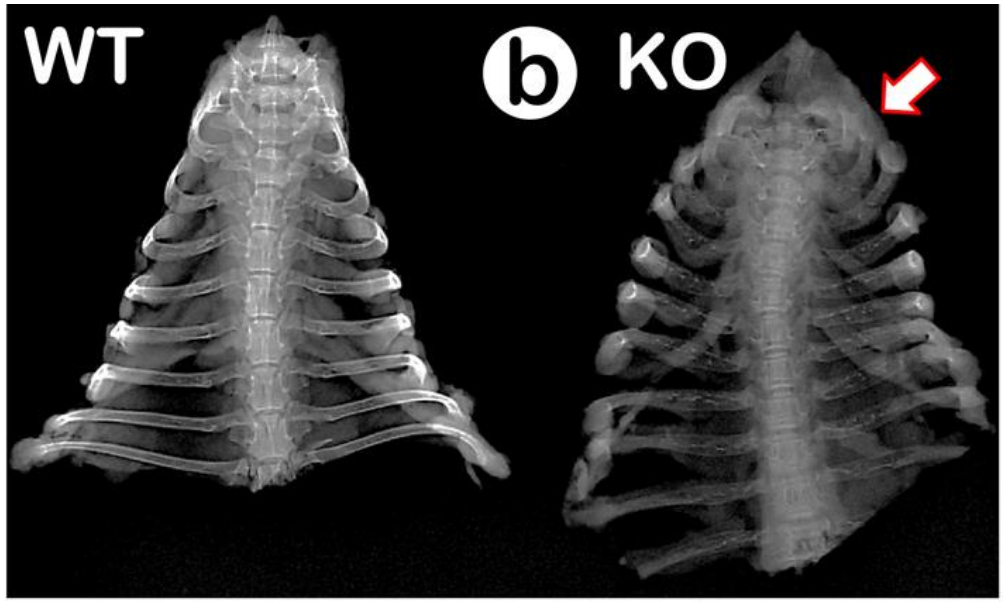


×

√

토끼에서 **DMP1(Dentin Matrix Protein 1, 상아질 기질 단백질 1) 유전자**를 **KO(Knockout)** 시키면 인간의 희귀 유전 질환인 **상염색체 열성 저인산혈증성 구루병(ARHR)**과 매우 유사한 증상이 나타납니다
마우스는 인간과달리 하버스관과 골단구조가 없어 실험에 적합하지 않습니다.





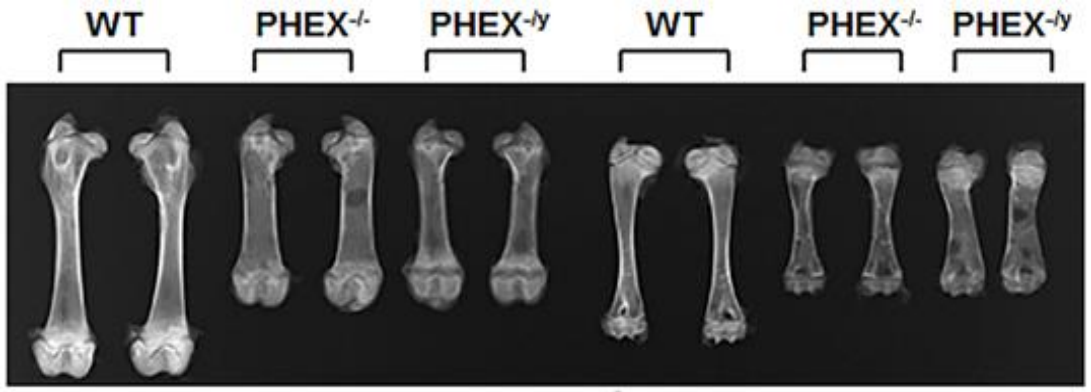
PHEX 유전자 Knock-out 토끼 — X연관 저인산성 구루병











토끼에서 **PHEX 유전자**를 **KO(Knockout)** 시키면 인간의 **X-연관 저인산혈증(XLH, X-linked Hypophosphatemia)**과 매우 유사한 골격 질환 모델이 됩니다.
<저인산혈증, 구루병및 골연화증, 성장지연 >

DMD 유전자 Knock-out 토끼 — 가성비대형 근이영양증



Table 3. Comparison of DMD phenotypes between human and rabbit

Pathological and functional defects	Human	Rabbit
Age at first symptom	0-5 years	0-3 weeks
Loss of ambulation	5-10 years	2-3 months
Development of cardiomyopathy	15-20 years	3-4 months
Respiratory/cardiac failure	20-30 years	5-8 months



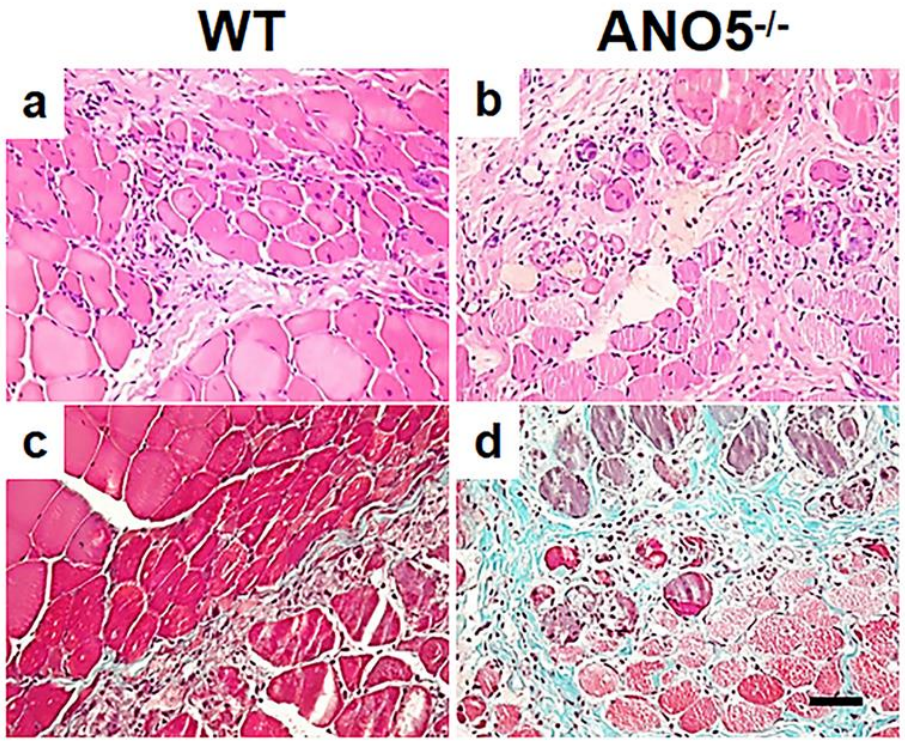
WT Rabbit



DMD KO Rabbit **행동장애**

토끼에서 DMD(Dystrophin) 유전자를 KO(Knockout) 시키면 인간의 **듀센 근이영양증**(Duchenne Muscular Dystrophy)과 매우 흡사한 증상을 보이는 모델이 됩니다. DMD KO 마우스는 마비증상이 없어 인간질병과 달라 부적합 <급격한 근육위축 보행장애 및 마비 심장및 호흡근손상, 조기사망>

ANO5 유전자 Knock-out 토끼 — 지대형 근이영양증



근섬유화

토끼에서 **ANO5(Anoctamin 5) 유전자**를 **KO(Knockout)** 시키면 인간의 **LGMD R12(사지대근 근이영양증)** 및 **미요시 근병증(Miyoshi Myopathy)**을 연구하기 위한 질병 모델이 됩니다. <지징연성 근이영양증, 막회복결함, 혈청 CK 수치 상승>

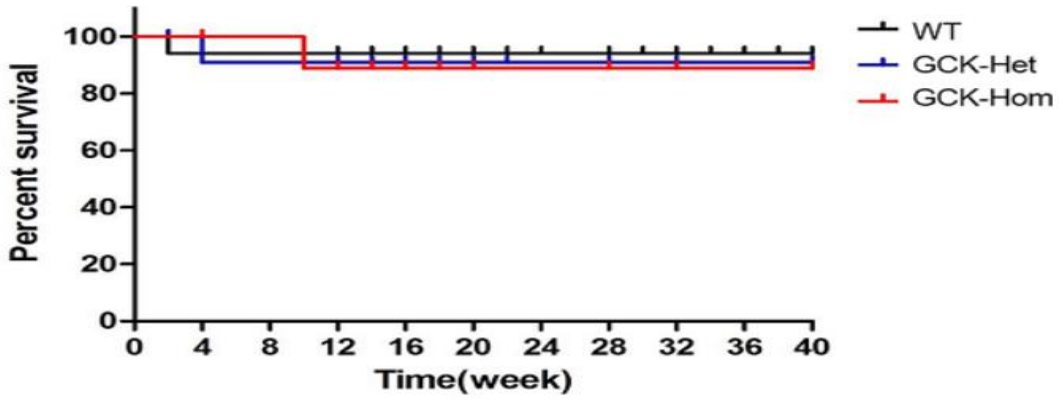
FBN1 유전자 Knock-out 토끼 — 마르판 증후군

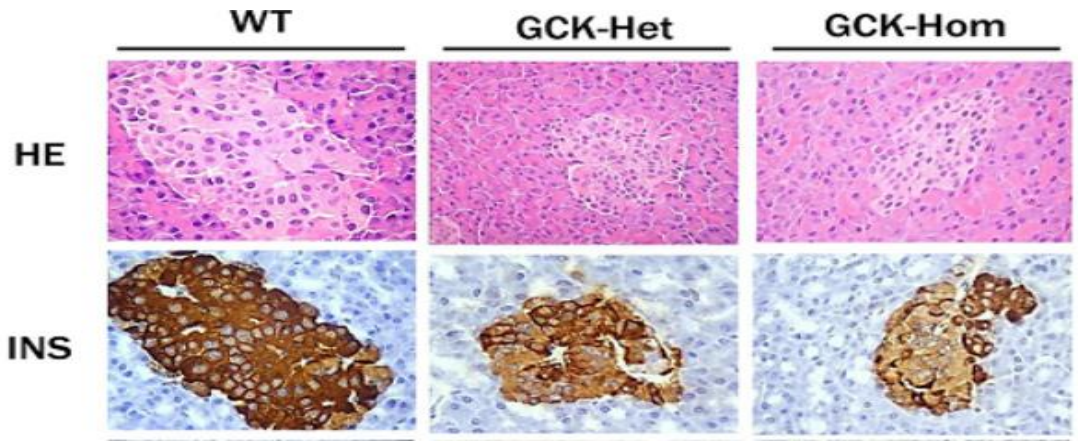


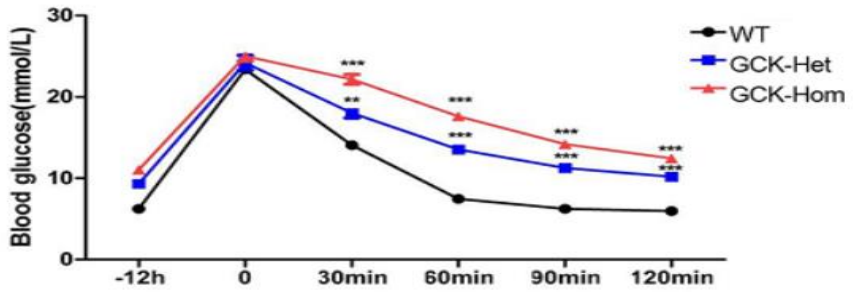
토끼에서 **FBN1(Fibrillin-1) 유전자**를 **KO(Knockout)** 시키면 인간의 대표적인 유전성 희귀 질환인 **마르판 증후군(Marfan Syndrome)** 모델이 됩니다

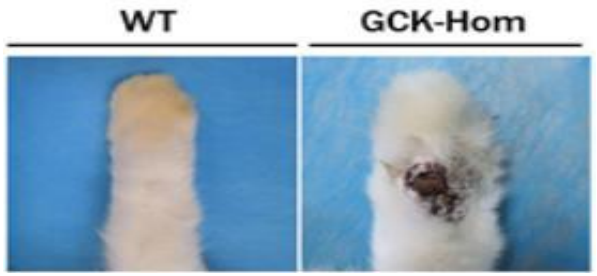
– 심혈관계이상, 골격변형, 안구질환

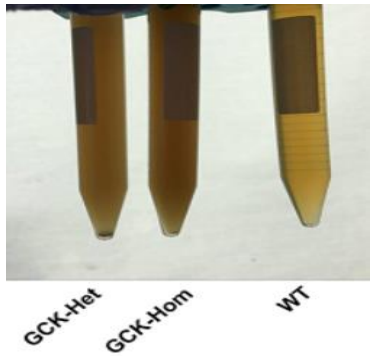
GCK 유전자 Knock-out 토끼 — MODY-2 당뇨병







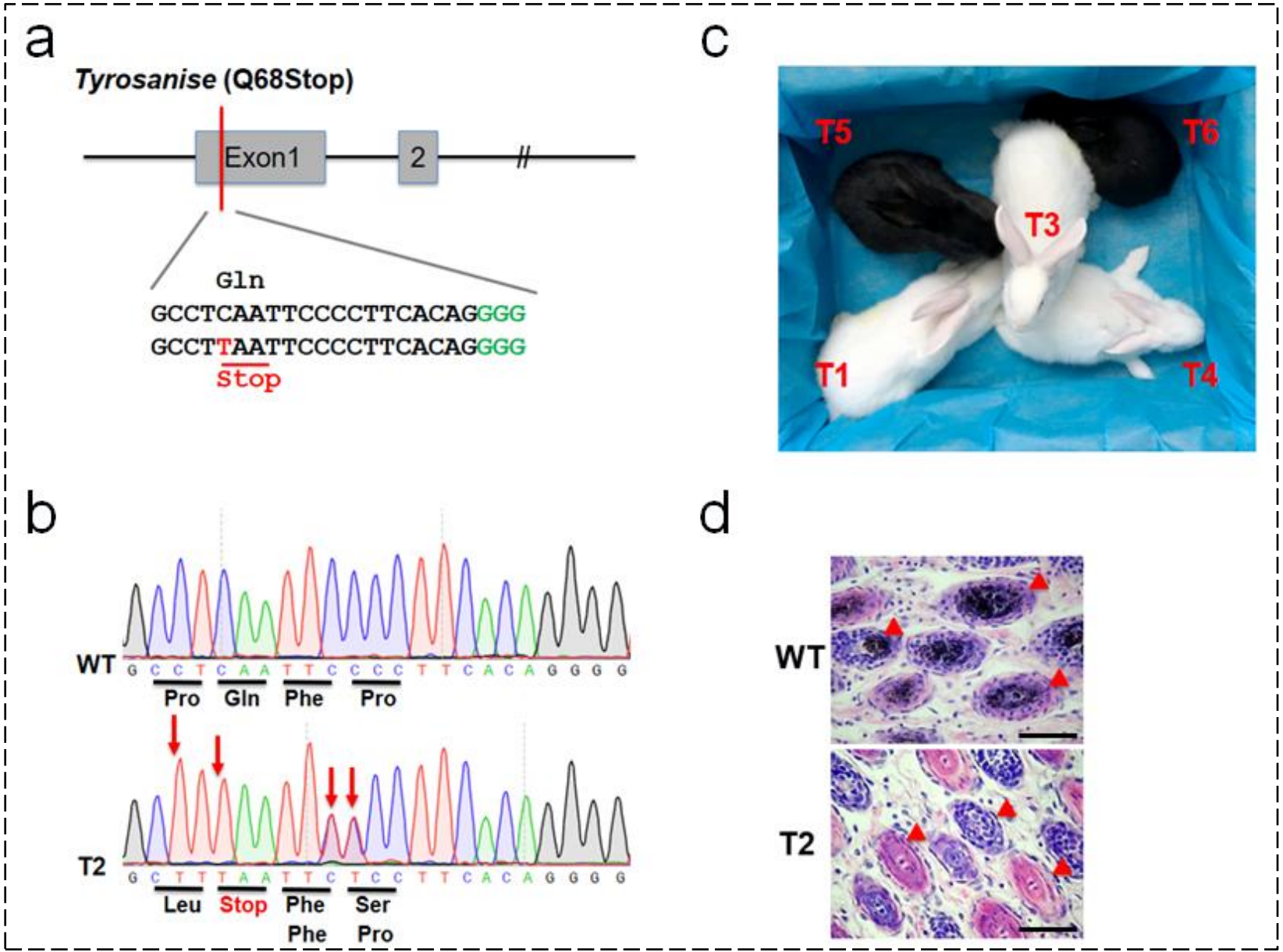




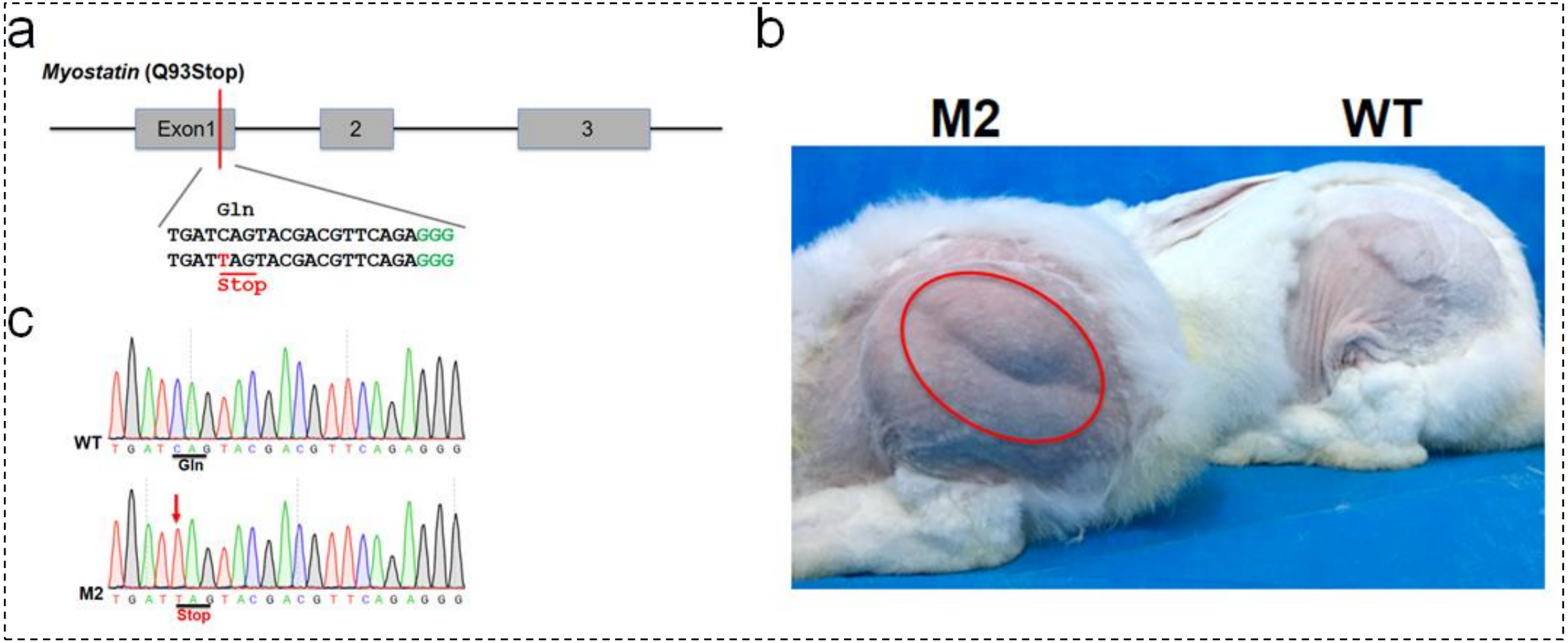
인간에게 GCK 유전적 변이가 생기면 지속적인 고혈당을 특징으로 하는 MODY-2가 발생합니다.
토끼에서 이 유전자를 제거하면 인간과 매우 유사한 당뇨 증상을 재현할 수 있습니다. 기존 GCK KO mouse는 2주이내 폐사로 실험이 어려운점이 확고히 개선

- 고혈당및 포도당내성 췌장및 신장기능장애, 정상체중유지

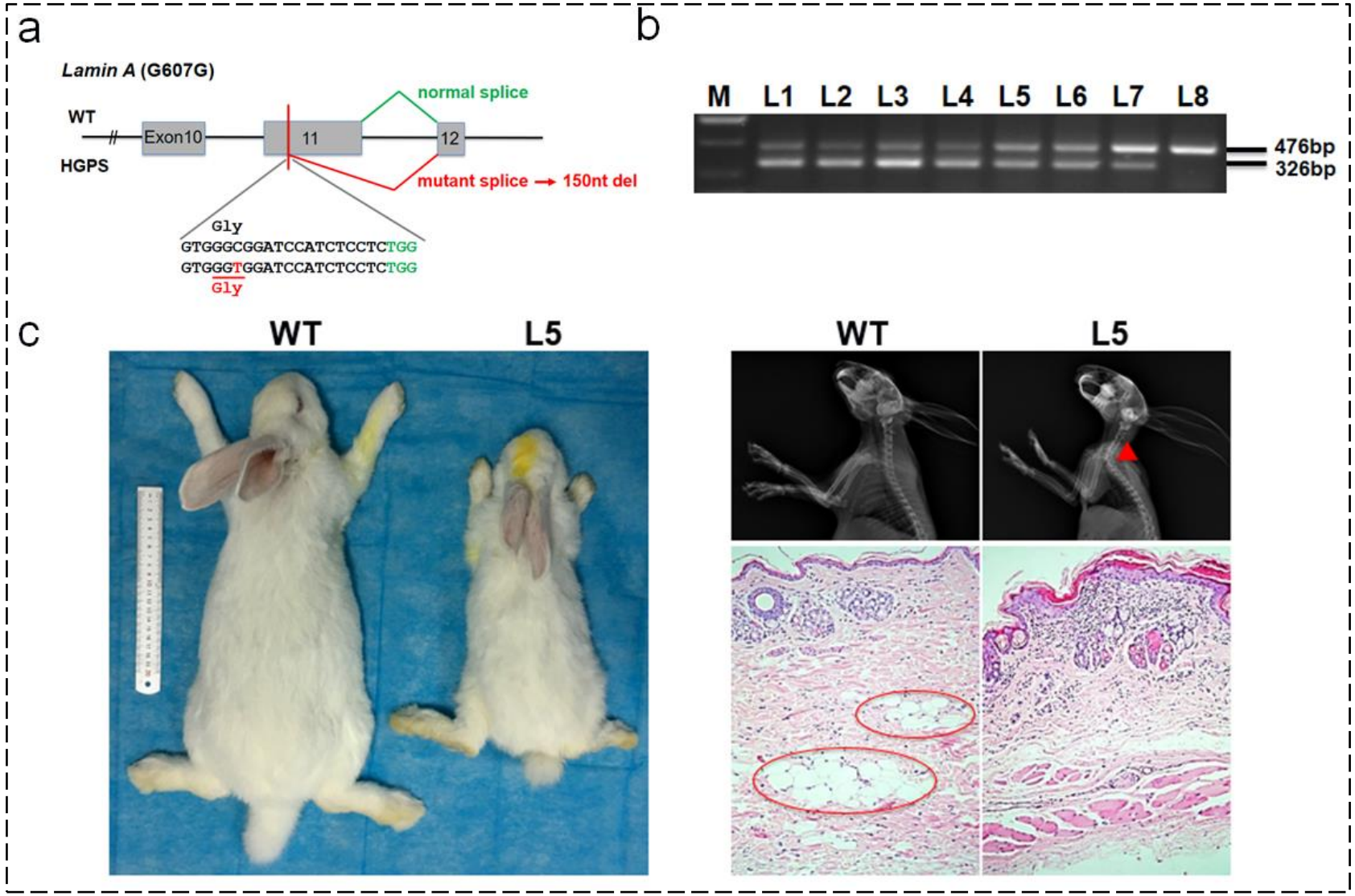
TYR Q68Stop 염기편집 토끼 — 백색 토끼



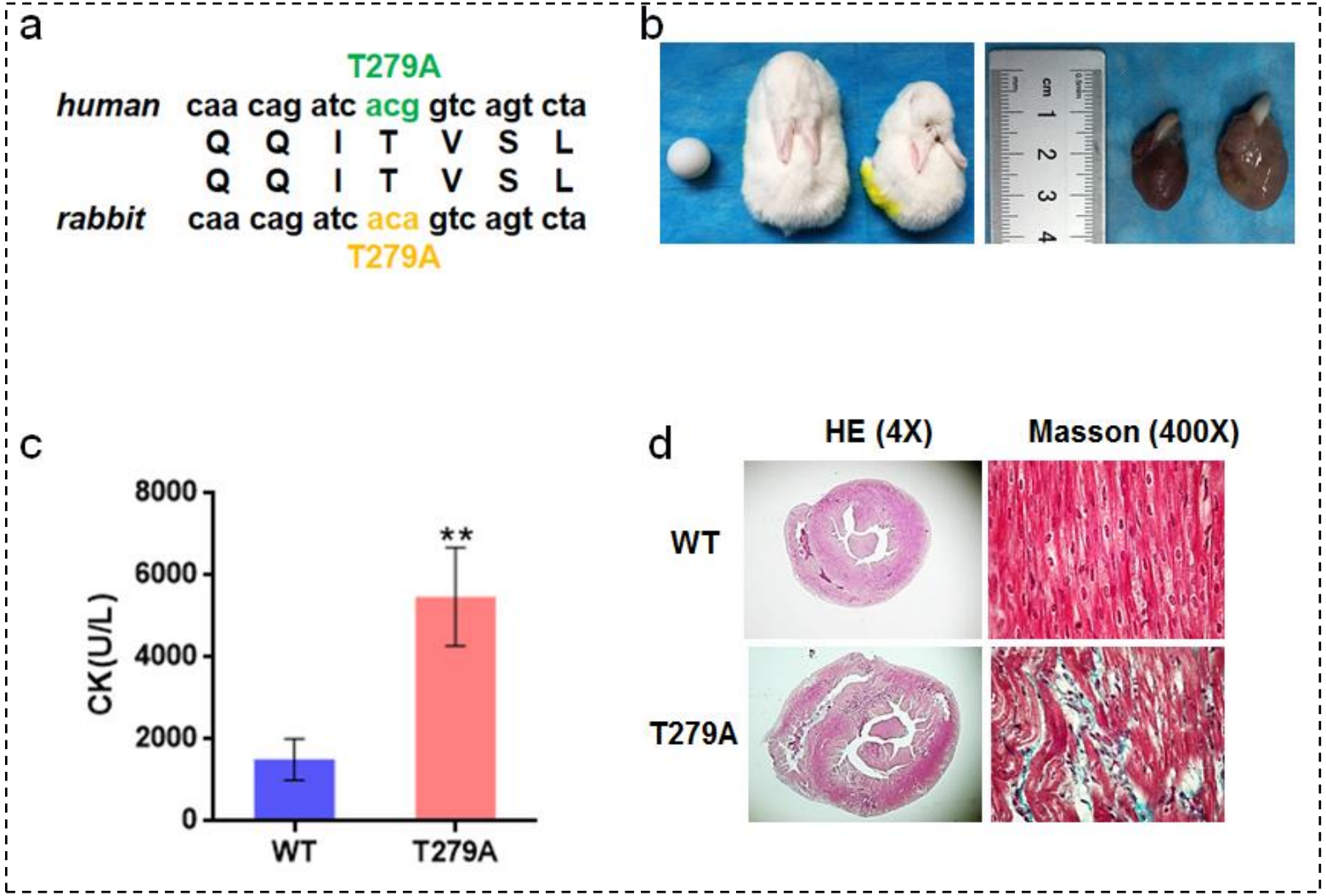
MSTN Q93Stop 염기편집 토끼 — 이중 근육(더블 머슬)



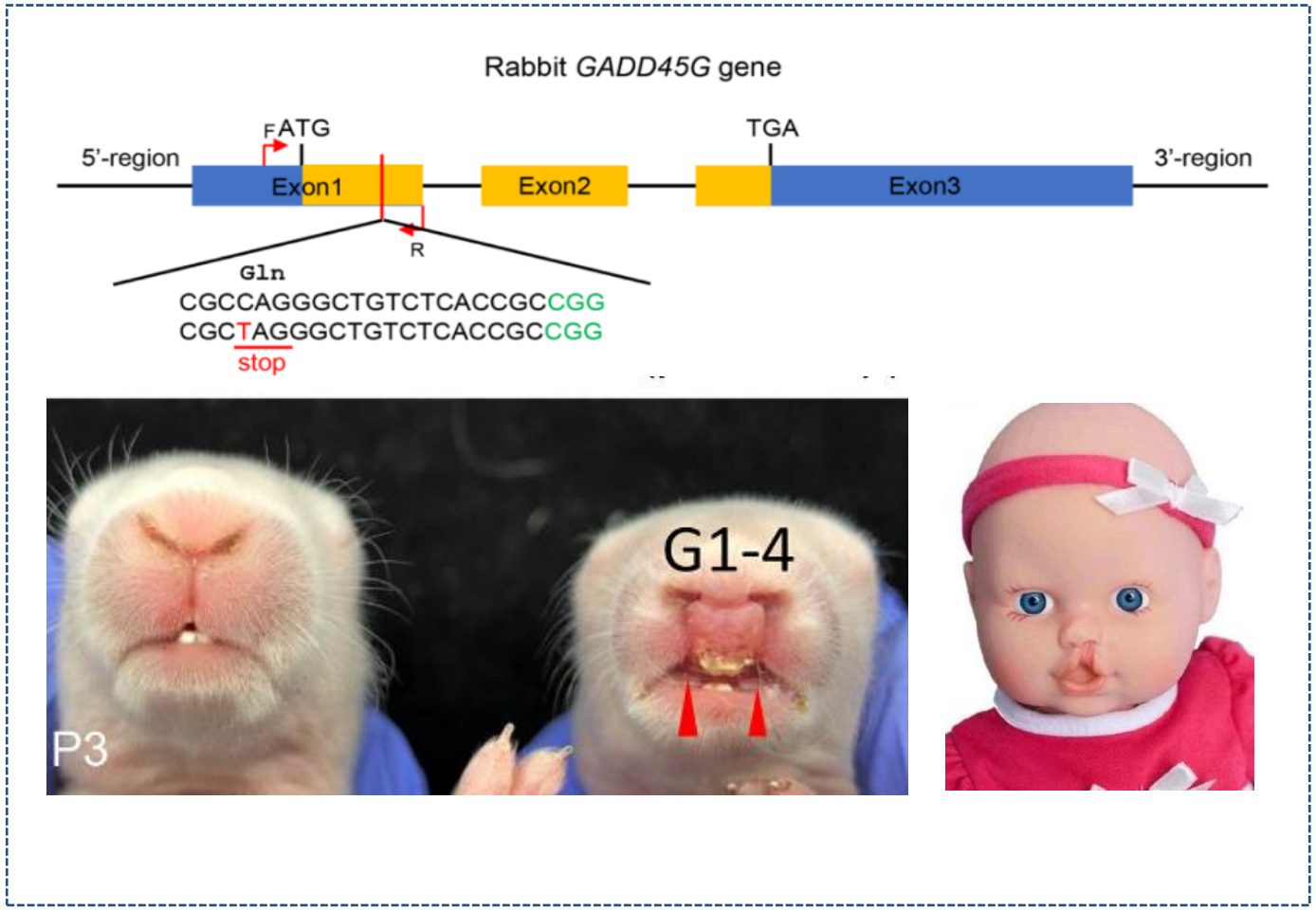
LMNA G93G 염기편집 토끼 — HGPS 조로증



DMD T279A 염기편집 토끼 — X-연관 확장성 심근병 모델



GADD45G 염기편집 토끼 — 구순열(입술갈림증) 모델



고효가(高效价) 항체 유전자편집 토끼

목표 : 면역이 잘 안되는 항원, 귀한 항원

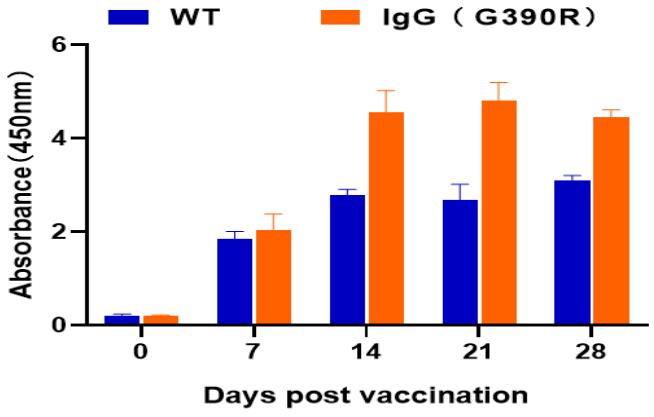
더 짧은 시간, 더 강력한 항체

A

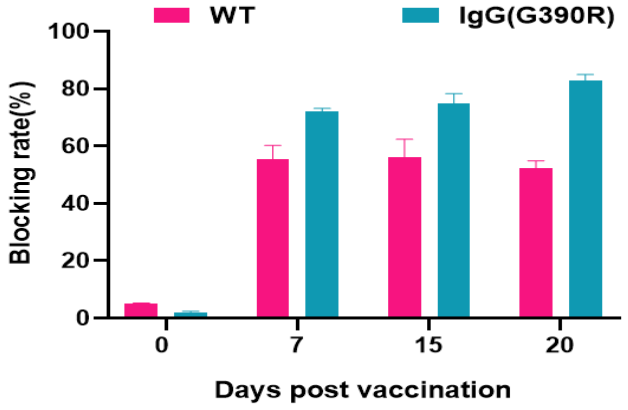




B



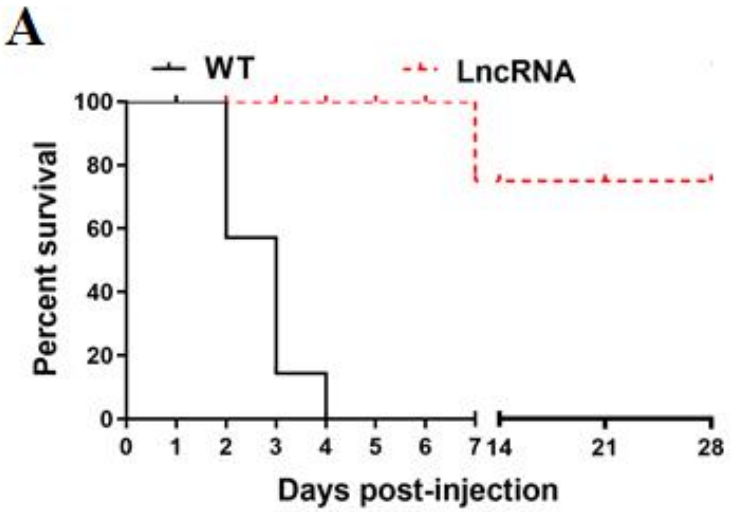
C

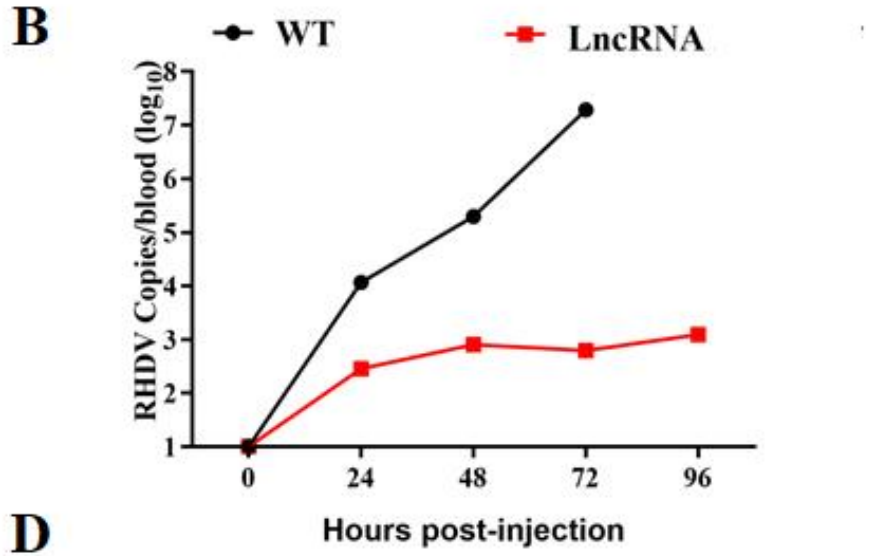


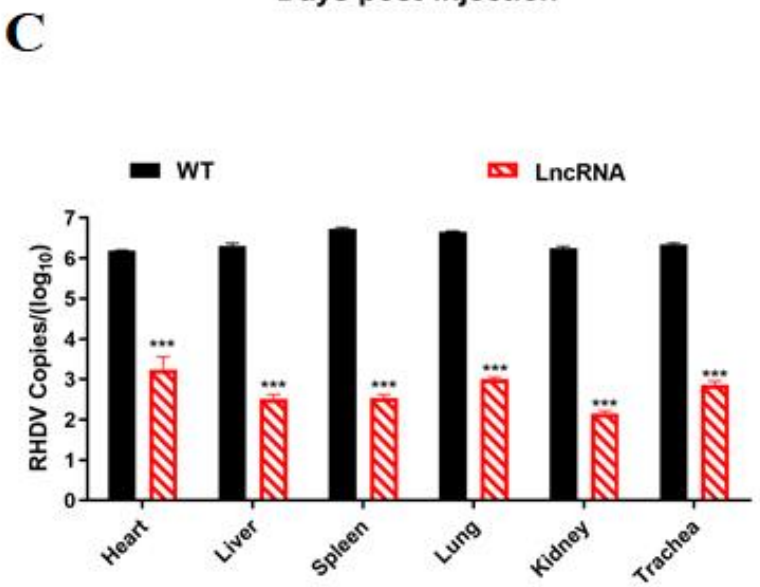


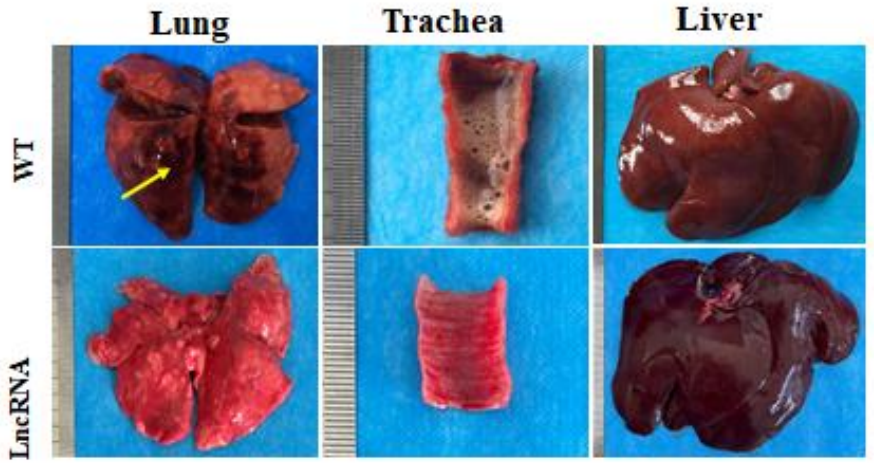


LncRNA X KO: 항토끼 출혈열(Anti-RHD) 모델

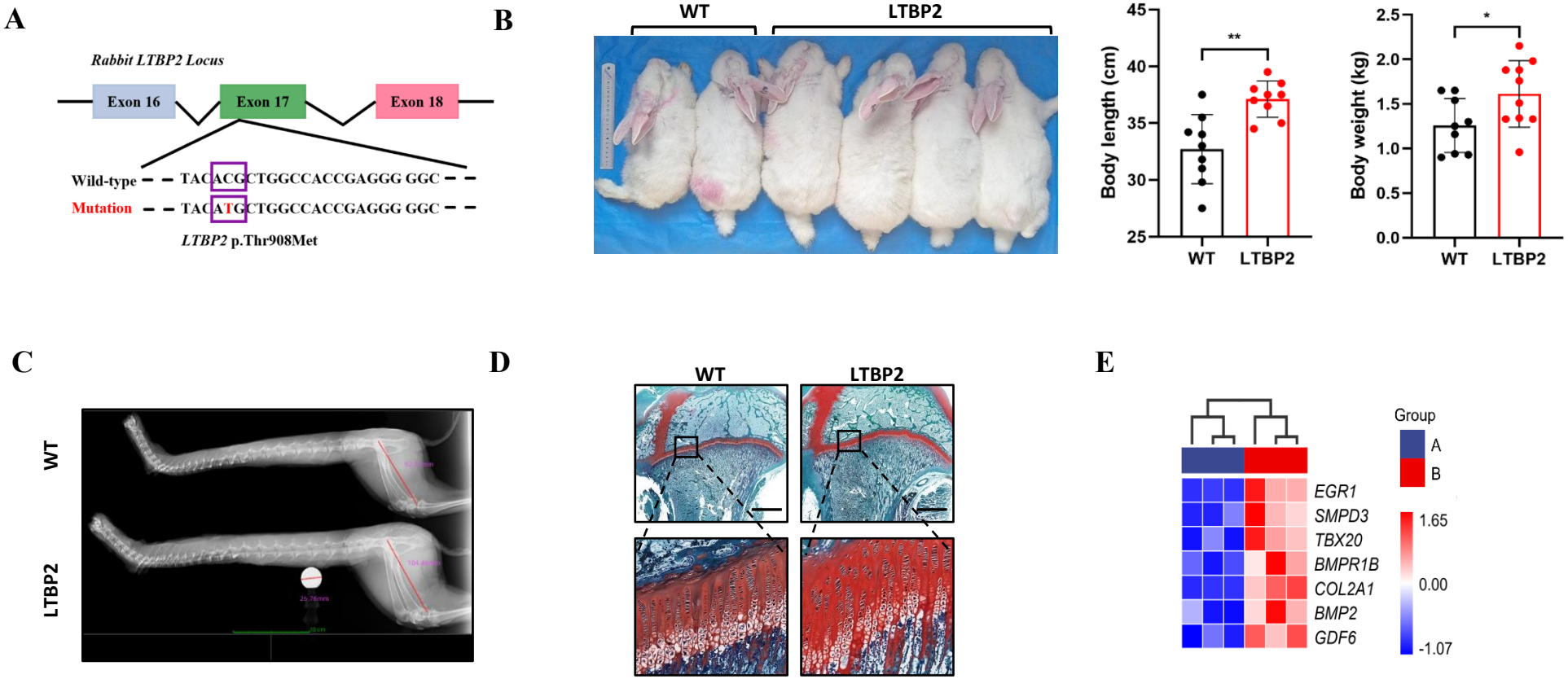






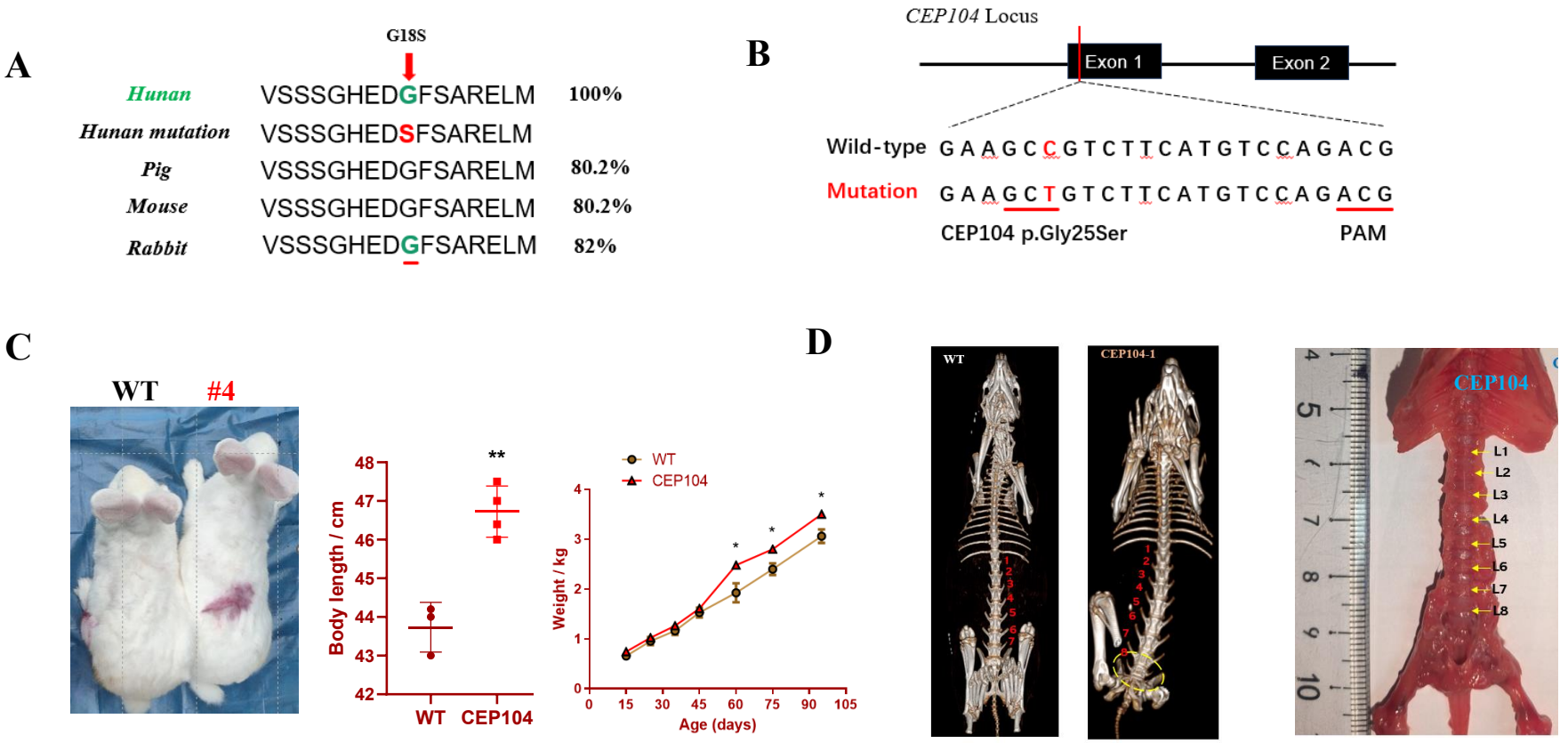


LTBP2 유전자편집 토끼 — 고산자(高产仔) 토끼 모델



LTBP2의 유전자 편집은 BMP 경로를 활성화하고 토끼의 몸 길이(13.5%)와 체중(28.1%)을 크게 증가시킵니다.

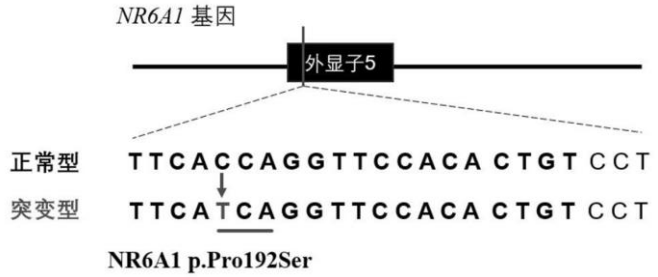
CEP104 유전자편집 토끼 — 고산자(高产仔) 토끼 모델



CEP104 유전자 편집을 통해 토끼의 요추는 7개에서 8개로, 몸길이는 7%, 체중은 24.4% 증가하였습니다.

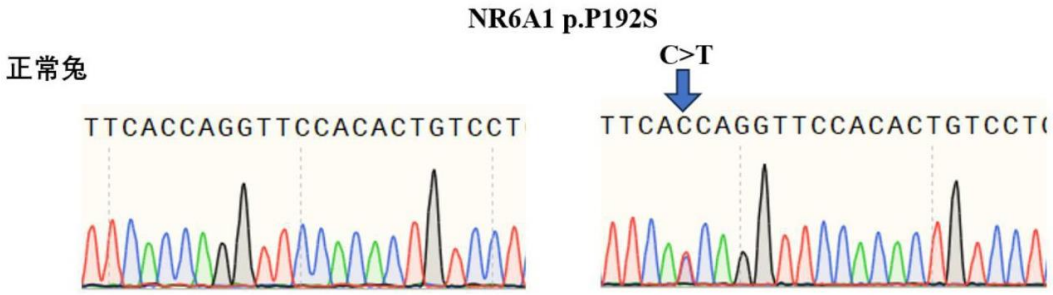
NR6A1 유전자편집 토끼 — 고산자(高产仔) 토끼 모델

A



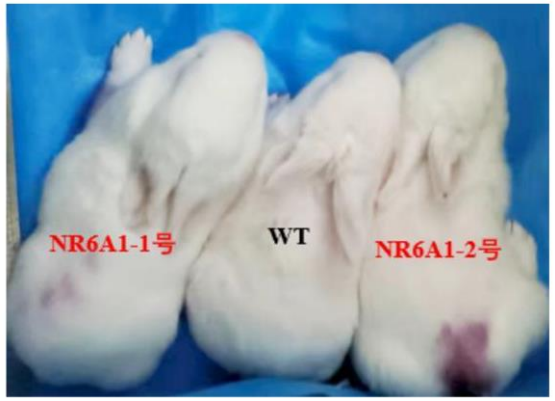
sgRNA 디자인

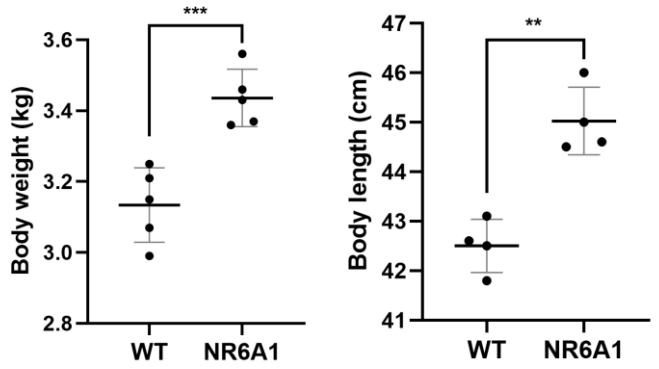
B



NR6A1 편집 토끼의 유전자형 식별

C





일반토끼보다 체중, 몸길이 월등히 증가

NR6A1 유전자 편집으로 키 6%, 체중 9% 증가, 다산 토끼 획득 성공

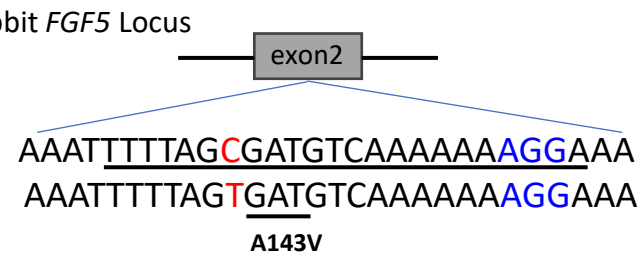
FGF5 유전자편집 토끼 — 장모(긴 털) 토끼 모델

A

A145V

绵羊（突变）QGIVGIRGVFSNKFLVMSKKGKLHASAKFTDDCK
小鼠QGIVGIRGVFSNKFLAMSKKGKLHASAKFTDDCK
家兔QGIVGIRGVFSNKFLAMSKKGKLHASAKFRDDCK

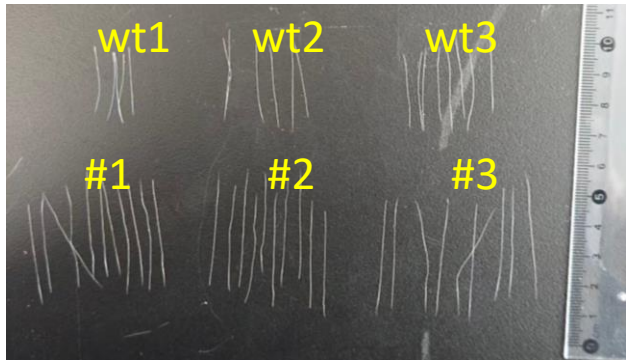
B

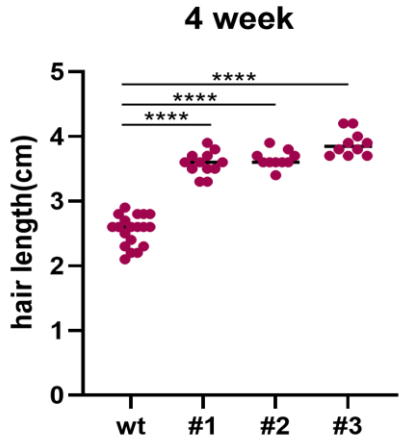


C



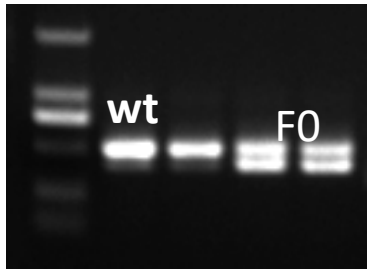
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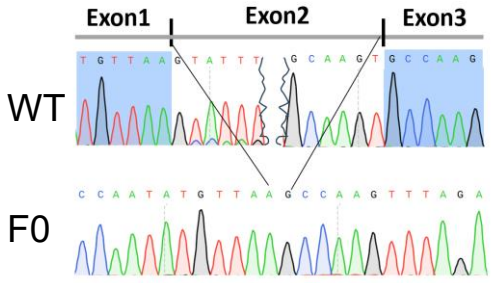




4주령 토끼 등털 길이 측정

E

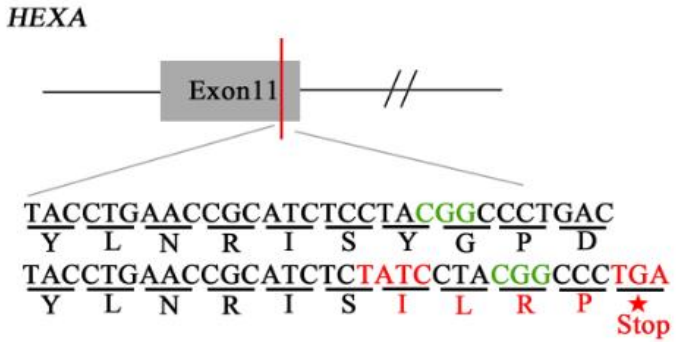




제2 엑손 전단을 촉진

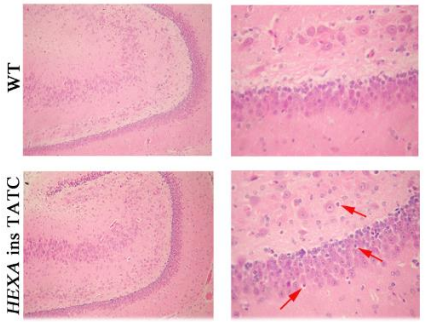
FGF5 유전자 편집을 통해 토끼 털 길이 40% 증가 촉진

HEXA 유전자 4bp 정밀 KI토끼 — Tay-Sachs disease 모델

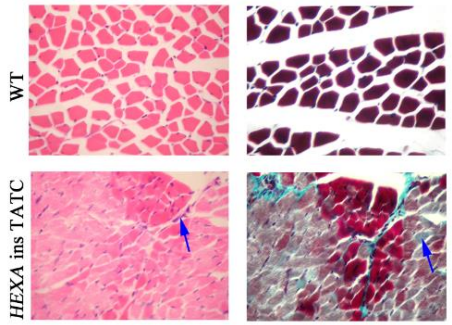


HEXA（1278 ins TATC）

해마 신경주위 커짐



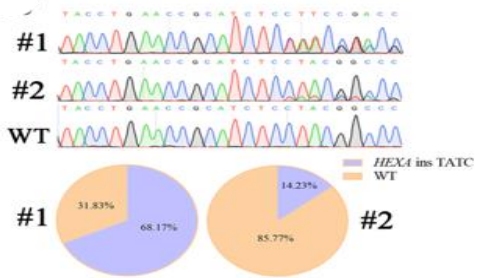
근섬유화



경추만곡





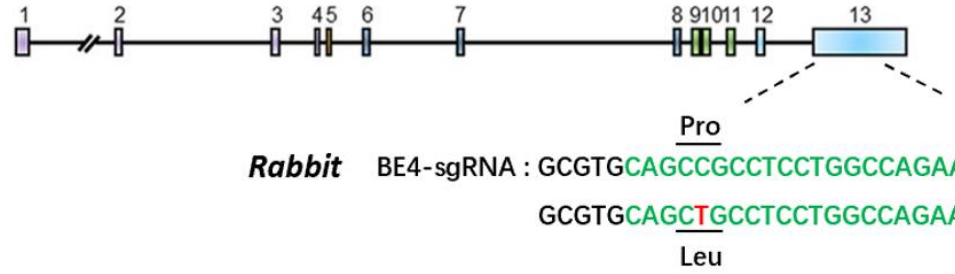






잦은고개숙임/ 경련

TIA1 P362L 염기편집 토끼 — 루게릭 모델

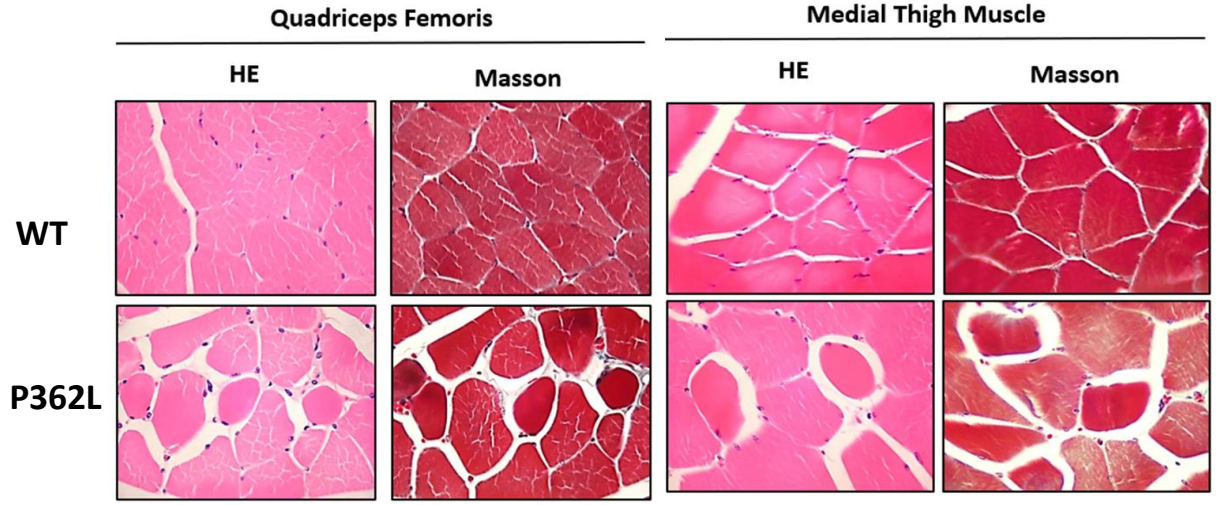


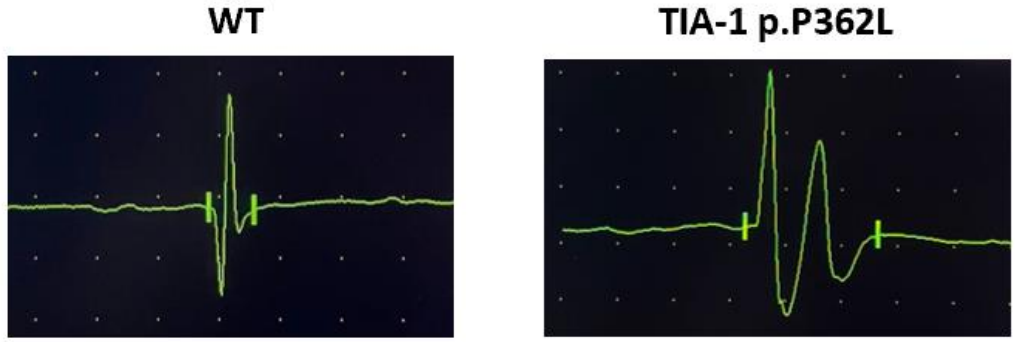


WT



ALS

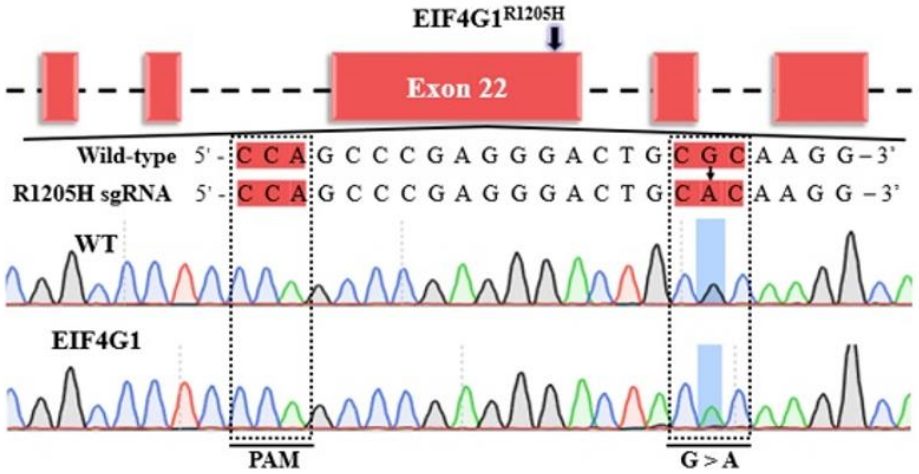




10개월령 ALS 모델 토끼 행동장애 뚜렷

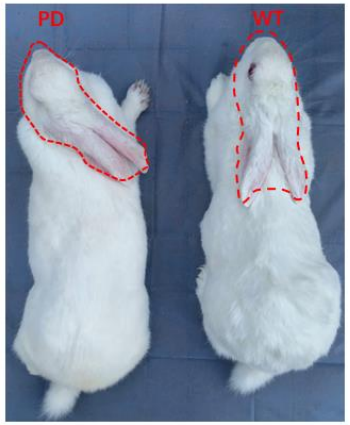
EIF4G1 R1205H 염기 교정 토끼: 파킨슨병(PD) 모델

A

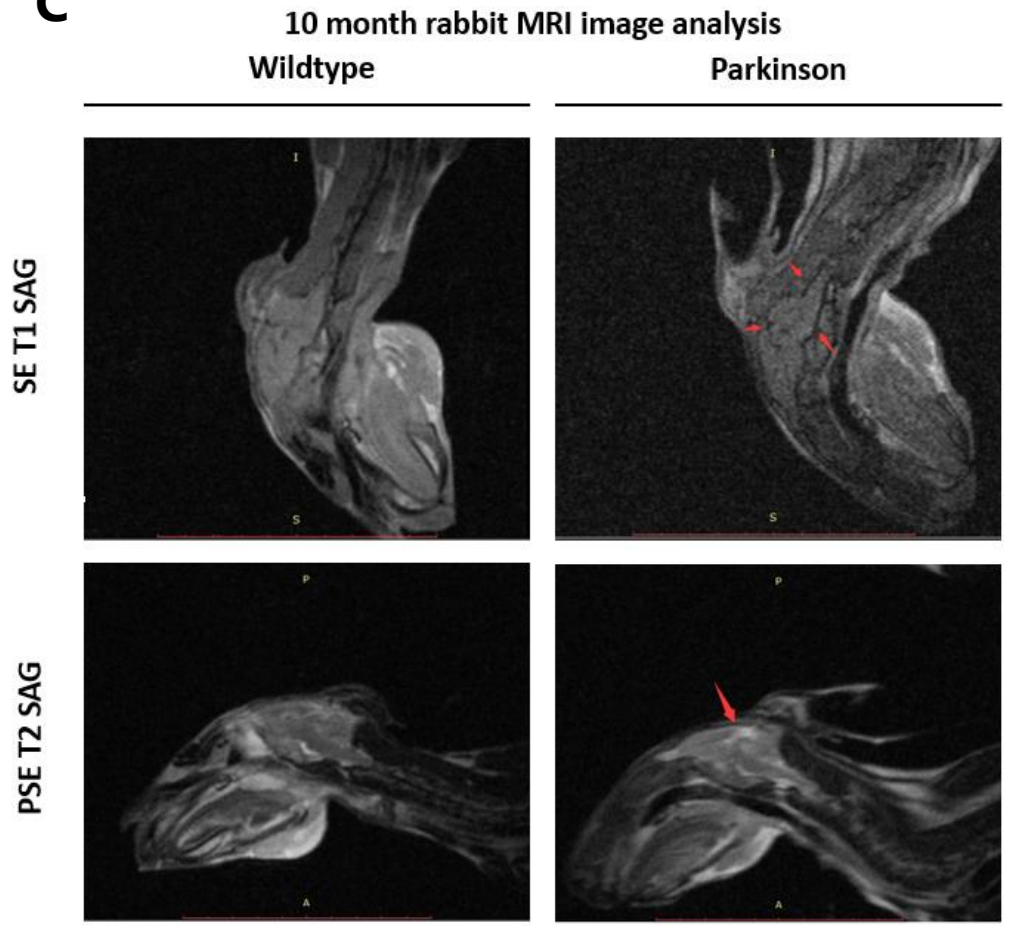


B





C



행동학적 이상 : 갸우뚱, 걸음걸이 이상

MRI 결과 PD토끼 모델 뇌 위축

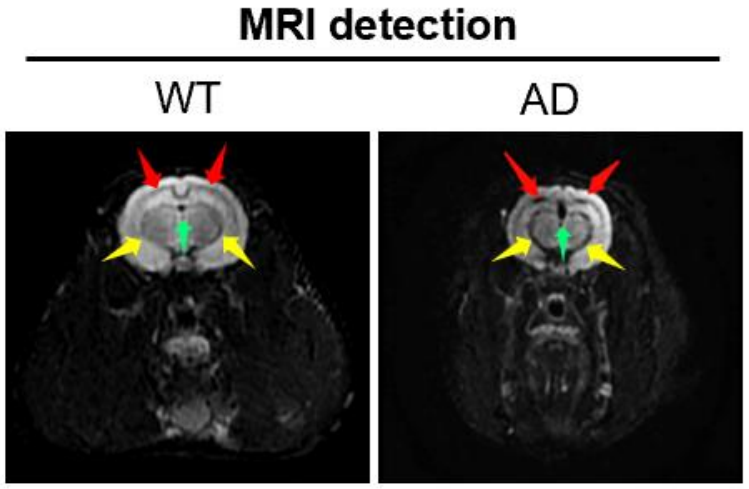
PSEN2 Y231C 염기편집 토끼 — 알츠하이머병 모델

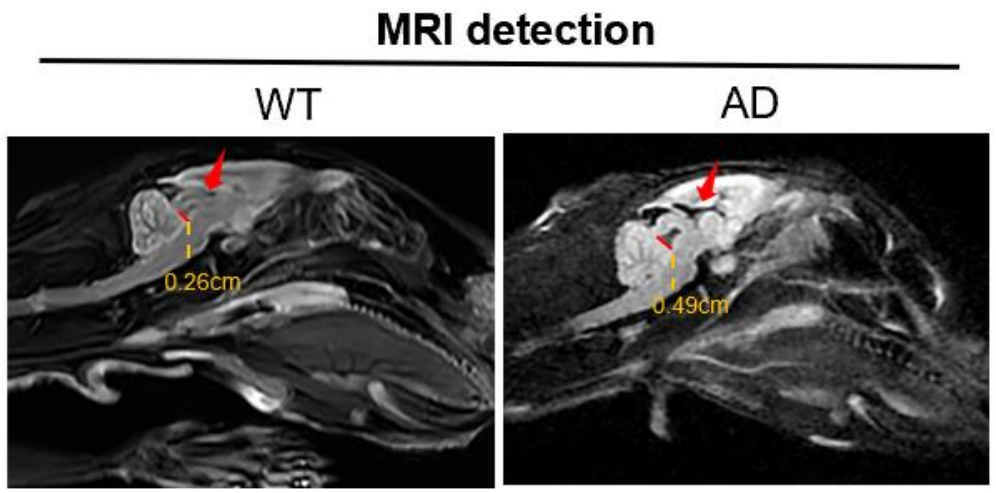


WT 새로운 방향모색



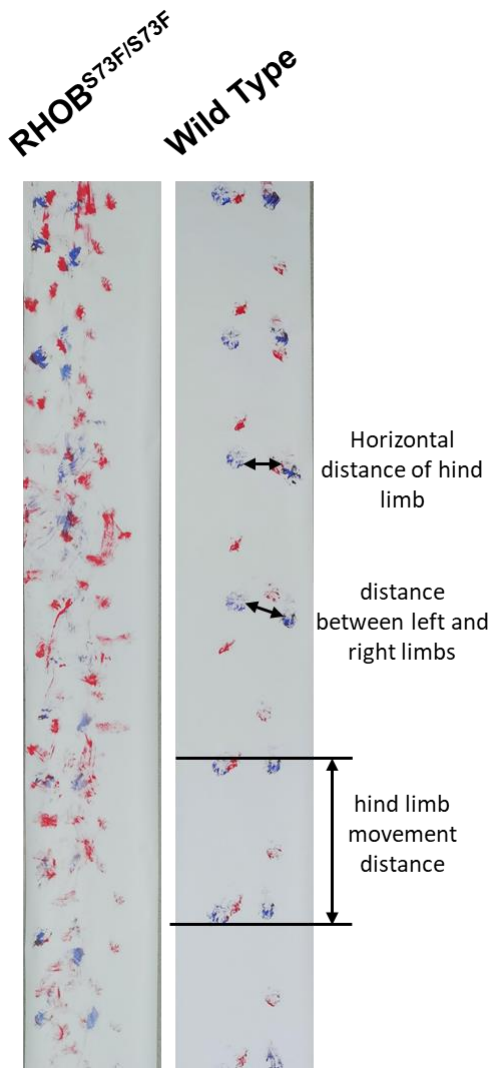
AD 동일방향만이동





AD 토끼 모형의 뇌 조직 구조가 파괴되고 측뇌실의 부피가 현저히 증가하며 대뇌피질과 해마 영역이 현저히 위축됩니다

RHOB S73F 염기편집 토끼 — 뇌성마비 모델

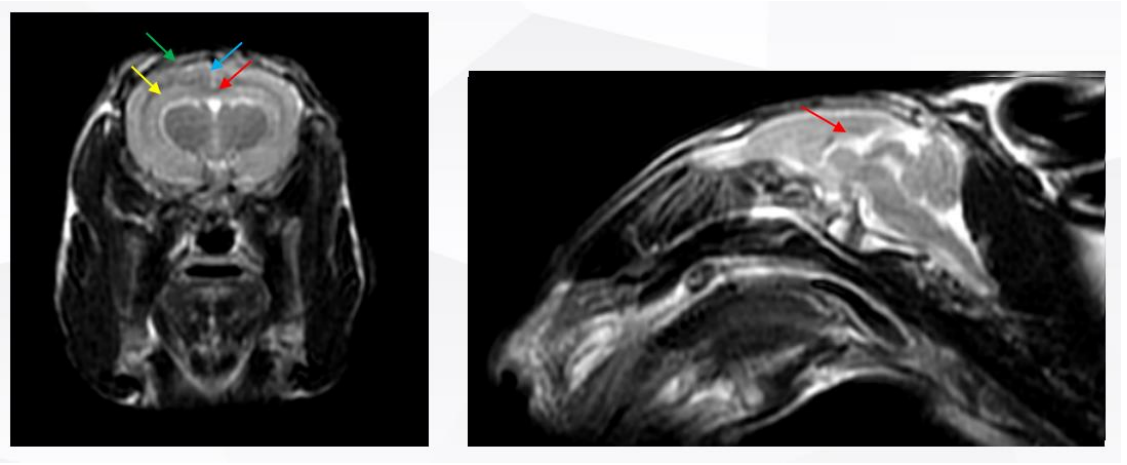


WT-4



RHOB-F0-10 S73F 纯合





→脑室旁白质
→侧脑室
→胼胝体
→第三脑室

CP 모델 토끼는 뇌실 내백질 연화, 측뇌실 확대, 뇌량 결손, 제3뇌실 확대 등의 증상이 있습니다. 。