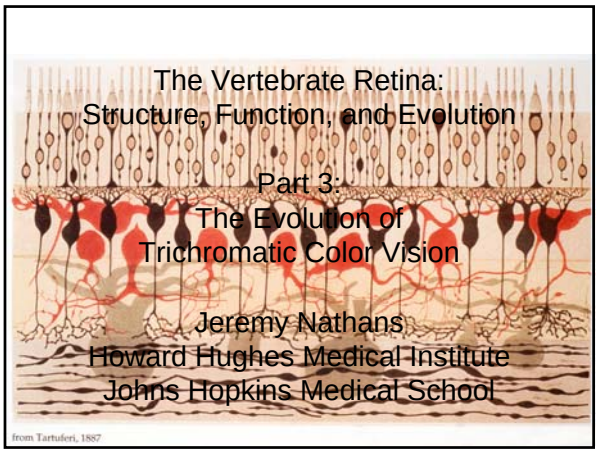
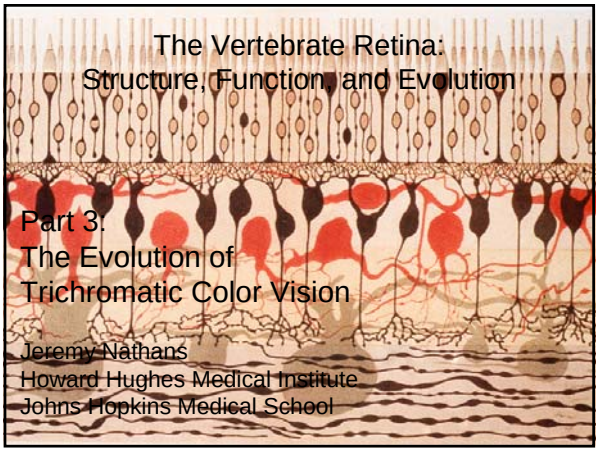

The Vertebrate Retina:
Structure, Function, and Evolution
Part 3:
The Evolution of
Trichromatic Color Vision
Jeremy Nathans
Howard Hughes Medical Institute
Johns Hopkins Medical School
from Tartuferi, 1887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How do we know if an animal has color vision?

Examples of primate diversity: Gibbons, Gorilla, Bushbaby

The natural habitats of primates

Under what circumstances is trichromacy better than dichromacy?

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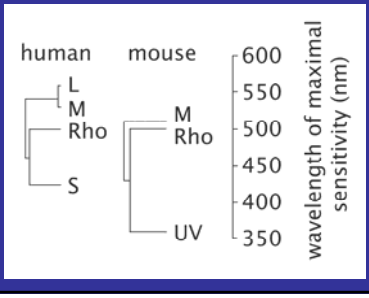
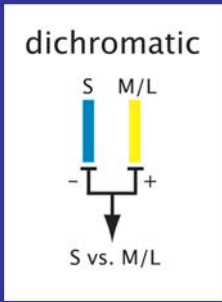
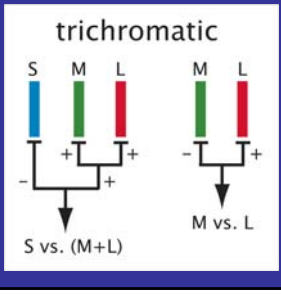
Sequence divergence of mammalian rod and cone pigments



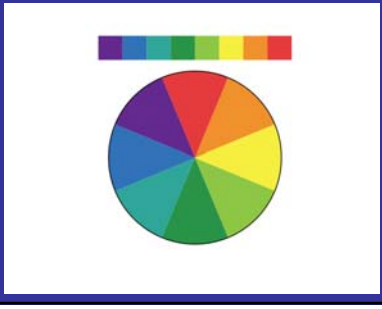
An ancient system for dichromatic color vision



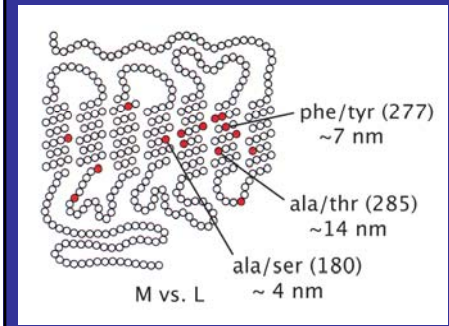
Trichromatic primates compare three cone signals along two dimensions



Human color perception converts a linear input (wavelength) into a circle



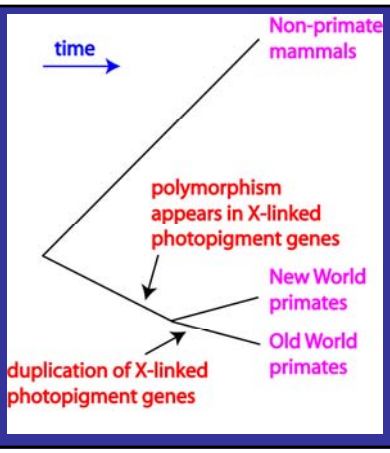
Three critical sites for L vs. M pigment spectral tuning



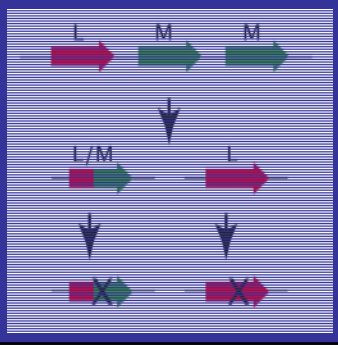
X-chromosome inactivation in female mammals

L vs. M spectral tuning mechanisms are conserved in New and Old World primates

	maximum sensitivity	amino acids at positions 180	277	285
Capuchin monkey (New World)				
	535 nm	ala	phe	ala
	550 nm	ala	phe	thr
	563 nm	ser	tyr	thr
Human (Old World)				
L M	530 nm (M)	ala	phe	ala
	560 nm (L)	ser	tyr	thr



A multi-step path to blue cone monochromacy



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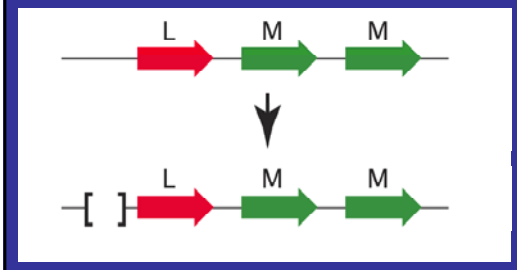
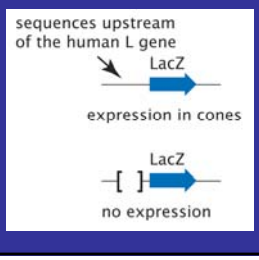
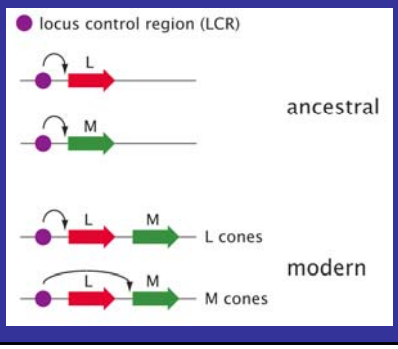


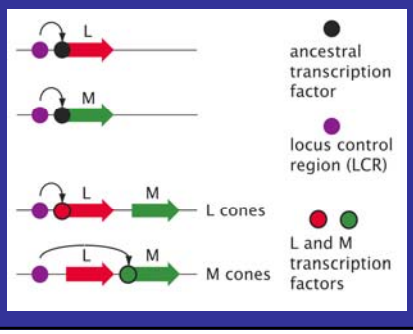
Sequences upstream of the human L pigment gene direct cone-specific expression in transgenic mice



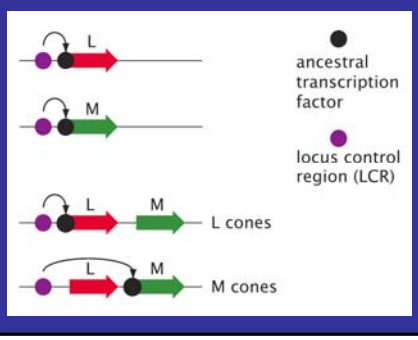
The locus control region and visual pigment gene expression



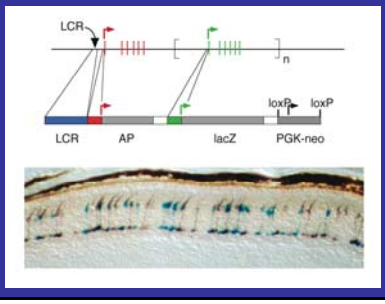
The standard model of cell type-specific gene expression



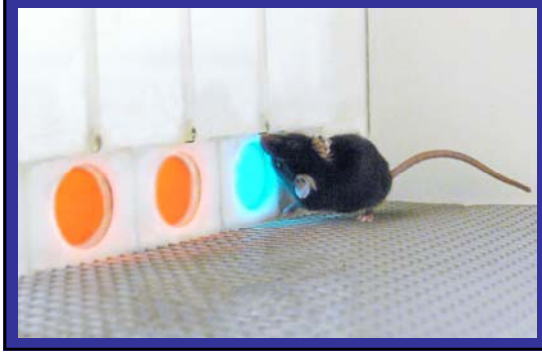
A stochastic model of cell type-specific gene expression



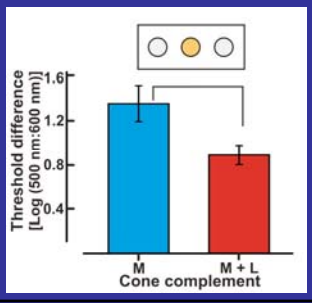
Mutually exclusive expression of L and M pigment genes in a transgenic mouse



A three-way forced choice test of color vision for mice



Enhanced long wavelength sensitivity in mice engineered to express human L pigment



Chromatic discrimination by female mice heterozygous for the human L pigment