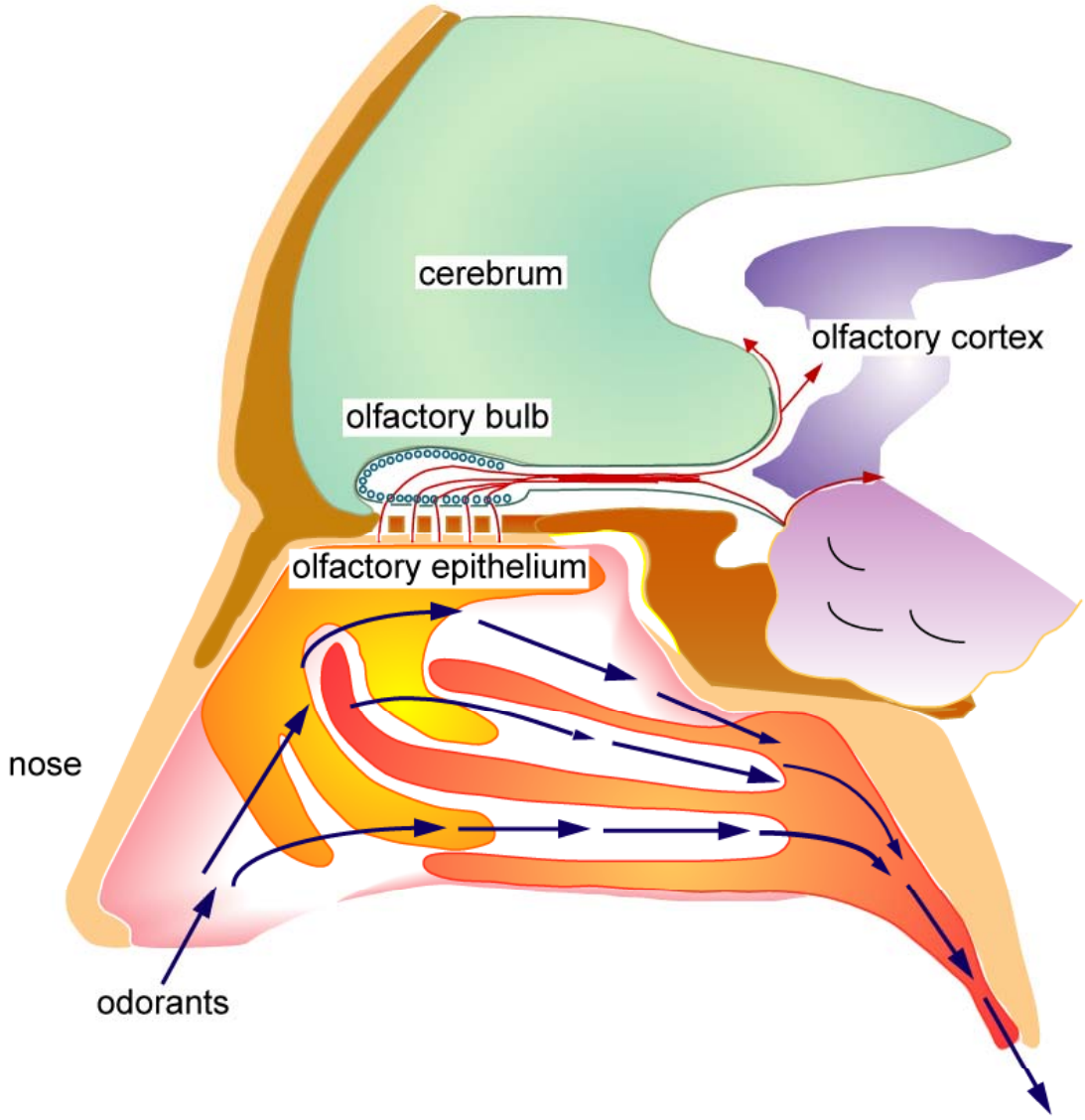
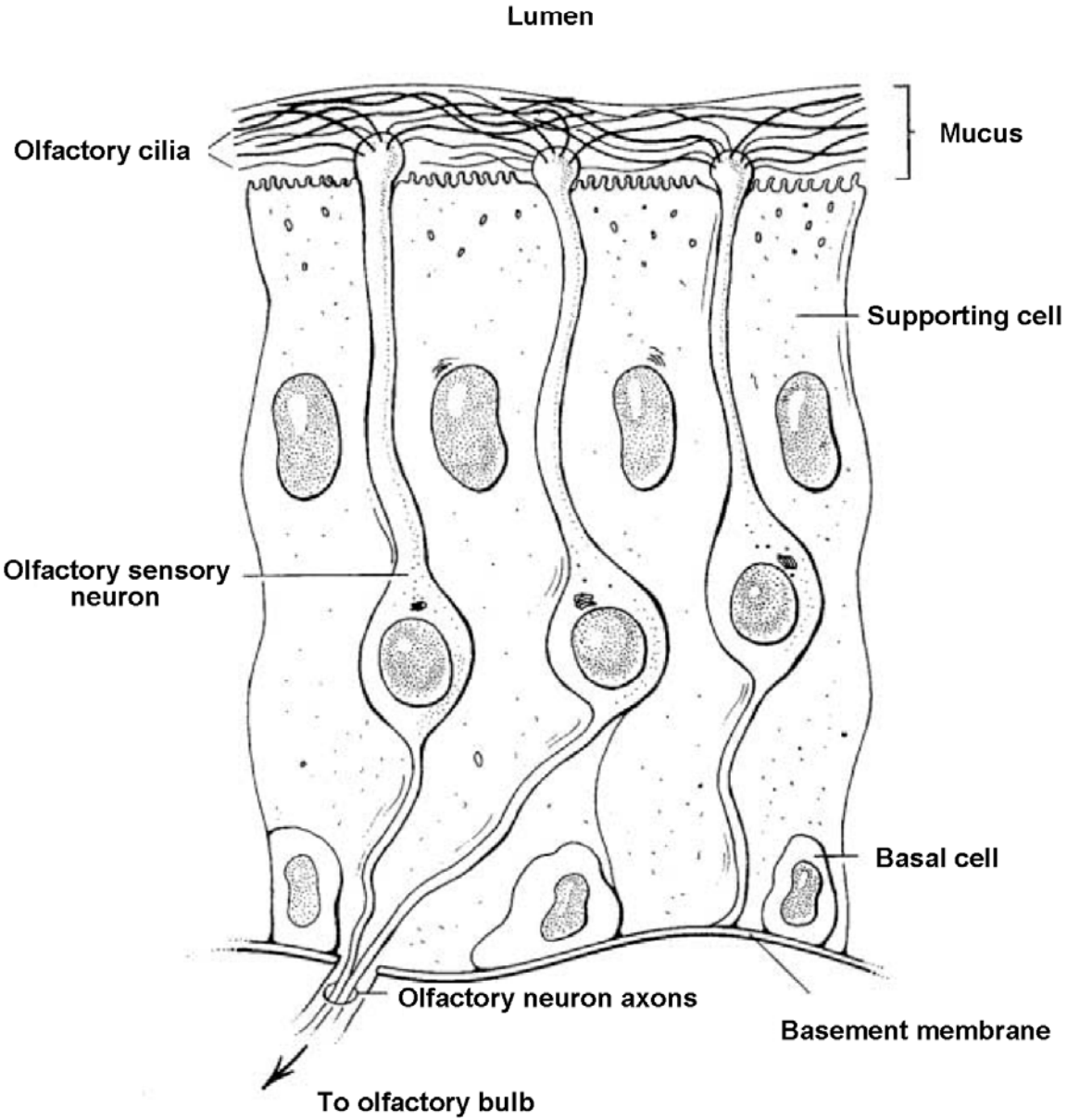
Molecular Basis of Odor Perception in the Mouse

Hitoshi Sakano
The University of Tokyo

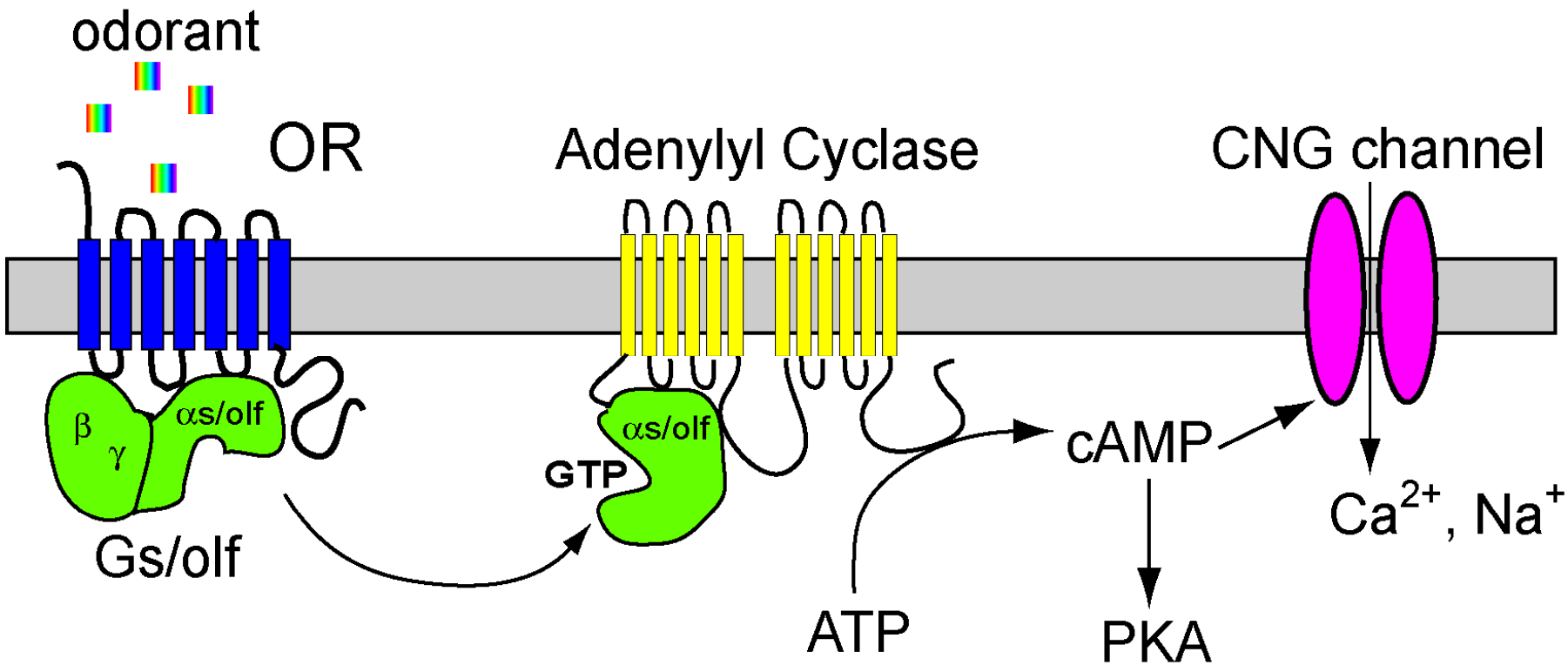
Human Olfactory System



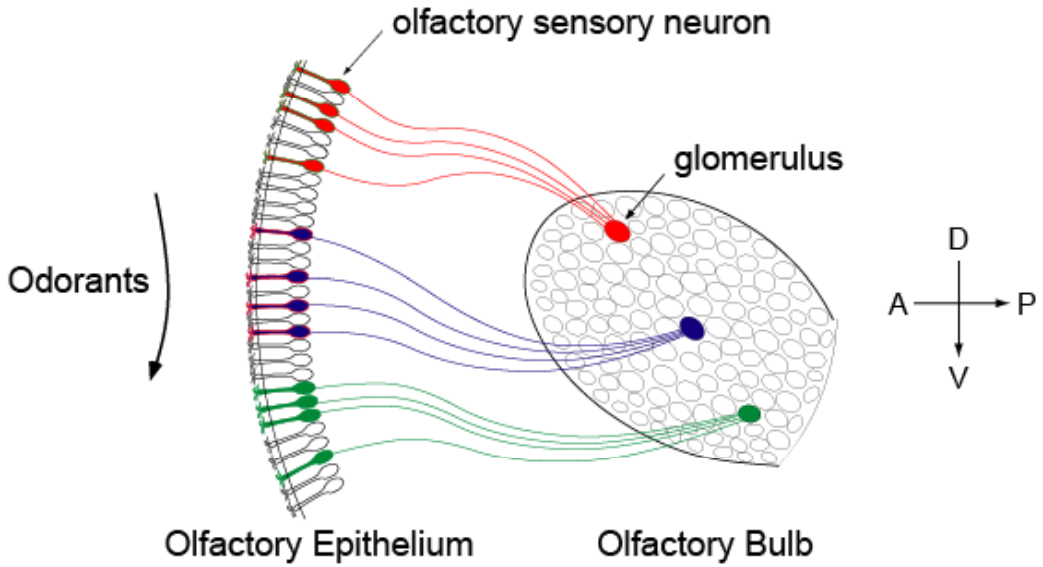
Olfactory Neuroepithelium

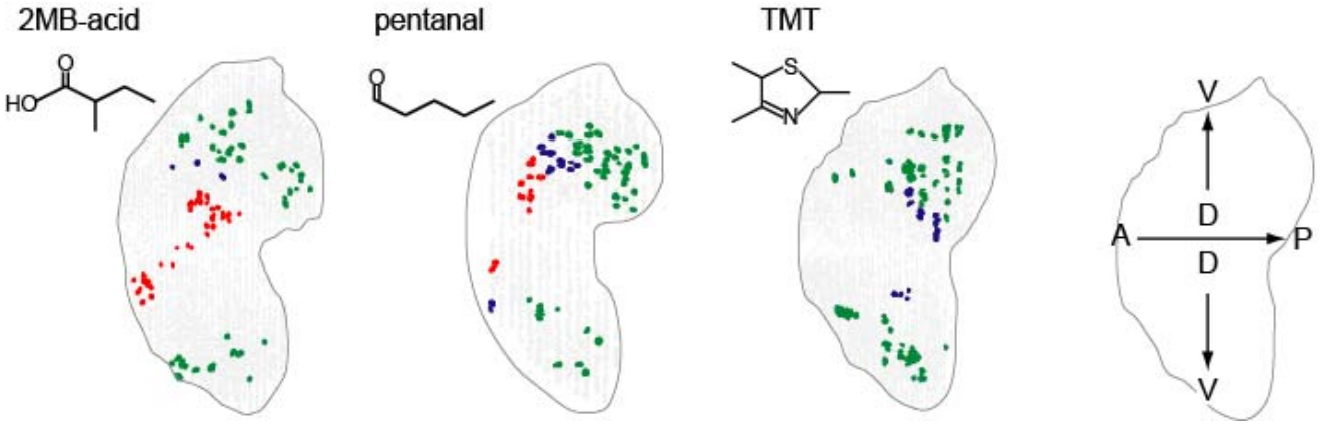


Olfactory Signal Transduction

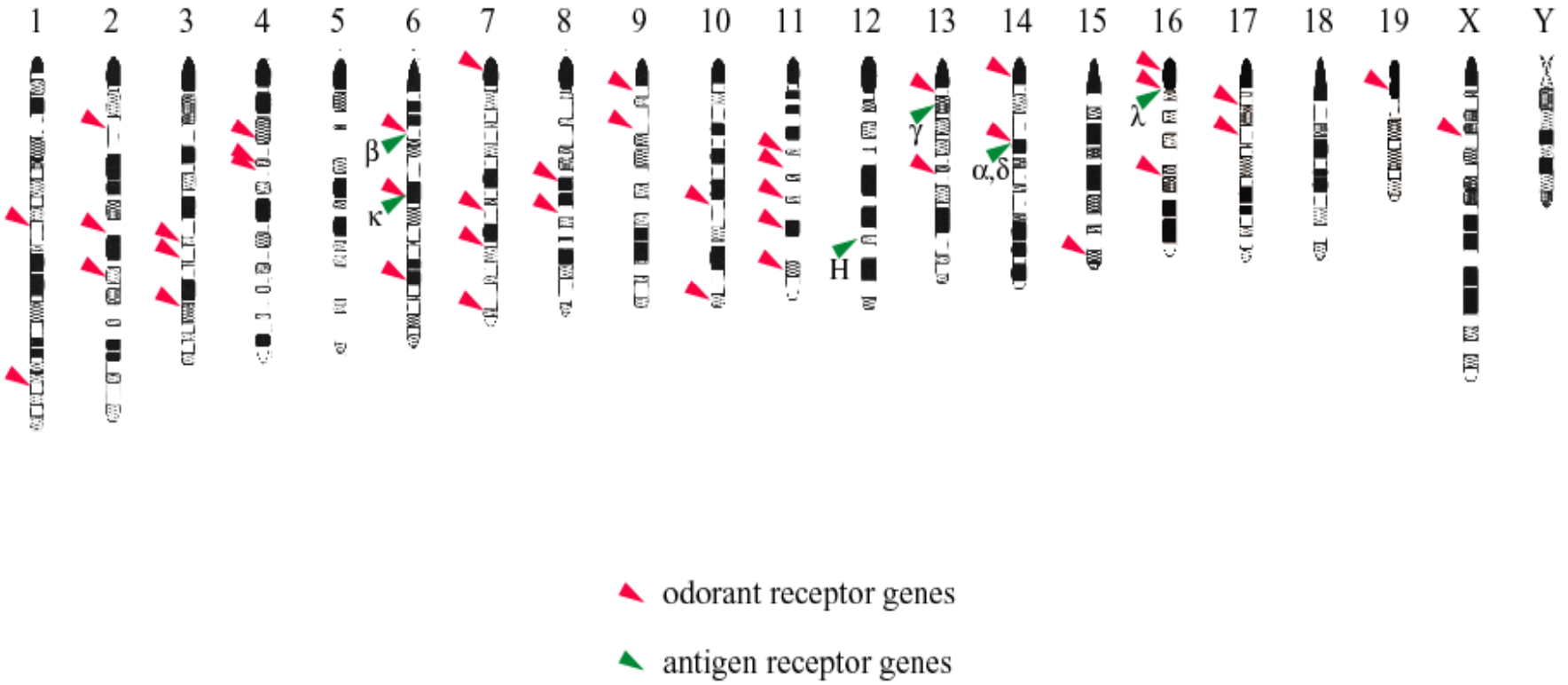


Conversion of olfactory signals

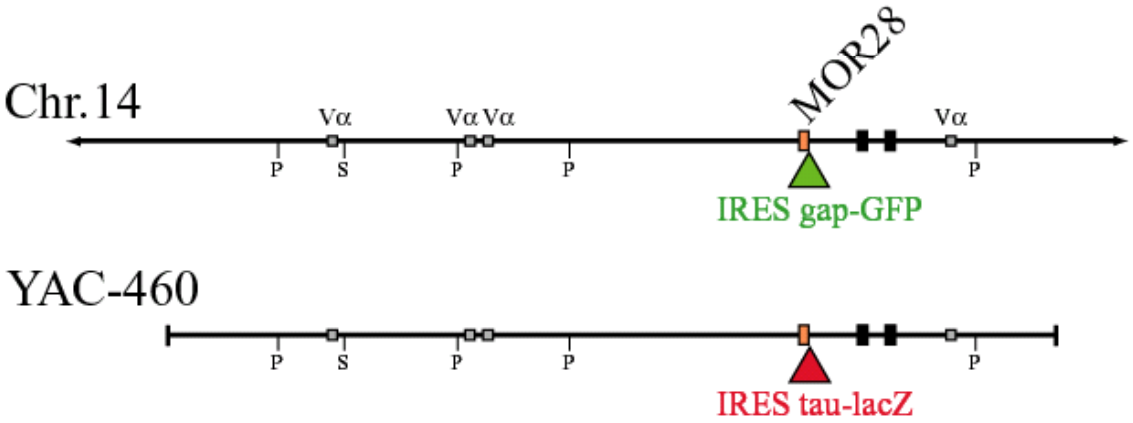


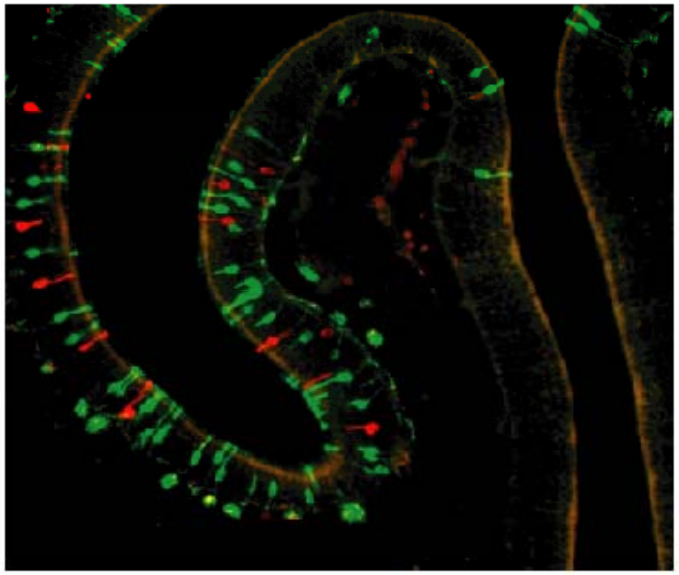


Distribution of the Mouse OR Gene Clusters



Exclusion Between the Transgenic and Endogenous *MOR28* Genes



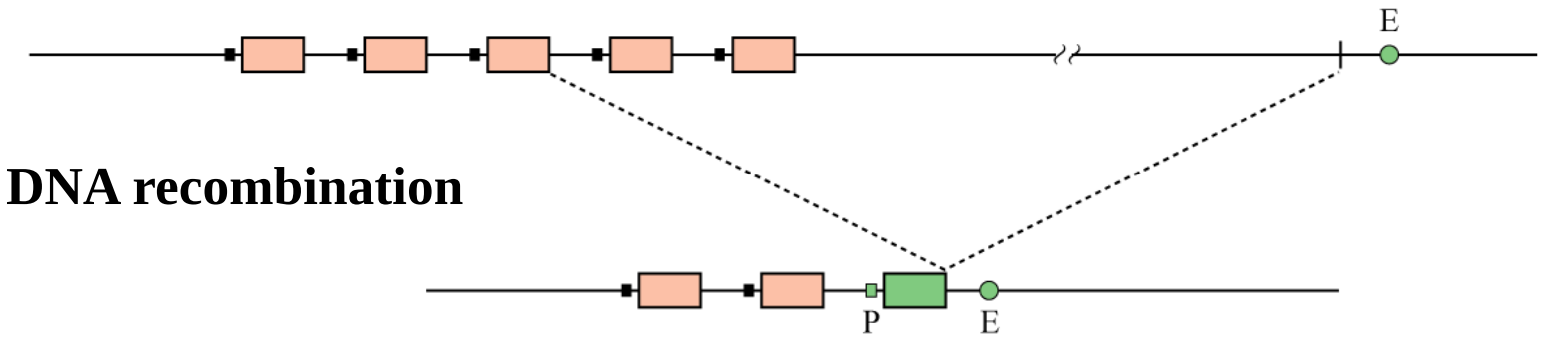


Olfactory epithelium

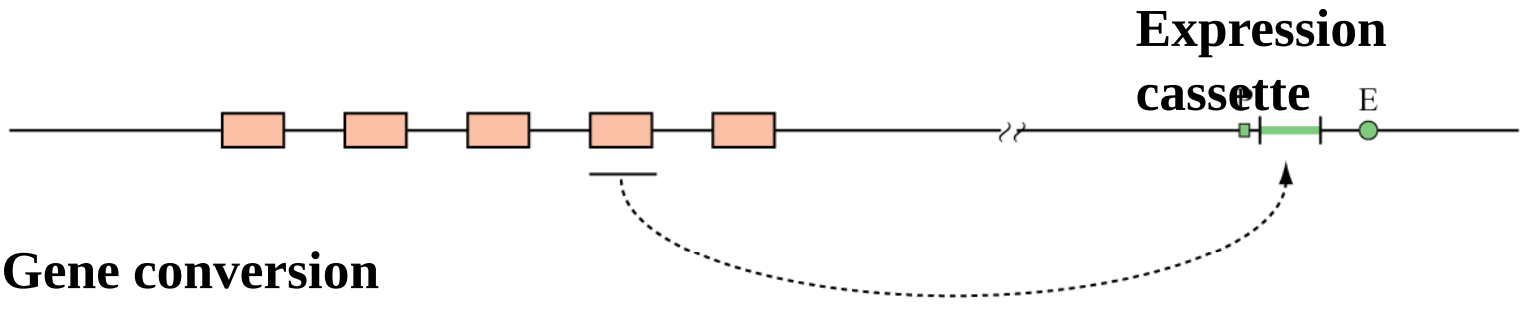
Serizawa *et al.*, *Nature Neurosci*. **7**, 687 (2000)

‡http://www.nature.com/neuro/journal/v3/n7/full/nn0700_687.html

Single Gene Choice by Somatic DNA Rearrangement

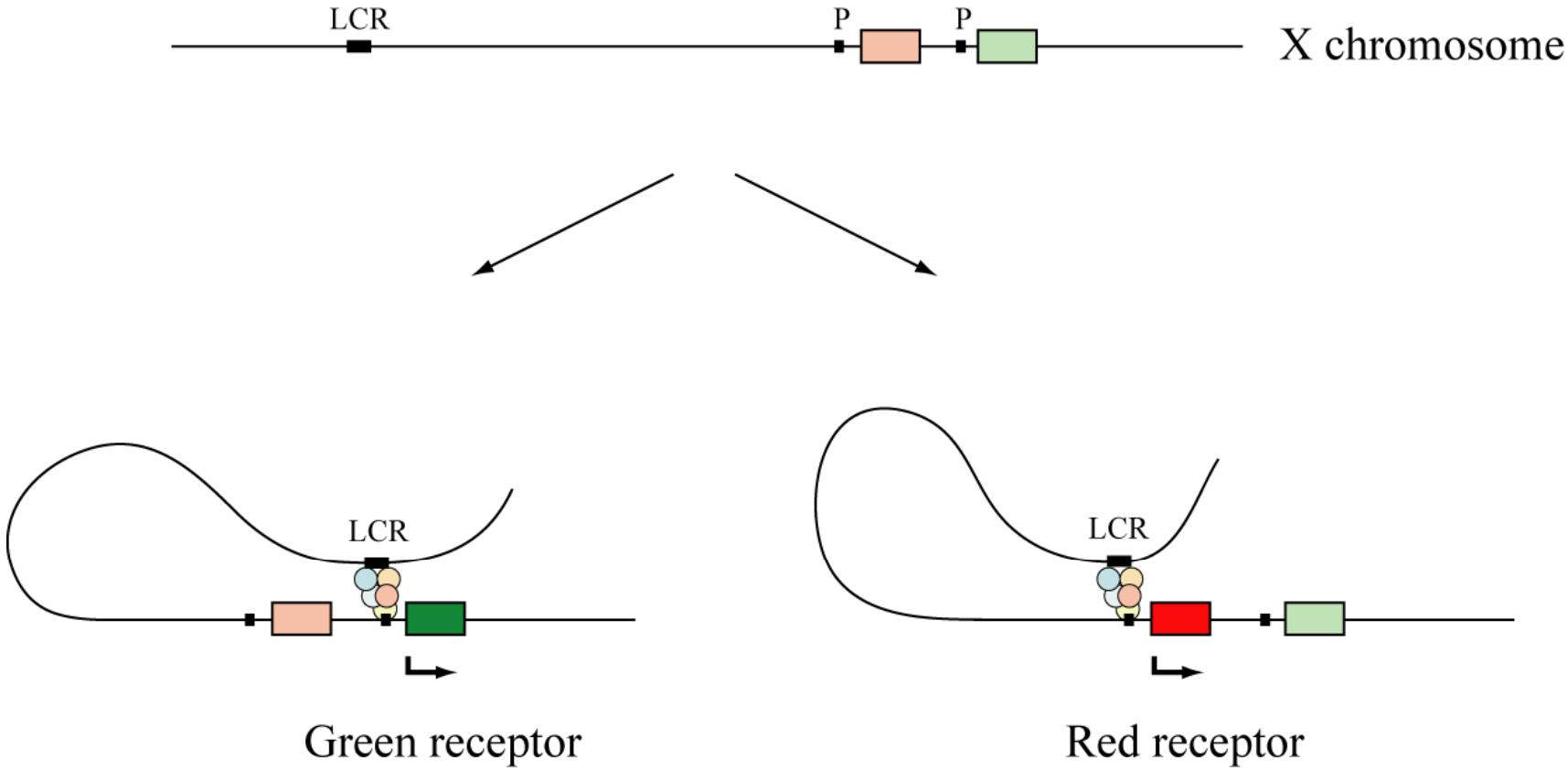


DNA recombination

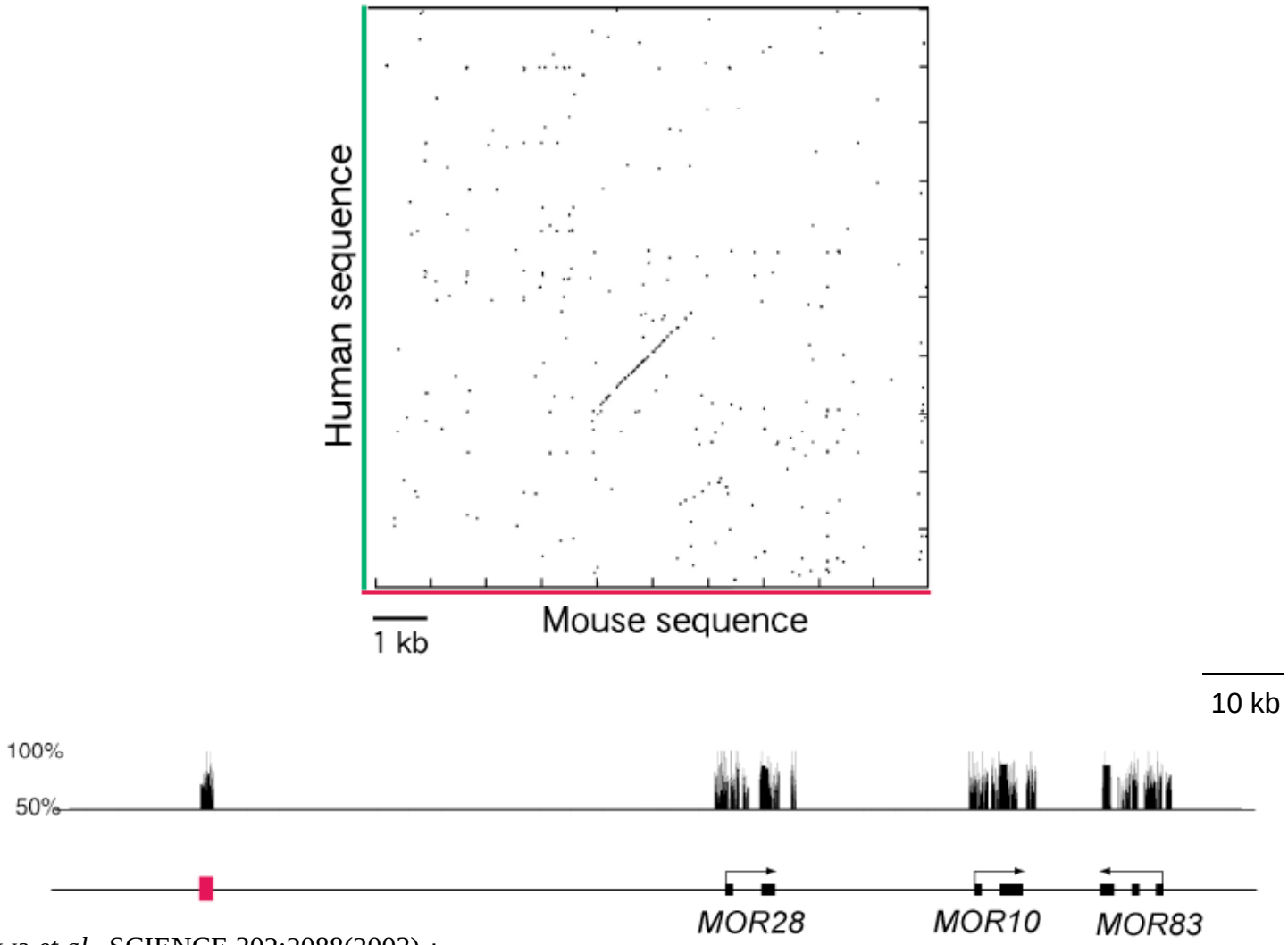


Gene conversion

Mutually Exclusive Activation of Visual Pigment Genes



Identification of the Homology (H) Region



‡ From Serizawa *et al.*, SCIENCE 302:2088(2003) :
http://www.sciencemag.org/cgi/content/full/sci;302/5653/2088?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&searchid=1&FIRSTINDEX=0&volume=302&firstpage=2088&resourcetype=HWCIT
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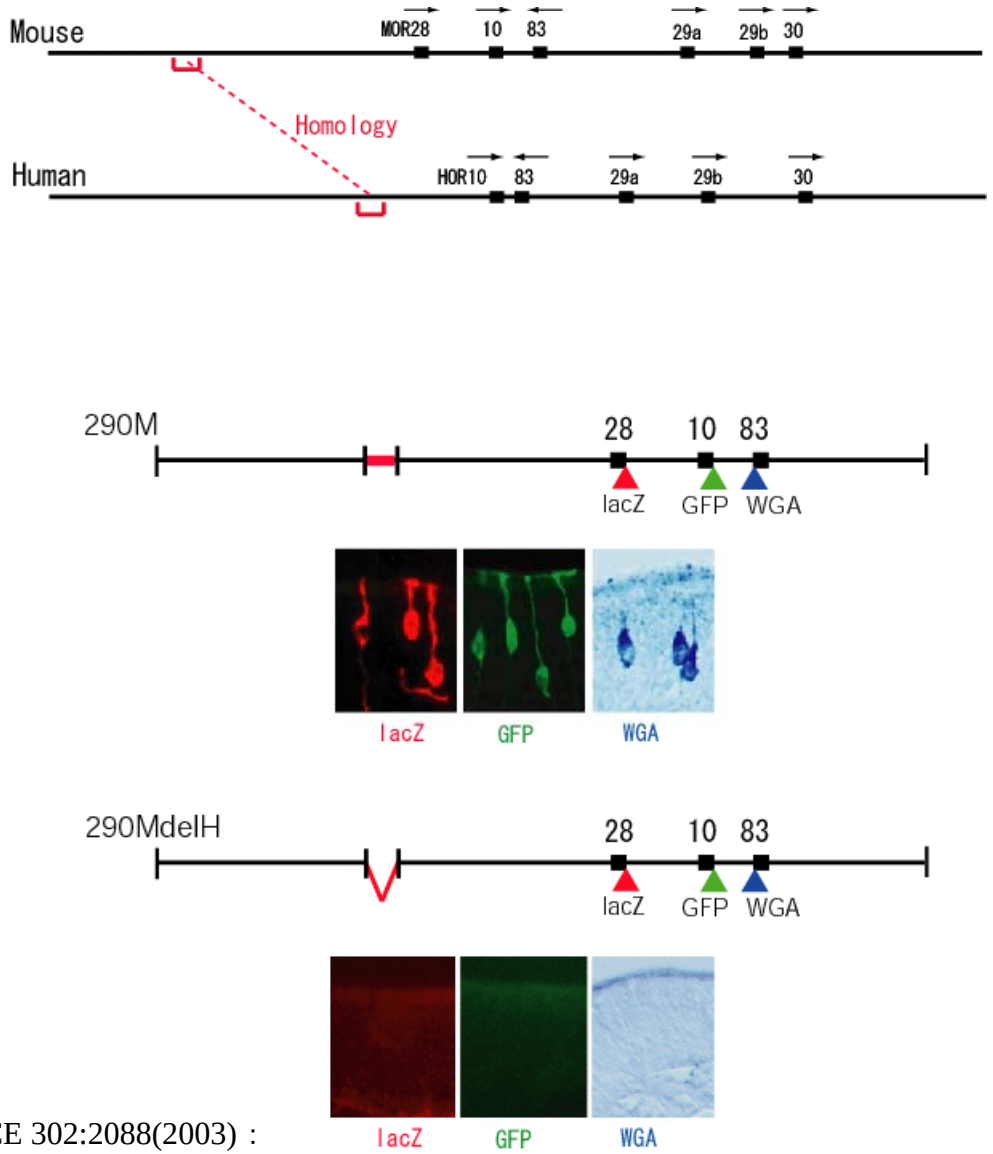
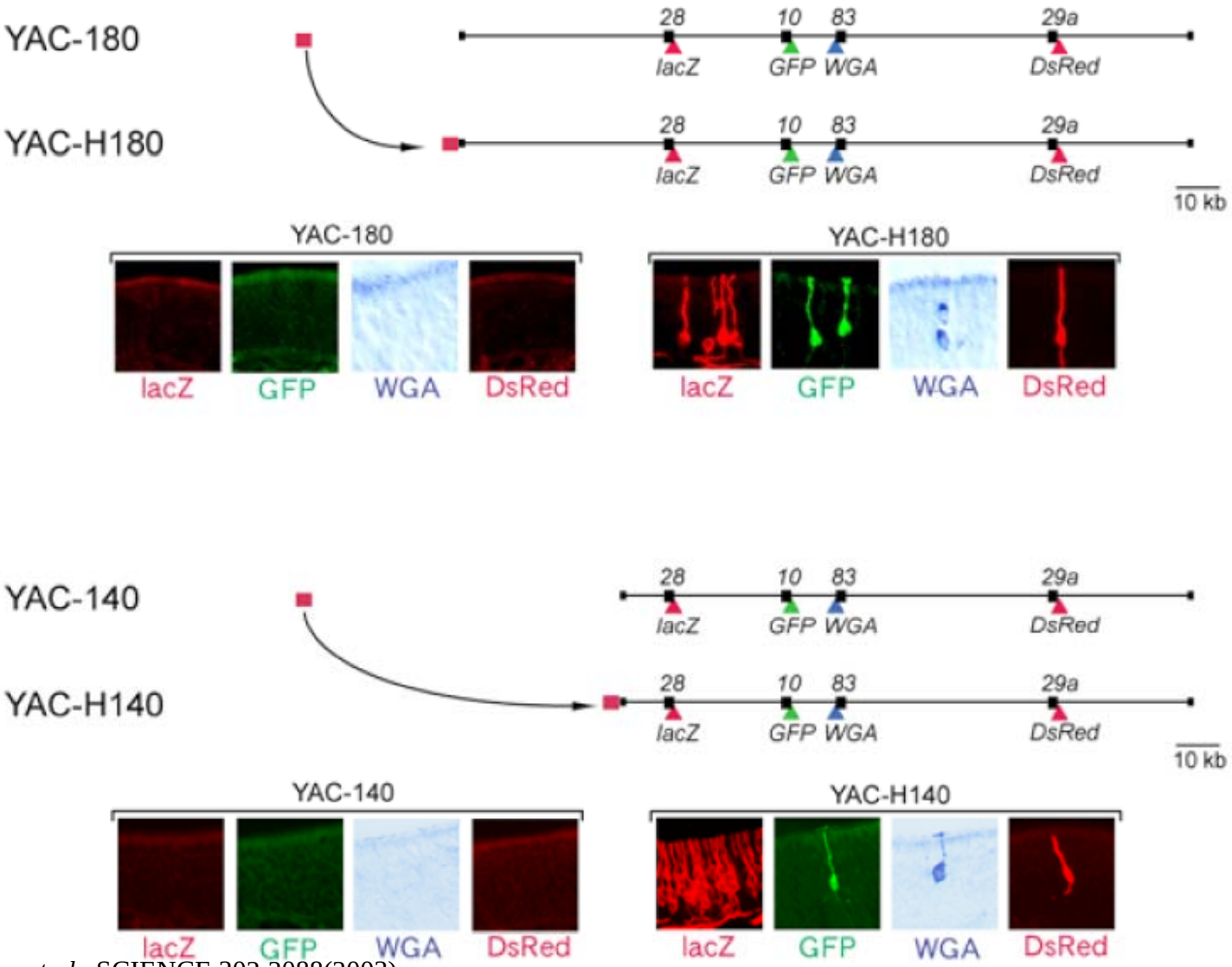
H-Region is Necessary for *MOR28* Expression



‡ From Serizawa *et al*., SCIENCE 302:2088(2003) : http://www.sciencemag.org/cgi/content/full/sci;302/5653/2088?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&searchid=1&FIRSTINDEX=0&volume=302&firstpage=2088&resourcetype=HWCIT

H-Region Reactivates Truncated Constructs



‡ From Serizawa *et al.*, SCIENCE 302:2088(2003) : http://www.sciencemag.org/cgi/content/full/sci;302/5653/2088?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&searchid=1&FIRSTINDEX=0&volume=302&firstpage=2088&resourcetype=HWCIT
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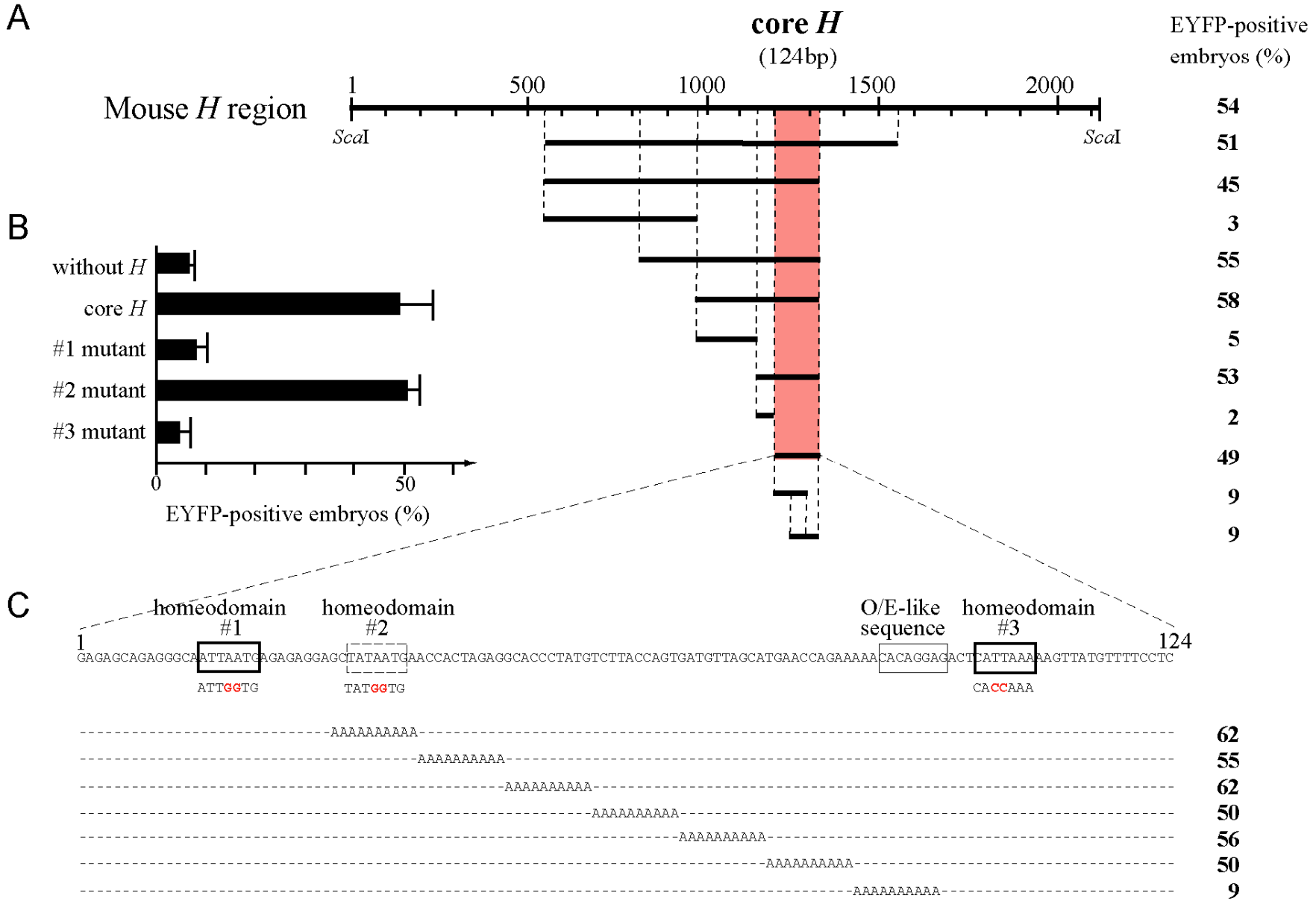
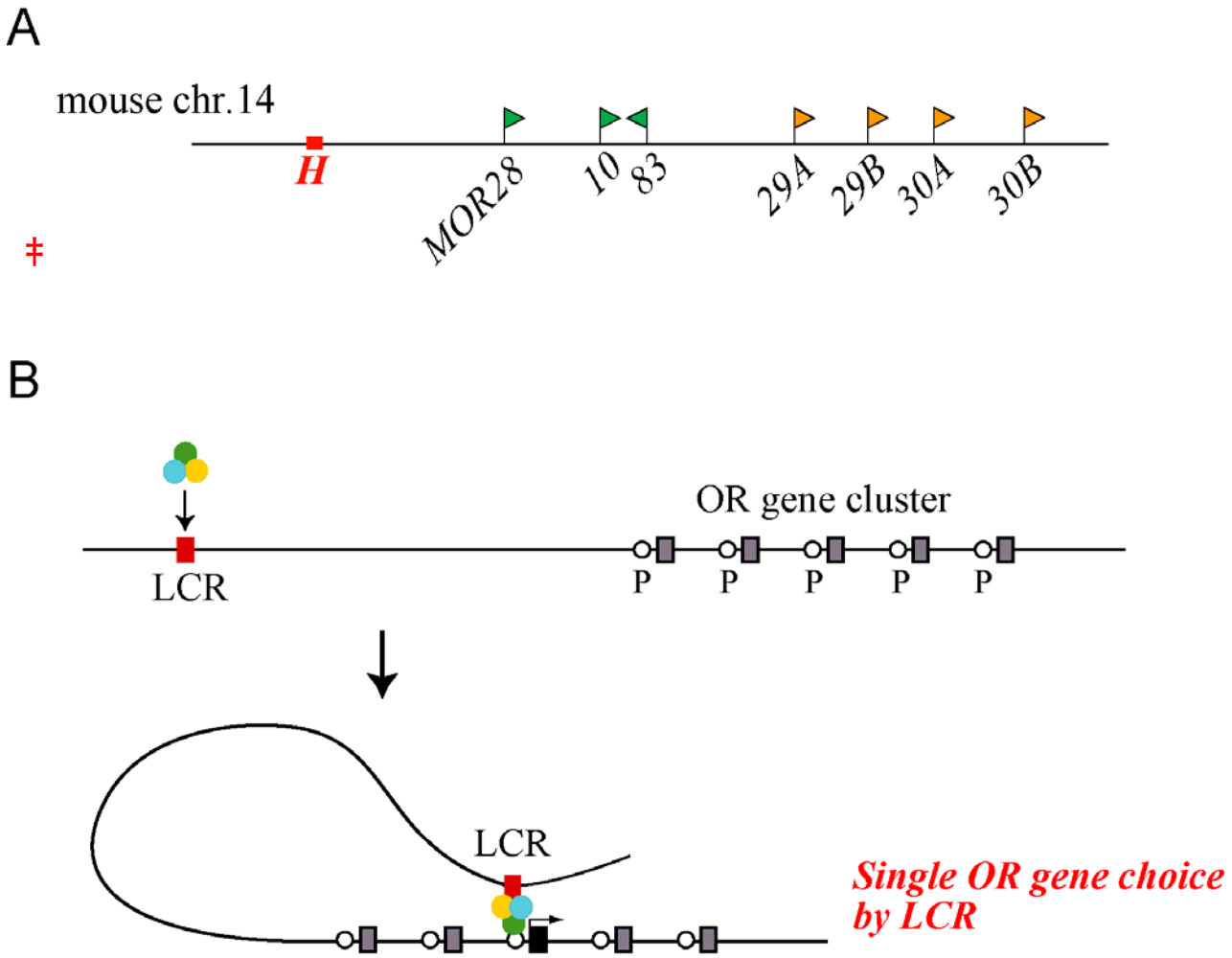
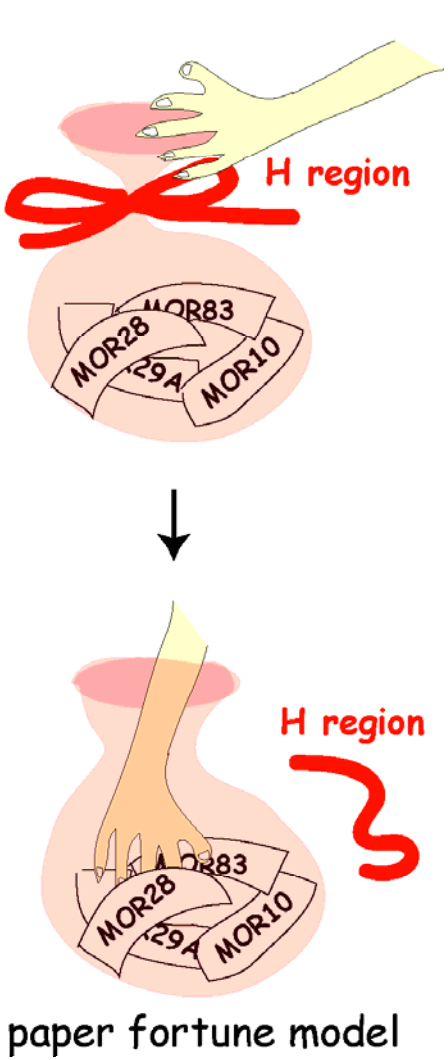
Dissection of the essential sequences of the mouse *H* region



‡PNAS vol.104, no.50, Decembe 11 2007 "Deletion of the core-H region in mice abolishes the expression of three proximal odorant receptor genes in cis"Hirofumi Nishizumi et al., P.20069, Fig.2, Copyright (2007) National Academy of Sciences, U.S.A.

Single OR gene choice by LCR





‡ From Serizawa *et al.*, SCIENCE 302:2088(2003) : http://www.sciencemag.org/cgi/content/full/sci;302/5653/2088?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&searchid=1&FIRSTINDEX=0&volume=302&firstpage=2088&resourcetype=HWCIT

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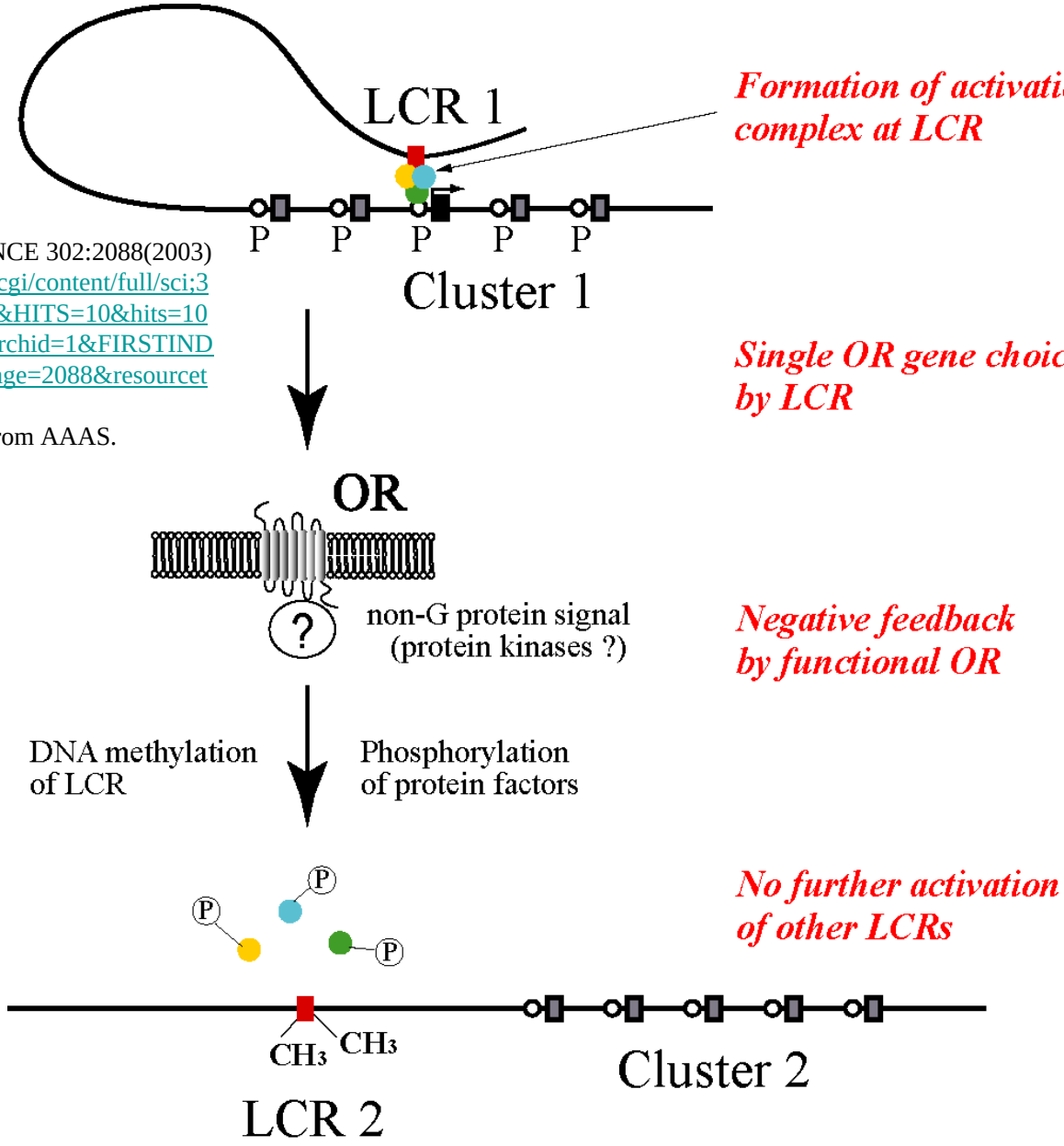
Maintenance of One Neuron – One Receptor Rule



Formation of activation complex at LCR

Single OR gene choice by LCR

Negative feedback by functional OR

No further activation of other LCRs

‡ From Serizawa *et al*., SCIENCE 302:2088(2003)
http://www.sciencemag.org/cgi/content/full/sci;302/5653/2088?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&searchid=1&FIRSTINDEX=0&volume=302&firstpage=2088&resourcetype=HWCIT
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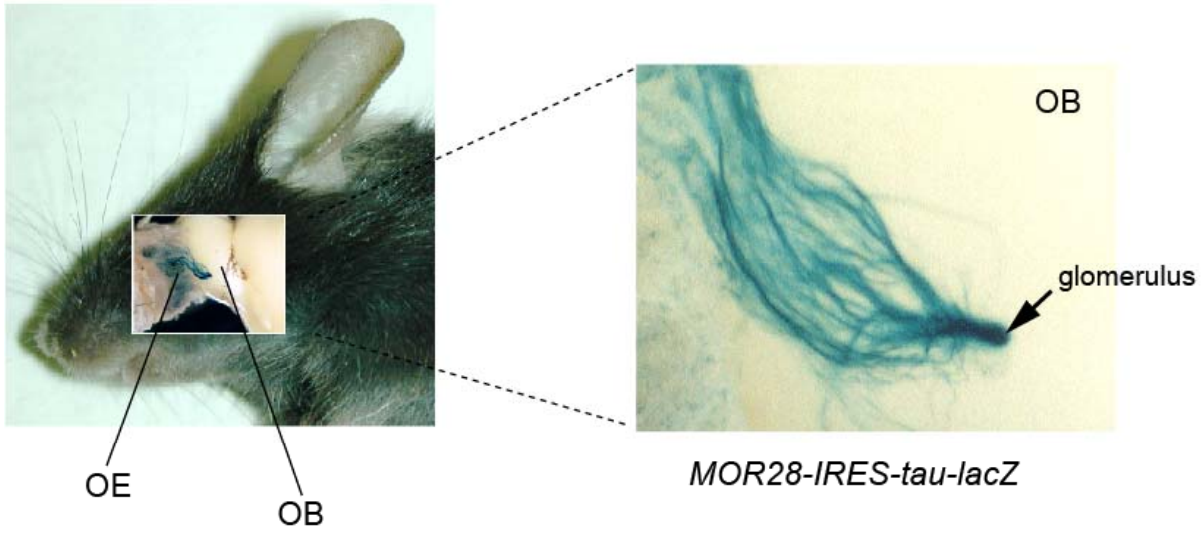
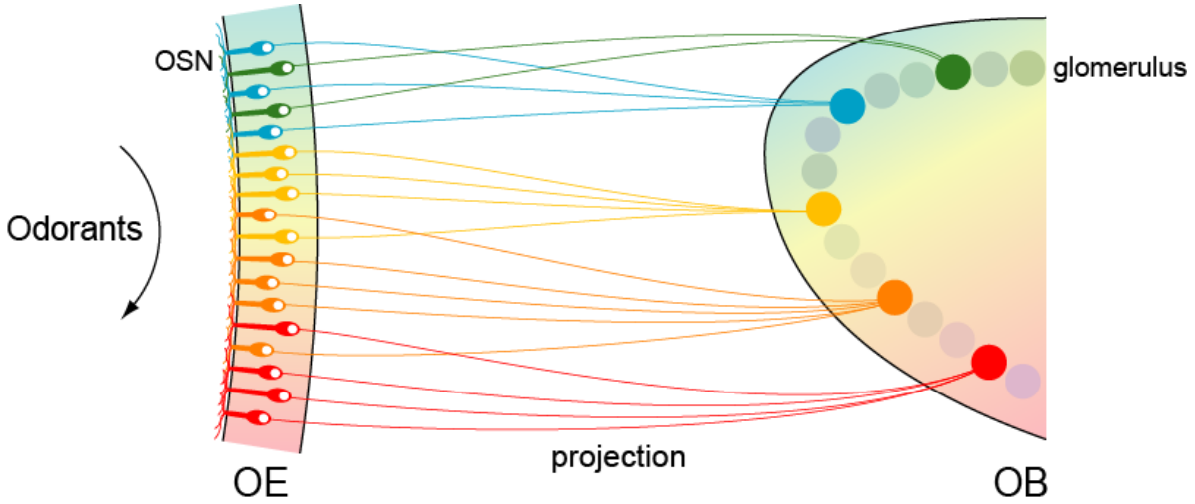
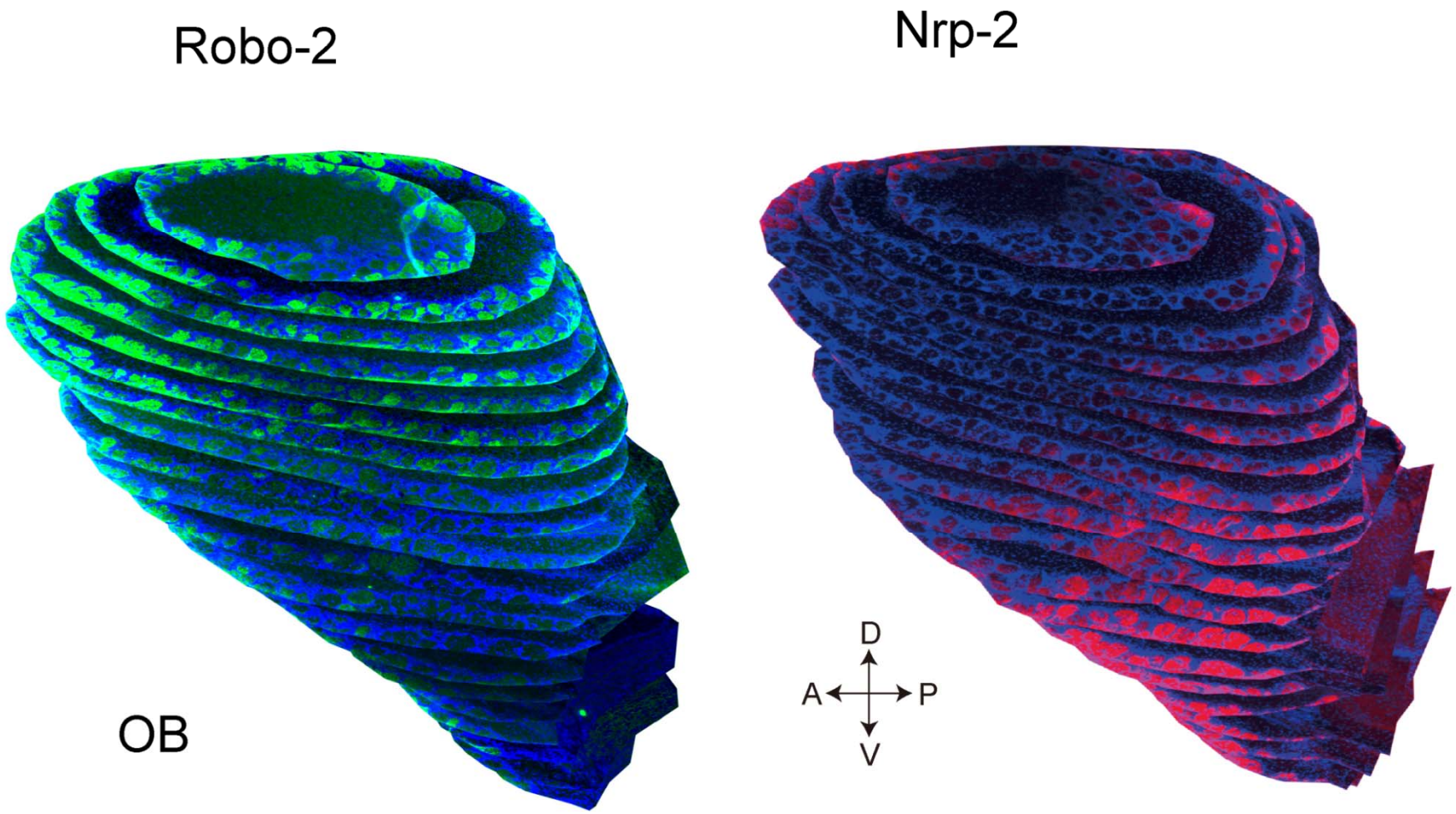
OR instructed axonal projection

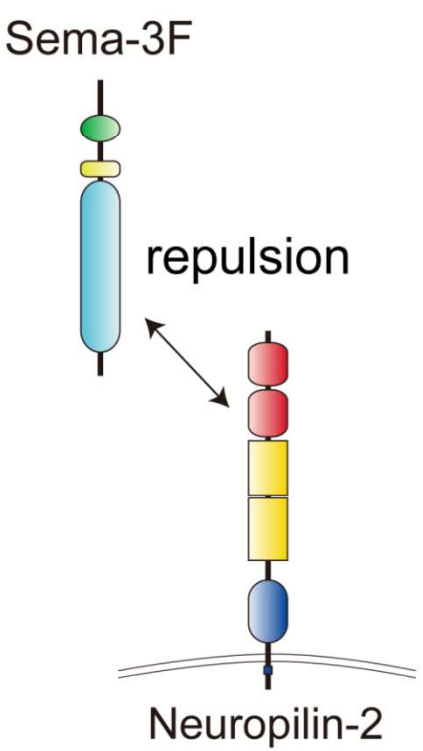




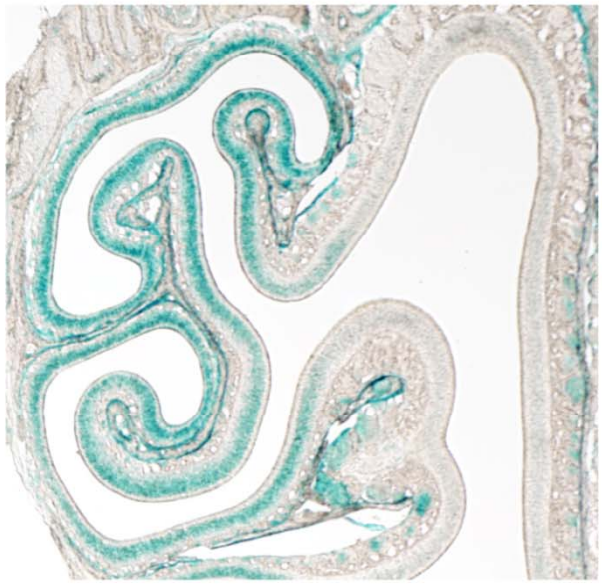
Graded ane complementary detection of Robo−2 and Nrp−2 in the glomerular map along the D/V axis of the OB



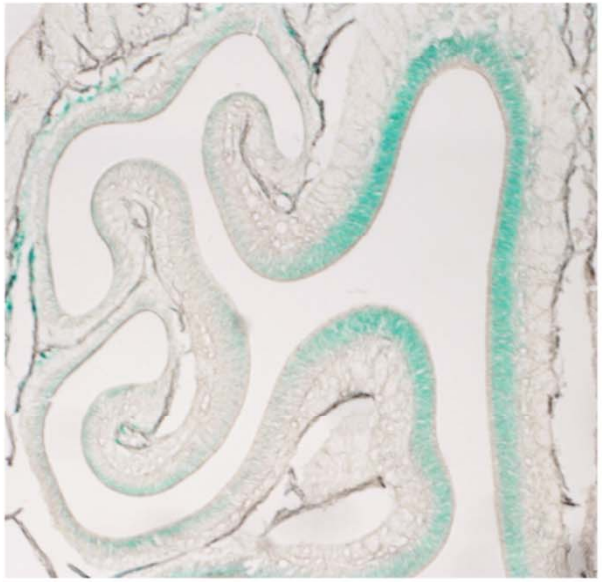
Complementary expression of Neuropilin-2 and Sema-3F



X-gal staining



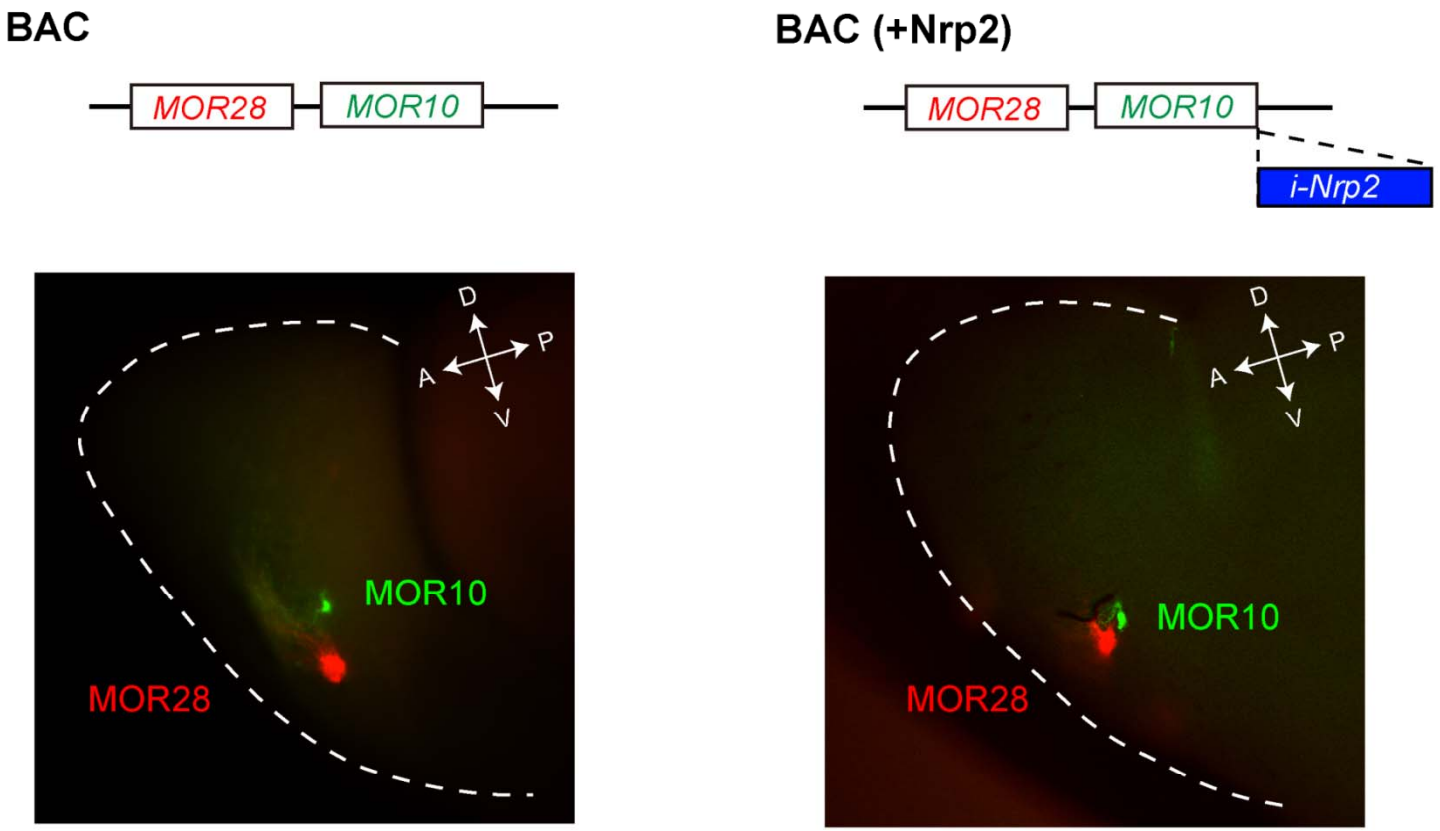
Neuropilin-2



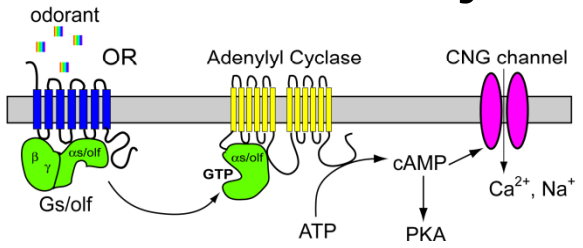
Sema-3F

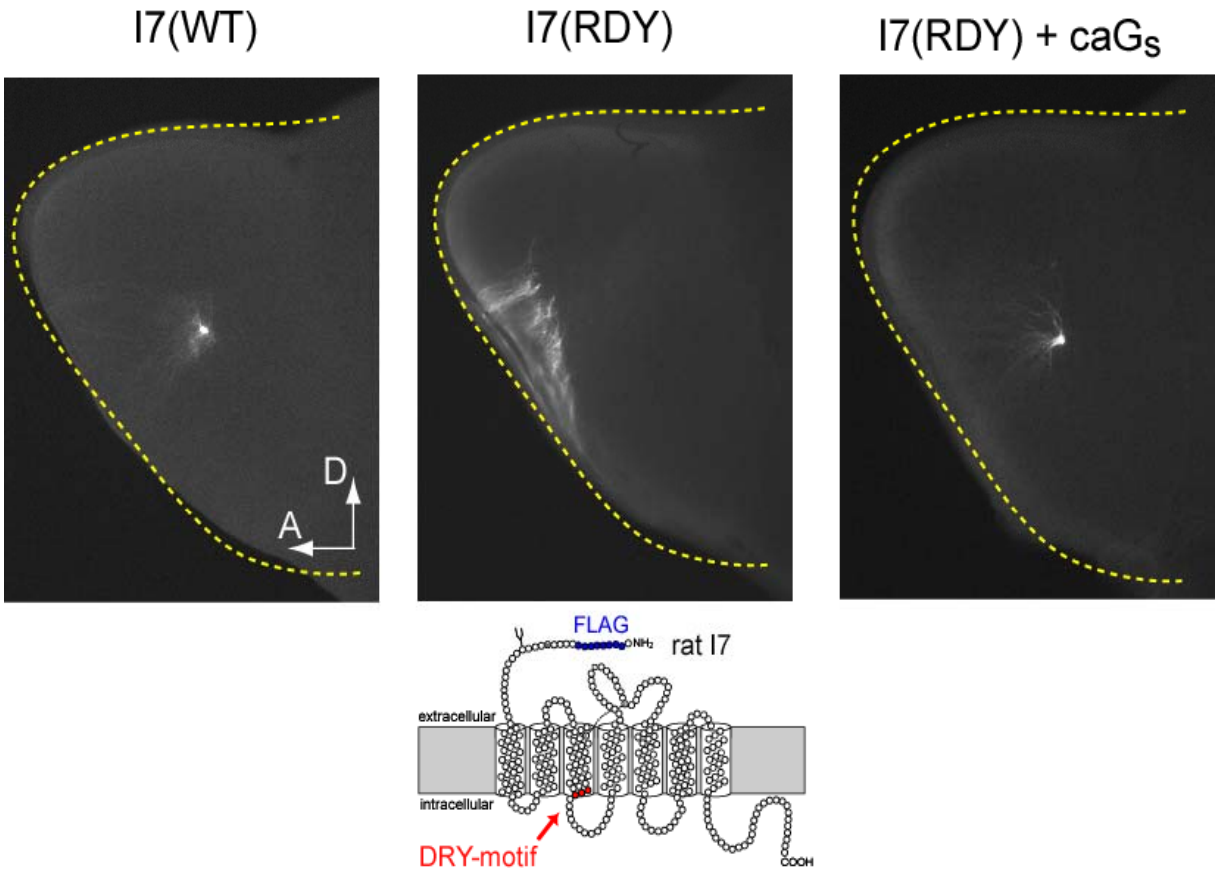
OE

Gain of function for Nrp2



G protein signals are necessary for axonal projection





‡ From Imai et al., SCIENCE 314:657(2006)
http://www.sciencemag.org/cgi/content/full/sci;314/5799/657?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&searchid=1&FIRSTINDEX=0&volume=314&firstpage=657&resourcetype=HWCIT
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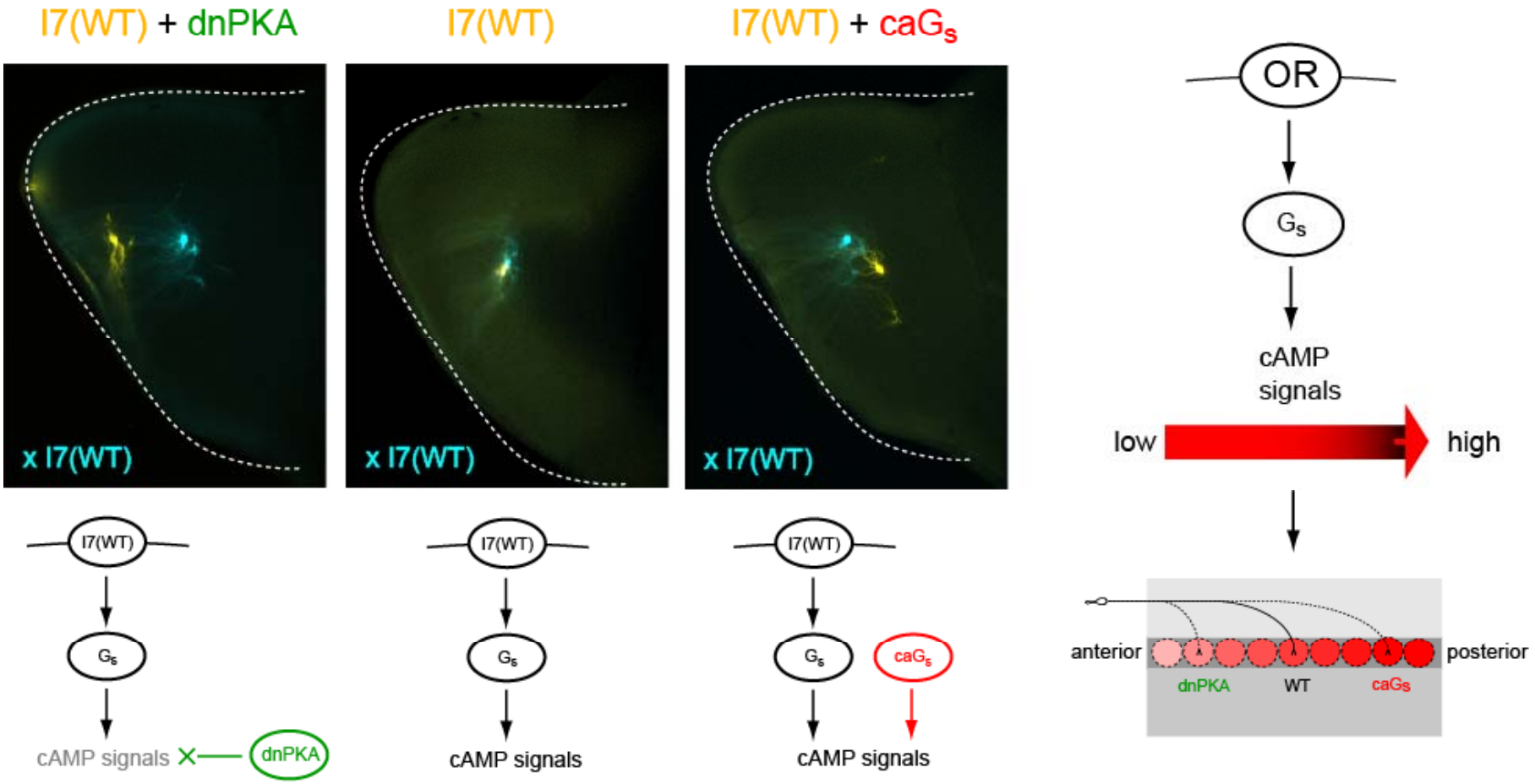
cAMP signals regulate glomerular positioning along the A/P axis



‡ From Imai et al., SCIENCE 314:657(2006)
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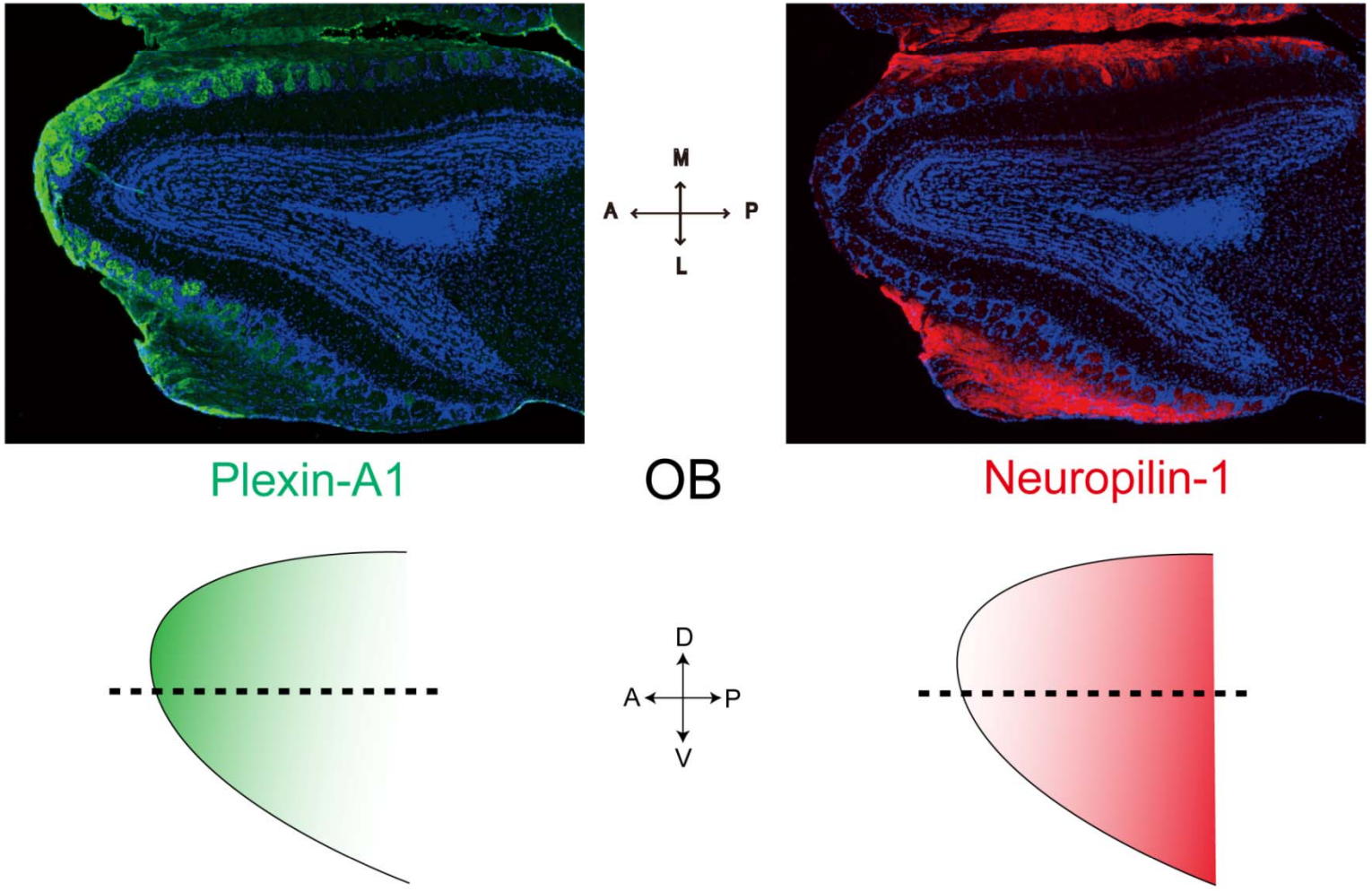
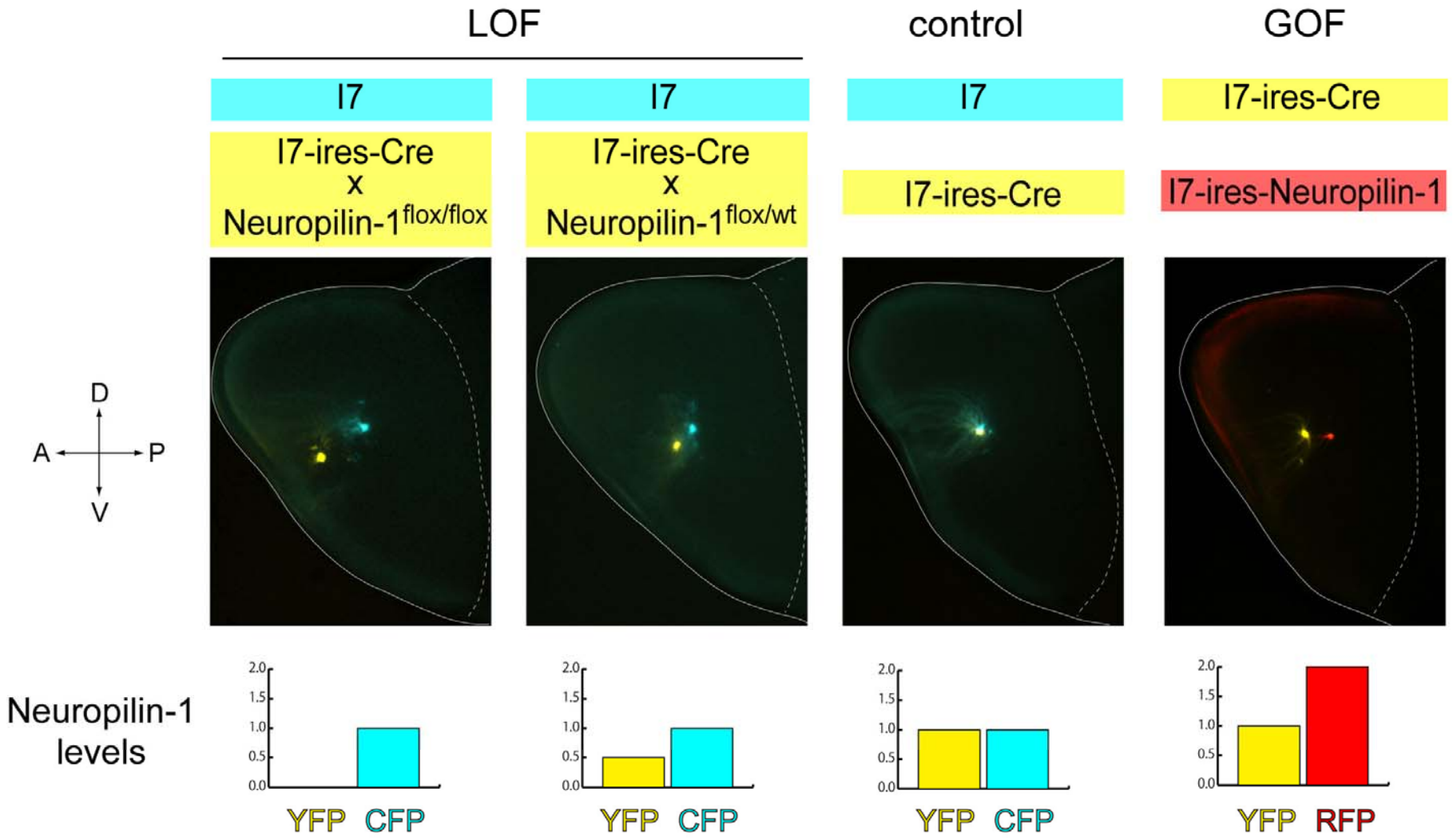
Complementary expression of Plexin-A1 and Neuropilin-1



Nrp1 level determines A-P positioning



‡ From Imai *et al*., SCIENCE 325:585(2009)
http://www.sciencemag.org/cgi/content/abstract/325/5940/585
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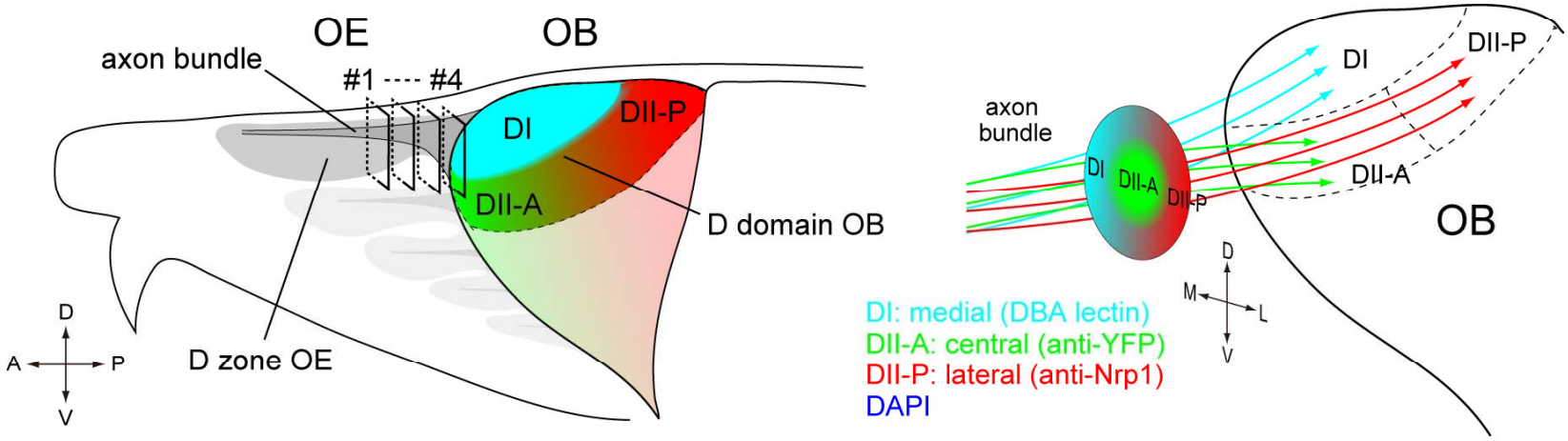
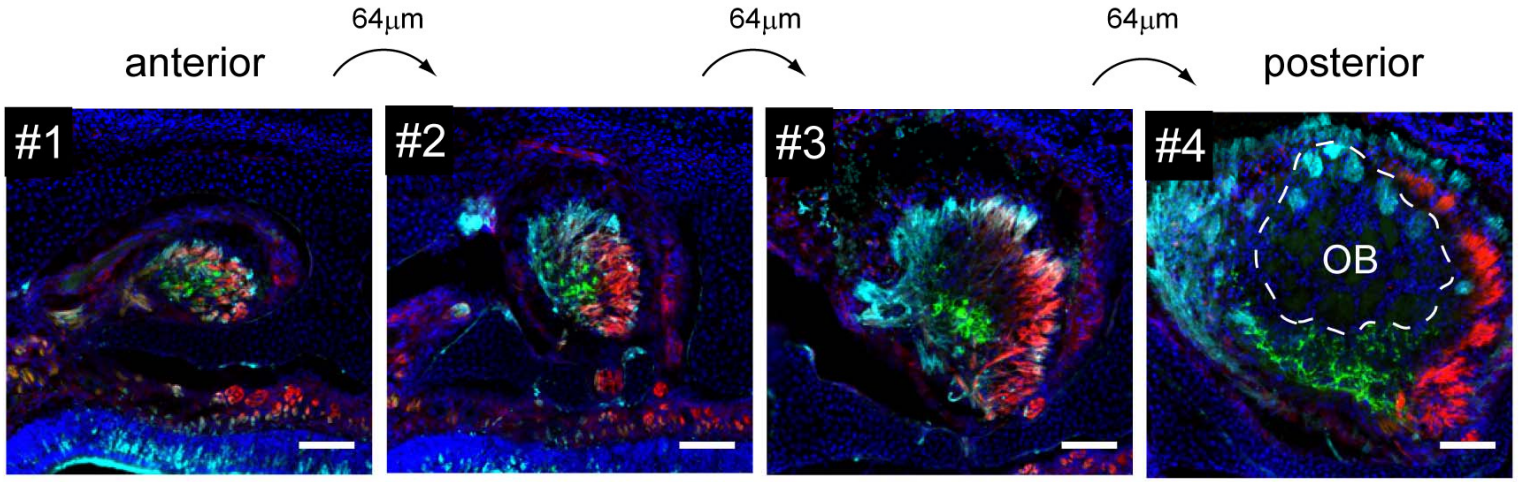
Pre-target axon sorting of OSNs





coronal sections of the axon bundle from D zone

‡ From Imai *et al*., SCIENCE 325:585(2009)
http://www.sciencemag.org/cgi/content/abstract/325/5940/585
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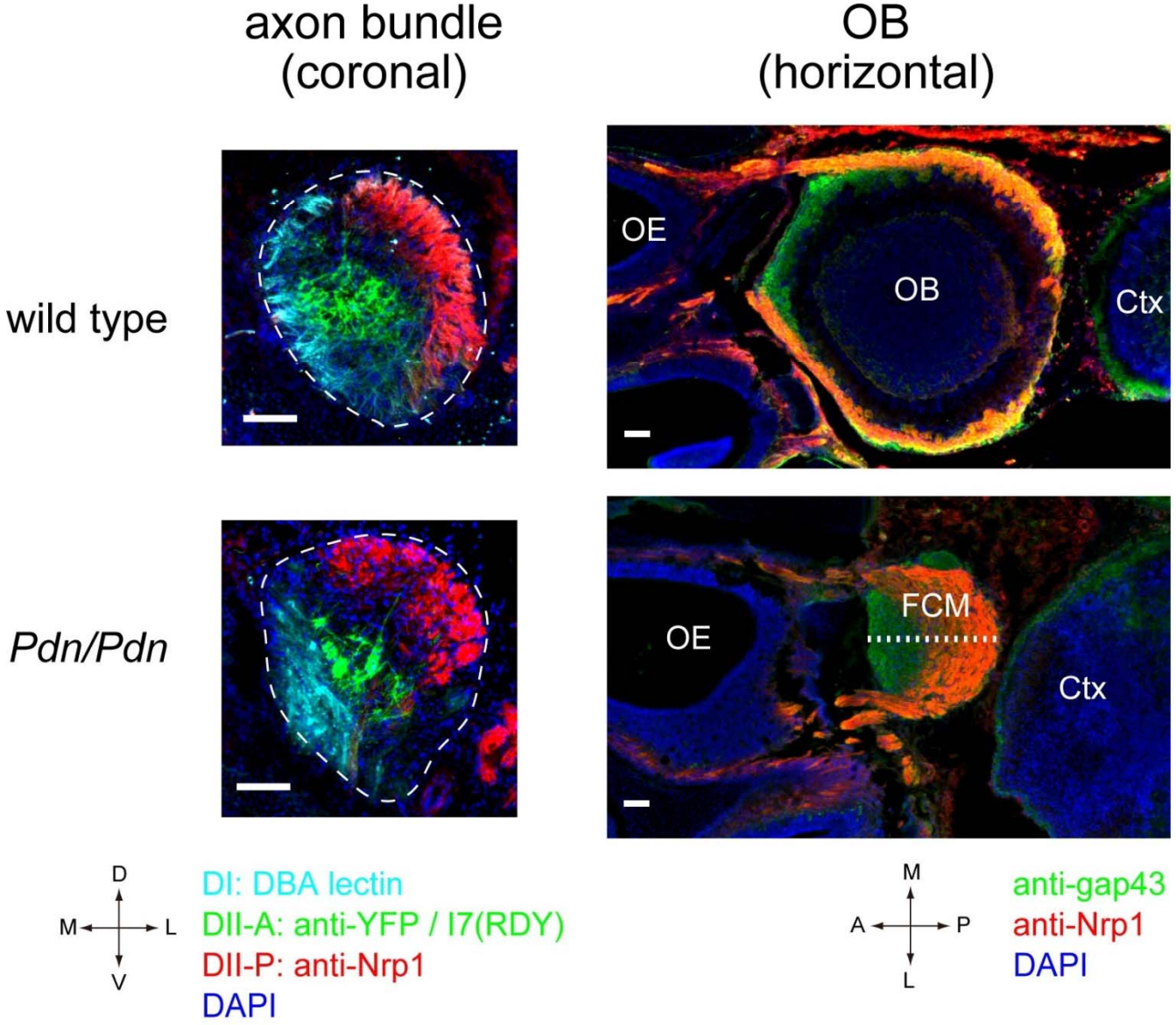
Pre-target axon sorting in the OB-less mutant



‡ From Imai *et al*., SCIENCE 325:585(2009)
http://www.sciencemag.org/cgi/content/abstract/325/5940/585
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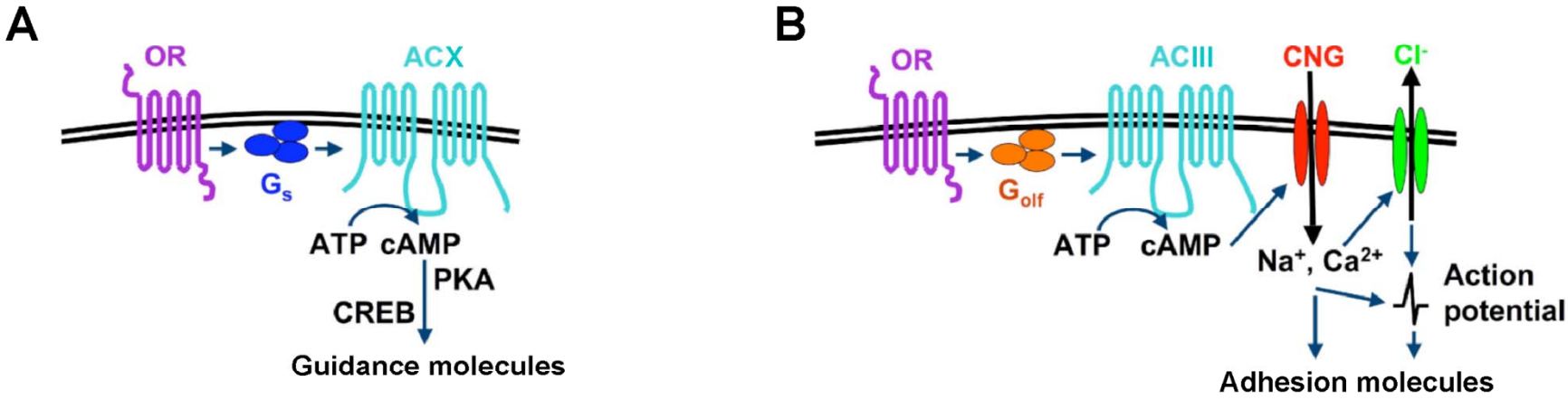
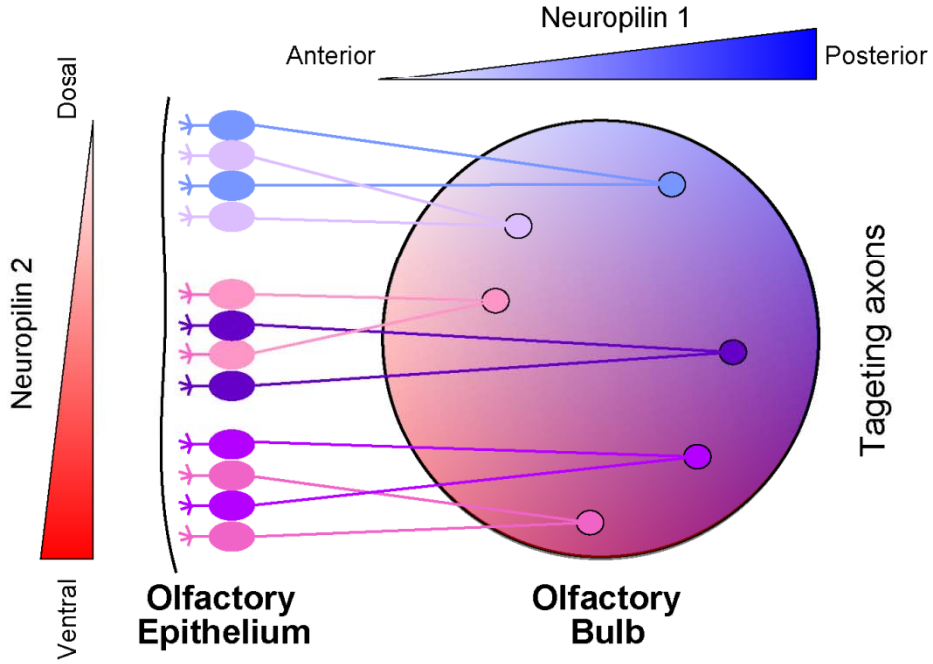
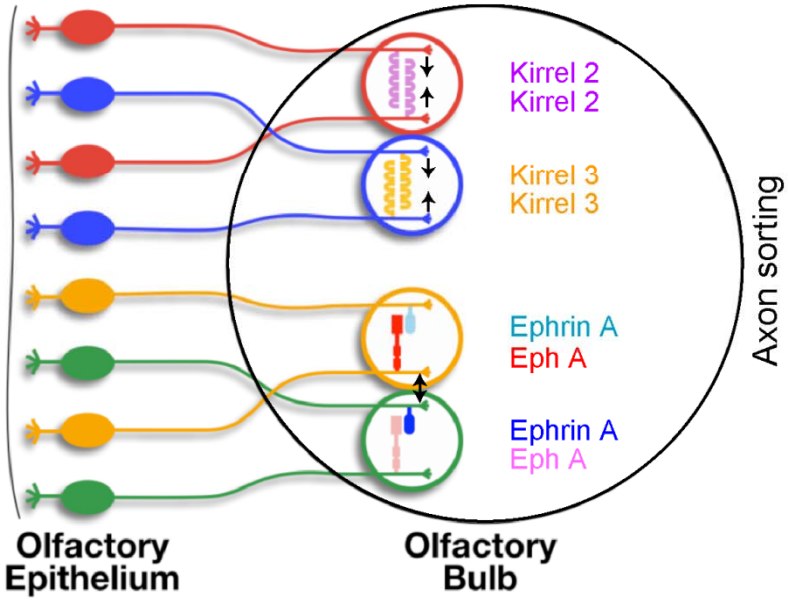
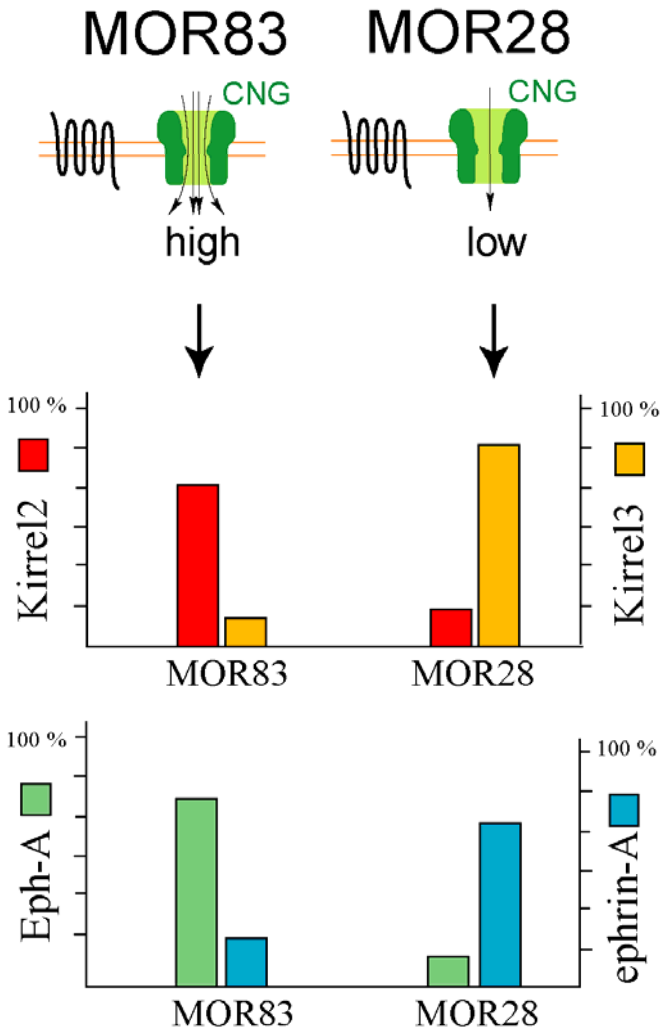
Two Step Model for Glomerular Map Formation

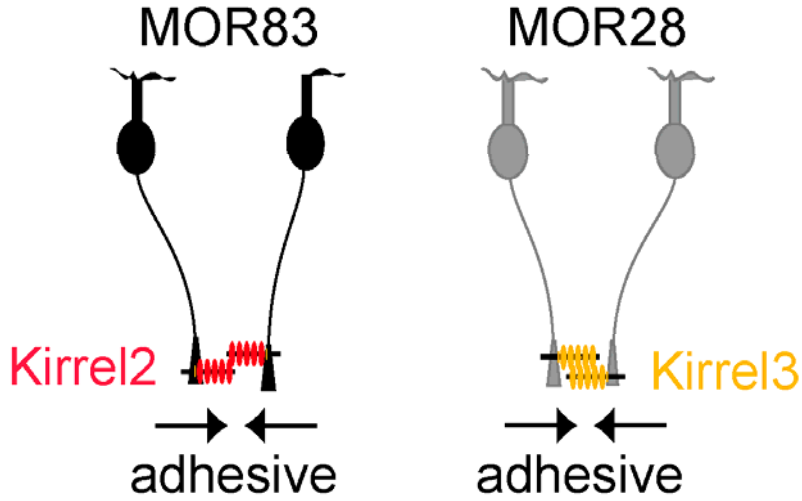


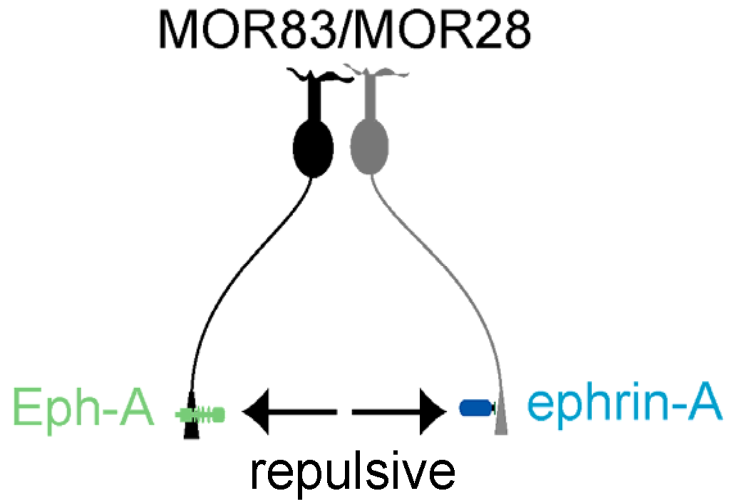




OR-specific and activity-dependent segregation of axon termini







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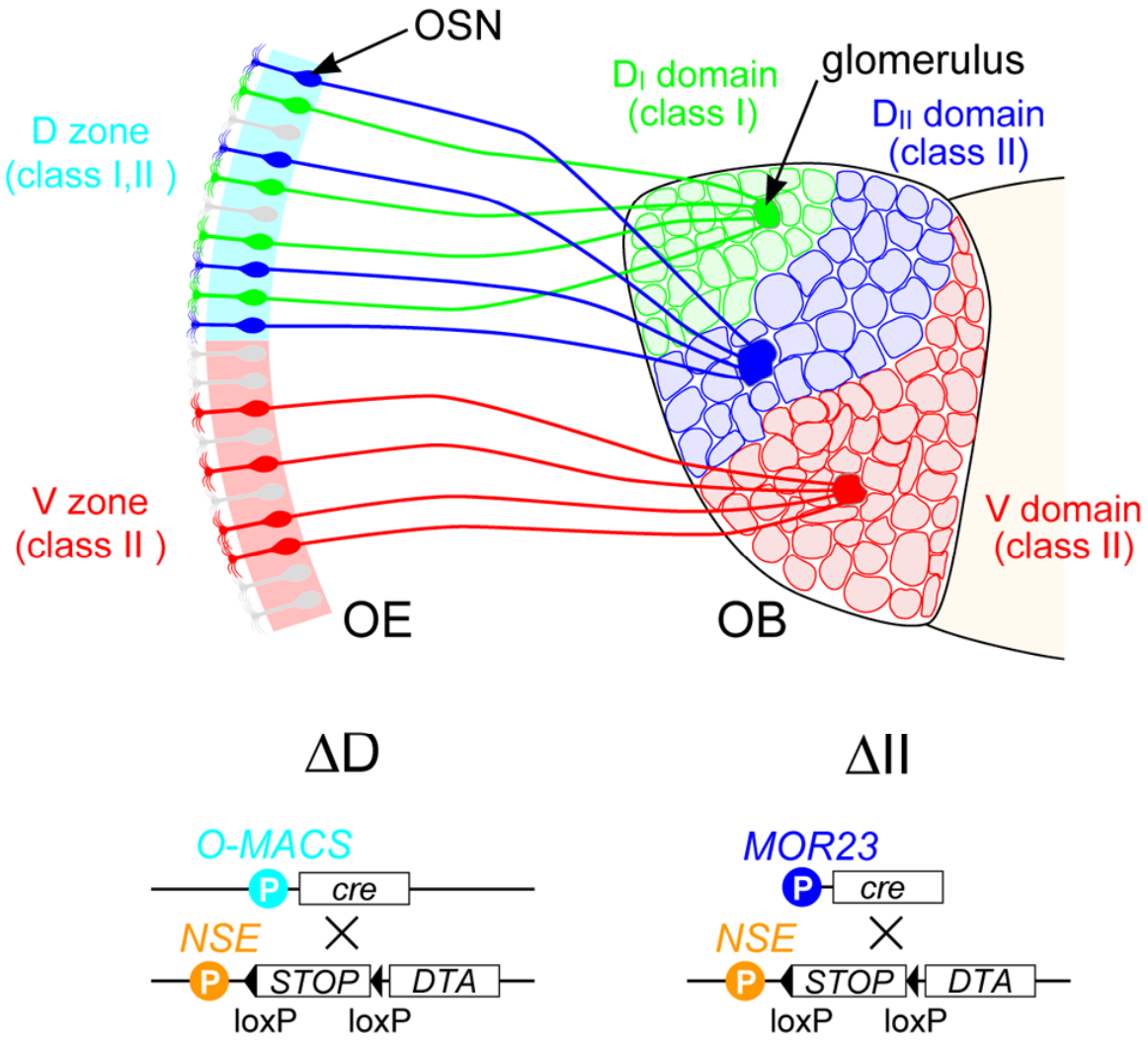
http://www.sciencedirect.com/science/journal/00928674
Volume 127, Issue 5, Shou Serizawa et al., A Neuronal Identity Code for the Odorant Receptor-Specific and Activity-Dependent Axon Sorting, Fig.8, Copyright (2006)National Academy of Sciences, U.S.A.

Domain-specific glomerular ablation



Kobayakawa *et al*. *Nature* **450**, 503 (2007)