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Selenoprotein T: From Discovery to Functional Studies Using Conditional Knockout Mice

Selenium pp 275-286 | Cite as

- Loubna Boukhzar (1)
- Yannick Tanguy (1)
- Houssni Abid (1)
- Matthieu Castex (1)
- Abdallah Hamieh (1)
- Ifat Alsharif (1)
- Dorthe Cartier (1)
- Gaëtan Prevost (1)
- Anthony Falluel-Morel (1)
- Isabelle Lihrmann (1)
- Abdeslam Chagraoui (1)
- Youssef Anouar (1) Email author (youssef.anouar@univ-rouen.fr)

1. Laboratory of Neuronal and Neuroendocrine Differentiation and Communication, INSERM U982, University of Rouen Normandy, , Mont-Saint-Aignan, France

Chapter
First Online: 16 September 2016

Abstract

Selenoprotein T (SELT) is a thioredoxin-like enzyme that exerts an essential oxidoreductase activity in the endoplasmic reticulum during development and after tissue injury where its expression is highly induced. Disruption of the *Selt* gene is lethal during embryogenesis, and its conditional knockout in the brain causes the reduction of several cerebral structures and increases the vulnerability of mice to neurotoxin-induced neurodegeneration. While its expression is silenced in most tissues in the adult, SELT persists at high levels in endocrine tissues such as the pancreas where it controls hormone production. Thus, SELT could be involved in the redox circuits that control homeostasis and survival of cells with intense metabolic activity during development or in adult endocrine and lesioned cerebral tissues.

Keywords

Brain Endocrine tissues Endoplasmic reticulum Knockout mice
Oxidoreductase Selenoprotein T Thioredoxin-like

Notes

Acknowledgements

This work was supported by the Institut National de la Santé et de la Recherche Médicale (INSERM, grant number U982); Normandy University of Rouen; the Regional Council of Normandy and the European Community Interreg IV Program (grants PeReNE and TC2N).

References

1. GV Kryukov et al 1999 *J Biol Chem* 274:33888
CrossRef (https://doi.org/10.1074/jbc.274.48.33888)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=10567350)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=GV.%20Kryukov&journal=J%20Biol%20Chem&volume=274&pages=33888&publication_year=1999)

2. GV Kryukov et al 2002 *Proc Natl Acad Sci U S A* 99:4245
CrossRef (https://doi.org/10.1073/pnas.072603099)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=11929995)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC123633)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=GV.%20Kryukov&journal=Proc%20Natl%20Acad%20Sci%20U%20S%20A&volume=99&pages=4245&publication_year=2002)

3. A Kaya et al 2015 *Antioxid Redox Signal* 23:814
CrossRef (https://doi.org/10.1089/ars.2015.6385)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=26181576)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=A.%20Kaya&journal=Antioxid%20Redox%20Signal&volume=23&pages=814&publication_year=2015)

4. RJ Hung et al 2013 *Nat Cell Biol* 15:1445
CrossRef (https://doi.org/10.1038/ncb2871)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=24212093)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4254815)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=RJ.%20Hung&journal=Nat%20Cell%20Biol&volume=15&pages=1445&publication_year=2013)

5. L Grumolato et al 2003 *Endocrinology* 144:2368
CrossRef (https://doi.org/10.1210/en.2002-0106)

PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=12746297)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=L.%20Grumolato&journal=Endocrinology&volume=144&pages=2368&publication_year=2003)

6. L Grumolato et al 2008 *FASEB J* 22:1756
CrossRef (https://doi.org/10.1096/fj.06-075820)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=18198219)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=L.%20Grumolato&journal=FASEB%20J&volume=22&pages=1756&publication_year=2008)

7. ME Moustafa et al 2012 *Biochem Genet* 50:736
CrossRef (https://doi.org/10.1007/s10528-012-9516-2)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=22614868)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=ME.%20Moustafa&journal=Biochem%20Genet&volume=50&pages=736&publication_year=2012)

8. J Liu et al 2015 *Antioxid Redox Signal* 23:795
CrossRef (https://doi.org/10.1089/ars.2015.6388)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=26168272)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=J.%20Liu&journal=Antioxid%20Redox%20Signal&volume=23&pages=795&publication_year=2015)

9. HF Clark et al 2003 *Genome Res* 13:2265
CrossRef (https://doi.org/10.1101/gr.1293003)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=12975309)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC403697)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=HF.%20Clark&journal=Genome%20Res&volume=13&pages=2265&publication_year=2003)

10. G Prevost et al 2013 *Endocrinology* 154:3796
CrossRef (https://doi.org/10.1210/en.2013-1167)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=23913443)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=G.%20Prevost&journal=Endocrinology&volume=154&pages=3796&publication_year=2013)

11. VM Labunskyy et al 2014 *Physiol Rev* 94:739
CrossRef (https://doi.org/10.1152/physrev.00039.2013)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=24987004)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4101630)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=VM.%20Labunskyy&journal=Physiol%20Rev&volume=94&pages=739&publication_year=2014)

12. A Dikiy et al 2007 *Biochemistry* 46:6871
CrossRef (https://doi.org/10.1021/bi602462q)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=17503775)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=A.%20Dikiy&journal=Biochemistry&volume=46&pages=6871&publication_year=2007)

13. JL Martin 1995 *Structure* 3:245
CrossRef (https://doi.org/10.1016/S0969-2126(01)00154-X)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=7788290)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=JL.%20Martin&journal=Structure&volume=3&pages=245&publication_year=1995)

14. AD Ferguson et al 2006 *J Biol Chem* 281:3536
CrossRef (https://doi.org/10.1074/jbc.M511386200)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=16319061)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=AD.%20Ferguson&journal=J%20Biol%20Chem&volume=281&pages=3536&publication_year=2006)

15. SV Novoselov et al 2007 *J Biol Chem* 282:11960
CrossRef (https://doi.org/10.1074/jbc.M701605200)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=17337453)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=SV.%20Novoselov&journal=J%20Biol%20Chem&volume=282&pages=11960&publication_year=2007)

16. VM Labunskyy et al 2007 *IUBMB Life* 59:1
CrossRef (https://doi.org/10.1080/15216540601126694)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=17365173)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=VM.%20Labunskyy&journal=IUBMB%20Life&volume=59&pages=1&publication_year=2007)

17. L Boukhzar et al 2016 *Antioxid Redox Signal* 24:557
CrossRef (https://doi.org/10.1089/ars.2015.6478)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=26866473)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4840926)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=L.%20Boukhzar&journal=Antioxid%20Redox%20Signal&volume=24&pages=557&publication_year=2016)

18. Y Tanguy et al 2011 *Endocrinology* 152:4322
CrossRef (https://doi.org/10.1210/en.2011-1246)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=21896670)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=Y.%20Tanguy&journal=Endocrinology&volume=152&pages=4322&p

ublication_year=2011)

19. GJ Beckett, JR Arthur 2005 *J Endocrinol* 184:455
CrossRef (https://doi.org/10.1677/joe.1.05971)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=15749805)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=GJ.%20Beckett&author=JR.%20Arthur&journal=J%20Endocrinol&volume=184&pages=455&publication_year=2005)

20. VM Labunskyy et al 2009 *Biochemistry* 48:8458
CrossRef (https://doi.org/10.1021/bi900717p)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=19650649)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2778599)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=VM.%20Labunskyy&journal=Biochemistry&volume=48&pages=8458&publication_year=2009)

21. VA Shchedrina et al 2011 *J Biol Chem* 286:42937
CrossRef (https://doi.org/10.1074/jbc.M111.310920)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=22016385)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3234841)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=VA.%20Shchedrina&journal=J%20Biol%20Chem&volume=286&pages=42937&publication_year=2011)

22. AA Turanov et al 2014 *Biochem J* 462:555
CrossRef (https://doi.org/10.1042/BJ20140076)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=24897171)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=AA.%20Turanov&journal=Biochem%20J&volume=462&pages=555&publication_year=2014)

23. M Conrad et al 2004 *Mol Cell Biol* 24:9414
CrossRef (https://doi.org/10.1128/MCB.24.21.9414-9423.2004)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=15485910)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC522221)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=M.%20Conrad&journal=Mol%20Cell%20Biol&volume=24&pages=9414&publication_year=2004)

24. C Jakupoglu et al 2005 *Mol Cell Biol* 25:1980
CrossRef (https://doi.org/10.1128/MCB.25.5.1980-1988.2005)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=15713651)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC549365)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=C.%20Jakupoglu&journal=Mol%20Cell%20Biol&volume=25&pages=1980&publication_year=2005)

25. SH Brütsch et al 2015 *Antioxid Redox Signal* 22:281
CrossRef (https://doi.org/10.1089/ars.2014.5967)

PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=25313597)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=SH.%20Br%C3%BCtsch&journal=Antioxid%20Redox%20Signal&volume=22&pages=281&publication_year=2015)

26. H Ghzili et al 2008 *Front Neuroendocrinol* 29:128
CrossRef (https://doi.org/10.1016/j.yfrne.2007.10.001)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=18048093)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=H.%20Ghzili&journal=Front%20Neuroendocrinol&volume=29&pages=128&publication_year=2008)

27. MA Reeves et al 2010 *Antioxid Redox Signal* 12:809
CrossRef (https://doi.org/10.1089/ars.2009.2883)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=19769485)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2864655)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=MA.%20Reeves&journal=Antioxid%20Redox%20Signal&volume=12&pages=809&publication_year=2010)

28. SB Ben et al 2011 *Biochemistry (Mosc)* 76:1030
Google Scholar (https://scholar.google.com/scholar?q=SB%20Ben%20et%20al%202011%20Biochemistry%20%28Mosc%29%2076%3A1030)

29. S Verma et al 2011 *J Immunol* 186:2127
CrossRef (https://doi.org/10.4049/jimmunol.1002878)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=21220695)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3088479)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=S.%20Verma&journal=J%20Immunol&volume=186&pages=2127&publication_year=2011)

30. GJ Fredericks et al 2014 *Proc Natl Acad Sci U S A* 111:16478
CrossRef (https://doi.org/10.1073/pnas.1417176111)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=25368151)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4246275)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=GJ.%20Fredericks&journal=Proc%20Natl%20Acad%20Sci%20U%20S%20A&volume=111&pages=16478&publication_year=2014)

31. M Marino et al 2015 *Hum Mol Genet* 24:1843
CrossRef (https://doi.org/10.1093/hmg/ddu602)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=25452428)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=M.%20Marino&journal=Hum%20Mol%20Genet&volume=24&pages=1843&publication_year=2015)

32. A Sengupta et al 2009 *Biochem Cell Biol* 87:953
CrossRef (https://doi.org/10.1139/O09-064)

PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=19935881)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3471091)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=A.%20Sengupta&journal=Biochem%20Cell%20Biol&volume=87&pages=953&publication_year=2009)

33. MT Castex et al 2015 *Mol Neurobiol* doi:10.1007/s12035-015-9505-7
Google Scholar (http://scholar.google.com/scholar_lookup?title=Selenoprotein%20T%20Deficiency%20Leads%20to%20Neurodevelopmental%20Abnormalities%20and%20Hyperactive%20Behavior%20in%20Mice&author=Matthieu%20T..%20Castex&author=Arnaud.%20Arabo&author=Magalie.%20B%C3%A9nard&author=Vincent.%20Roy&author=Vadim.%20Le%20Joncour&author=Ga%C3%ABtan.%20Pr%C3%A9vost&author=Jean-Jacques.%20Bonnet&author=Youssef.%20Anouar&author=Anthony.%20Fallu el-Morel&journal=Molecular%20Neurobiology&volume=53&issue=9&pages=5818-5832&publication_year=2015)

34. FP Bellinger et al 2011 *Mol Neurodegener* 6:8
CrossRef (https://doi.org/10.1186/1750-1326-6-8)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=21255396)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3037910)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=FP.%20Bellinger&journal=Mol%20Neurodegener&volume=6&pages=8&publication_year=2011)

35. FP Bellinger et al 2012 *J Parkinsons Dis* 2:115
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=23268326)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3527083)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=FP.%20Bellinger&journal=J%20Parkinsons%20Dis&volume=2&pages=115&publication_year=2012)

36. VM Labunskyy et al 2011 *Antioxid Redox Signal* 14:2327
CrossRef (https://doi.org/10.1089/ars.2010.3526)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=21194350)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3096499)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=VM.%20Labunskyy&journal=Antioxid%20Redox%20Signal&volume=14&pages=2327&publication_year=2011)

37. M Hotta et al 1998 *J Exp Med* 188:1445
CrossRef (https://doi.org/10.1084/jem.188.8.1445)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=9782121)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2213419)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=M.%20Hotta&journal=J%20Exp%20Med&volume=188&pages=1445&publication_year=1998)

38. FC Chou et al 2009 *J Biomed Sci* 16:71

CrossRef (https://doi.org/10.1186/1423-0127-16-71)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=19671194)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2736160)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=FC.%20Chou&journal=J%20Biomed%20Sci&volume=16&pages=71&publication_year=2009)

39. CM Oslowski et al 2012 *Cell Metab* 16:265
CrossRef (https://doi.org/10.1016/j.cmet.2012.07.005)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=22883234)
PubMedCentral (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3418541)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=CM.%20Oslowski&journal=Cell%20Metab&volume=16&pages=265&publication_year=2012)

40. MH Kester 2009 *Endocrinology* 150:540
CrossRef (https://doi.org/10.1210/en.2008-0344)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=18787028)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=MH.%20Kester&journal=Endocrinology&volume=150&pages=540&publication_year=2009)

41. R Malik et al 2002 *Semin Cell Dev Biol* 13:425
CrossRef (https://doi.org/10.1016/S1084952102001301)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=12468243)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=R.%20Malik&journal=Semin%20Cell%20Dev%20Biol&volume=13&pages=425&publication_year=2002)

42. K Ikematsu et al 2007 *Forensic Sci Int* 169:168
CrossRef (https://doi.org/10.1016/j.forsciint.2006.08.015)
PubMed (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=17034973)
Google Scholar (http://scholar.google.com/scholar_lookup?&author=K.%20Ikematsu&journal=Forensic%20Sci%20Int&volume=169&pages=168&publication_year=2007)

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Cite this chapter as:
Boukhzar L. et al. (2016) Selenoprotein T: From Discovery to Functional Studies Using Conditional Knockout Mice. In: Hatfield D., Schweizer U., Tsuji P., Gladyshev V. (eds) Selenium. Springer, Cham. https://doi.org/10.1007/978-3-319-41283-2_23

- First Online 16 September 2016

- DOI https://doi.org/10.1007/978-3-319-41283-2_23
- Publisher Name Springer, Cham
- Print ISBN 978-3-319-41281-8
- Online ISBN 978-3-319-41283-2
- eBook Packages Biomedical and Life Sciences Biomedical and Life Sciences (R0)