Lecture 04 – The Eye

Today's Learning Objectives:

1. Describe the most important functional parts of the eye.
2. Describe the functionally important parts of the retina.
3. Discuss how the anatomy of the retina impacts vision.
4. Describe the roles of spatial frequency and contrast in pattern recognition.
5. Define five types of visual acuity.
6. Define aliasing and discuss how to avoid it.
7. Describe the effects of chromatic aberration on vision.

Model of Visual Perception

Stage 1: Parallel

- First pass processing
- Parallel
- Transitory
- Rapid
- Extraction of features
- Bottom-up, data-driven
- Understand visual salience

Stage 2: Patterns

- Visual field is divided up, used for pattern finding
- Top-down attention
- Flexible
- Slower
- Serial
- Where/ what split

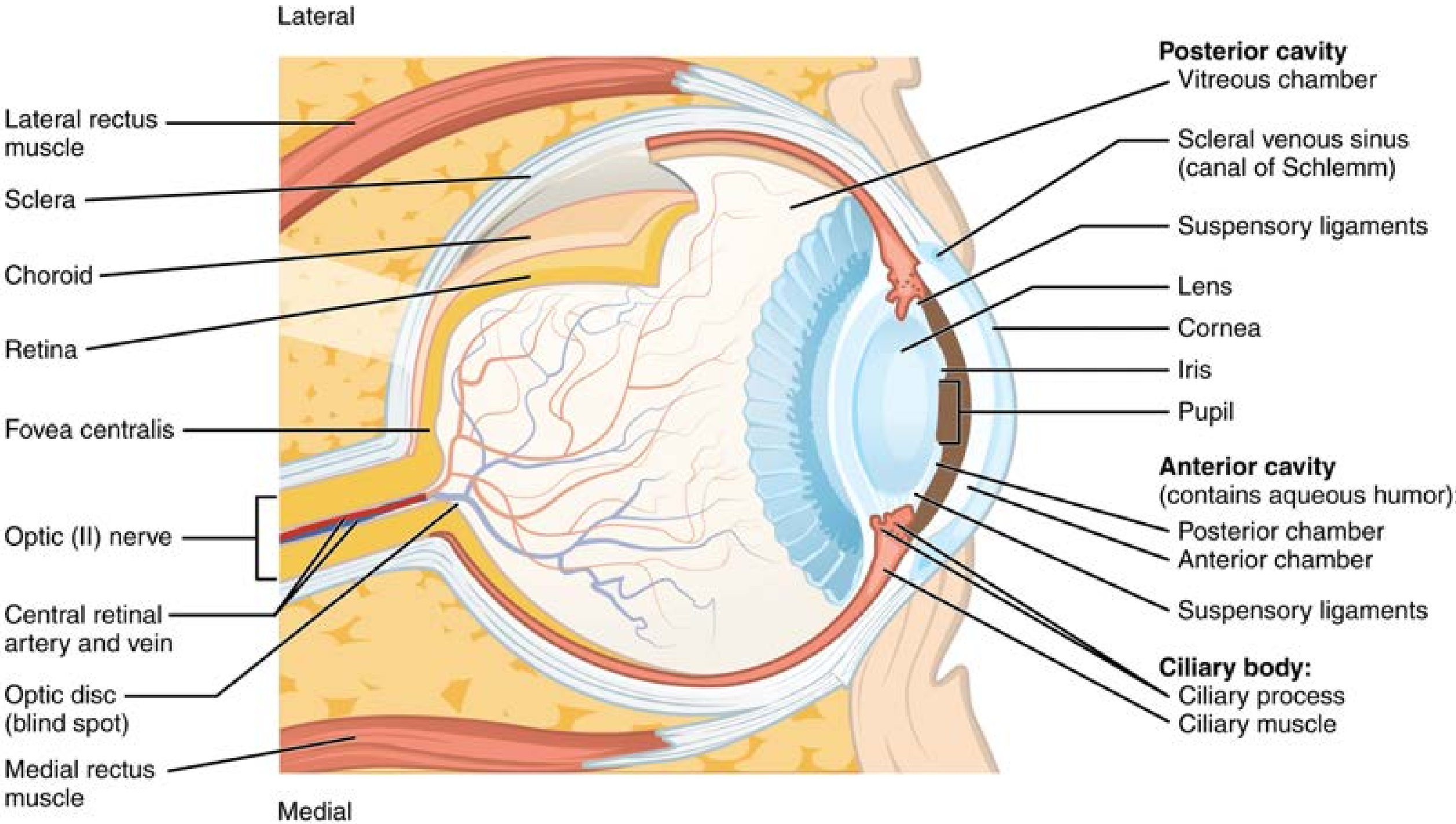
Stage 3: Visual Working Memory

- Small no. patterns (<4) passed to VWM
- Objects held in VWM by active attention
- Limited number of WM “slots” available

below awareness

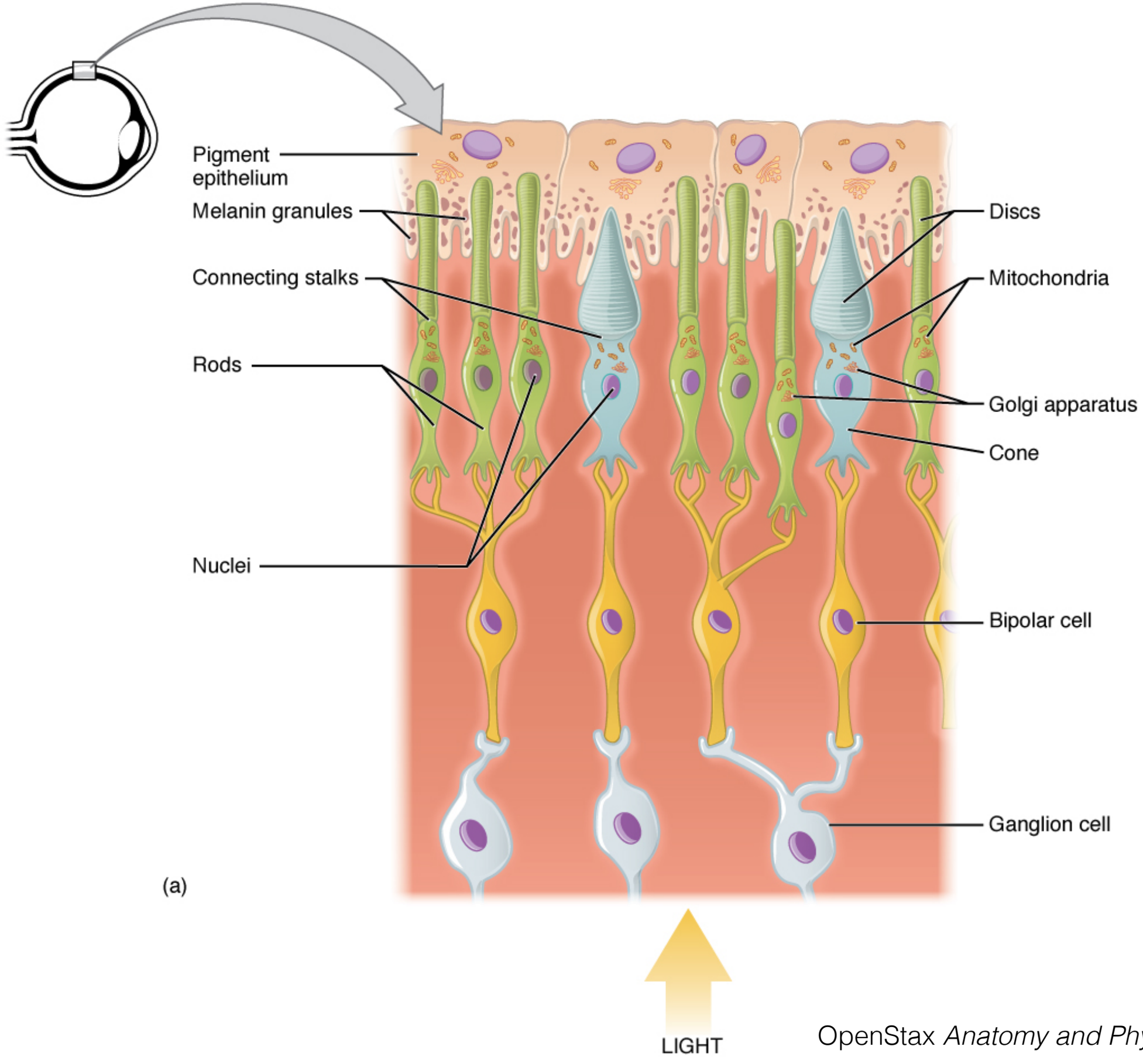
within awareness

Diagram of the Eye in cross section:



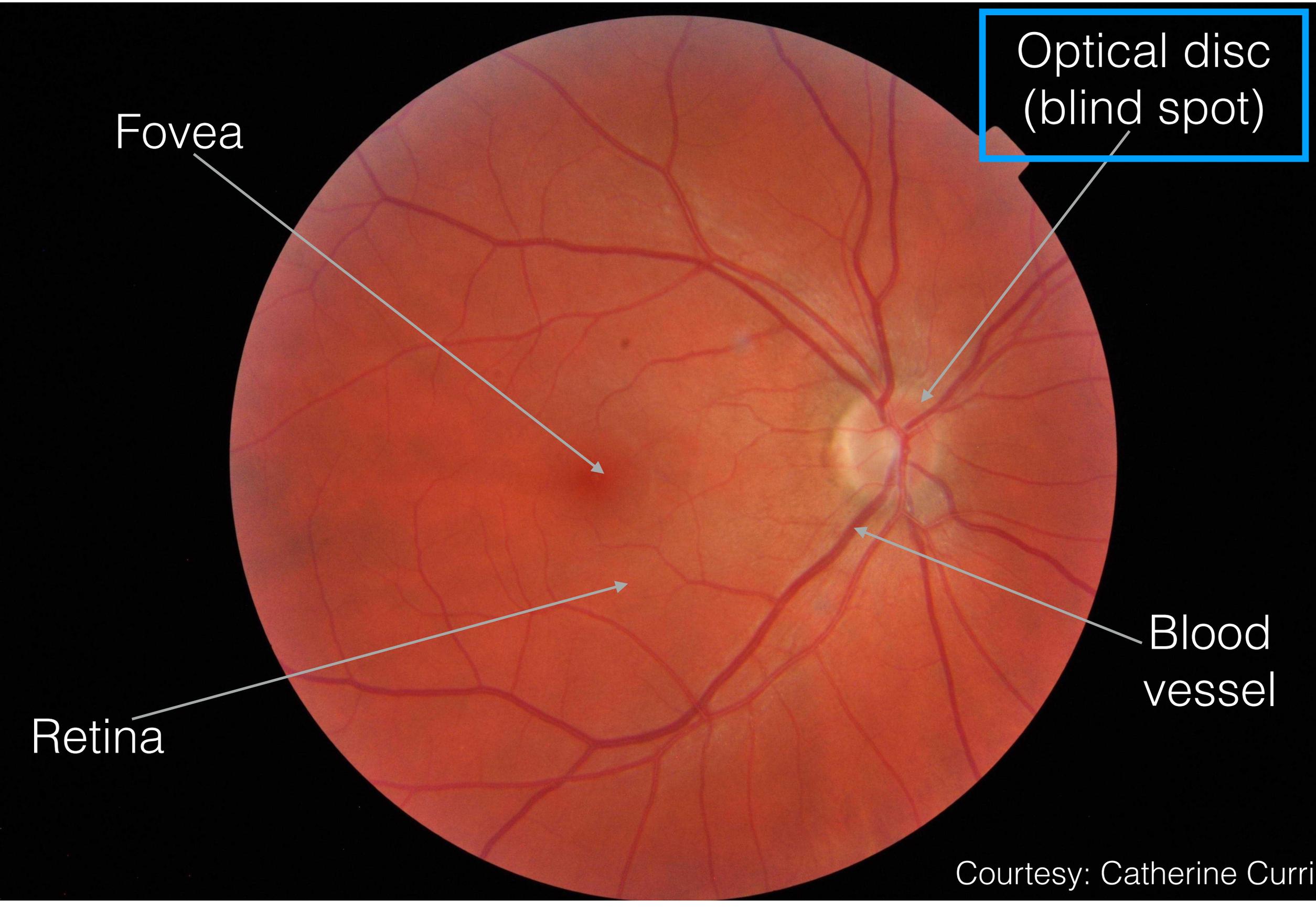
OpenStax *Anatomy and Physiology* Fig.14.15

Diagram of retinal tissue:



OpenStax *Anatomy and Physiology* Fig.14.16

This is my eyeball.

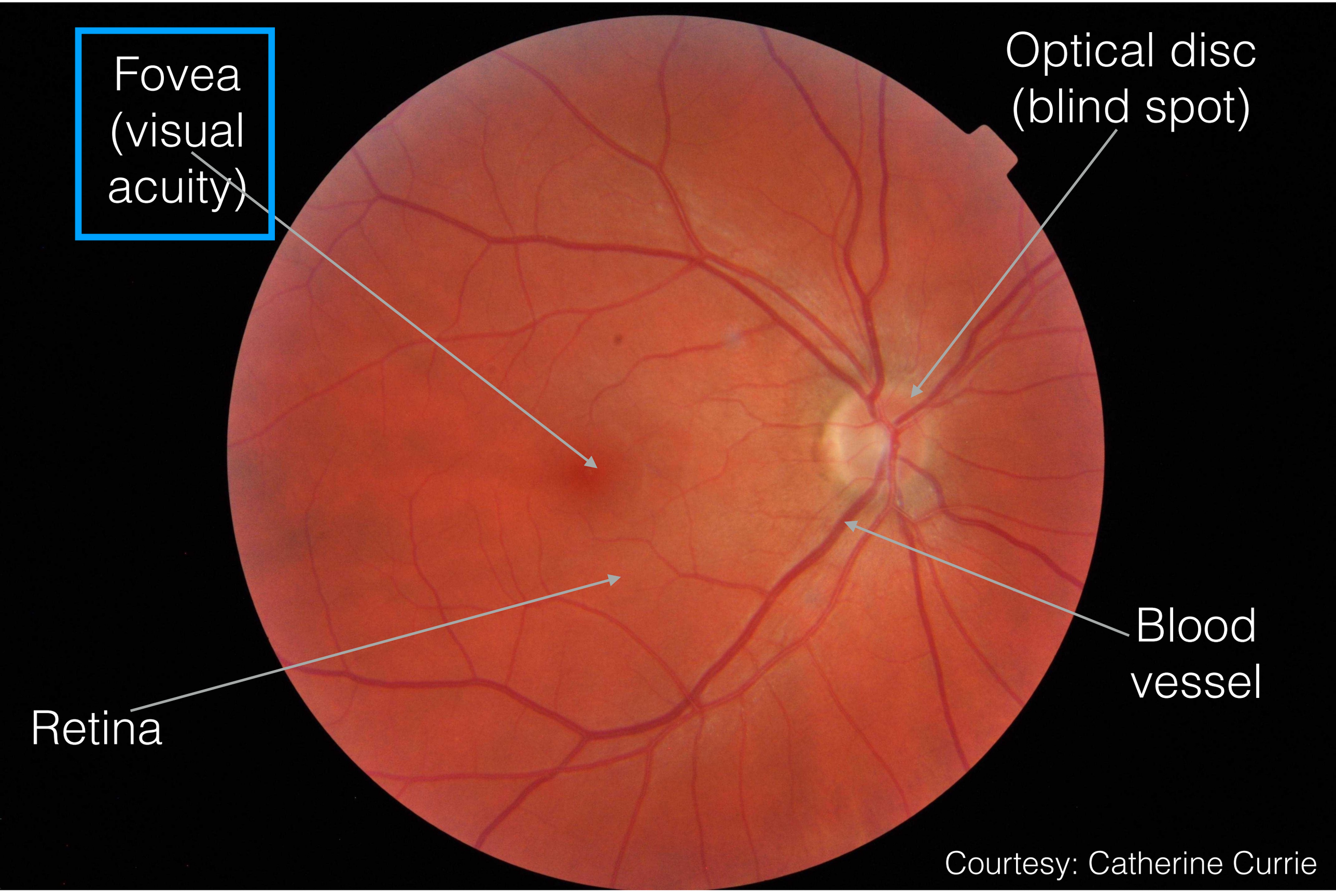


Find Your Blind Spot

O

X

This is my eyeball.

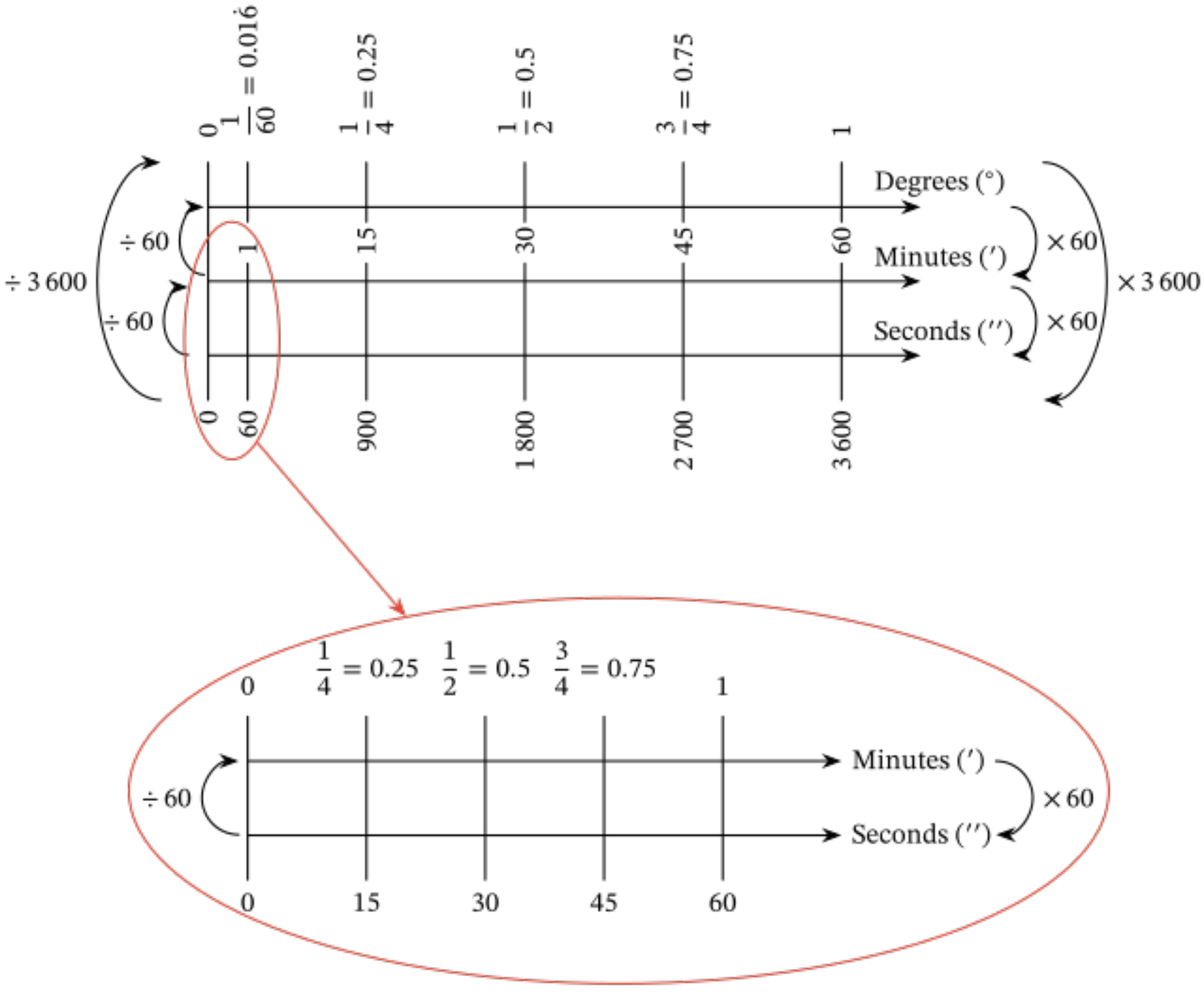


Defining Measurements of Arc

Circle has 360°

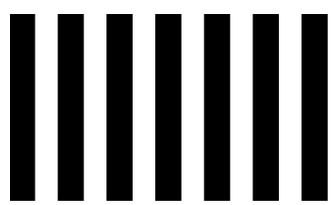
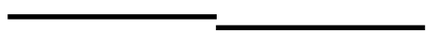
Each degree has 60’ (minutes)

Each minute has 60” (seconds)

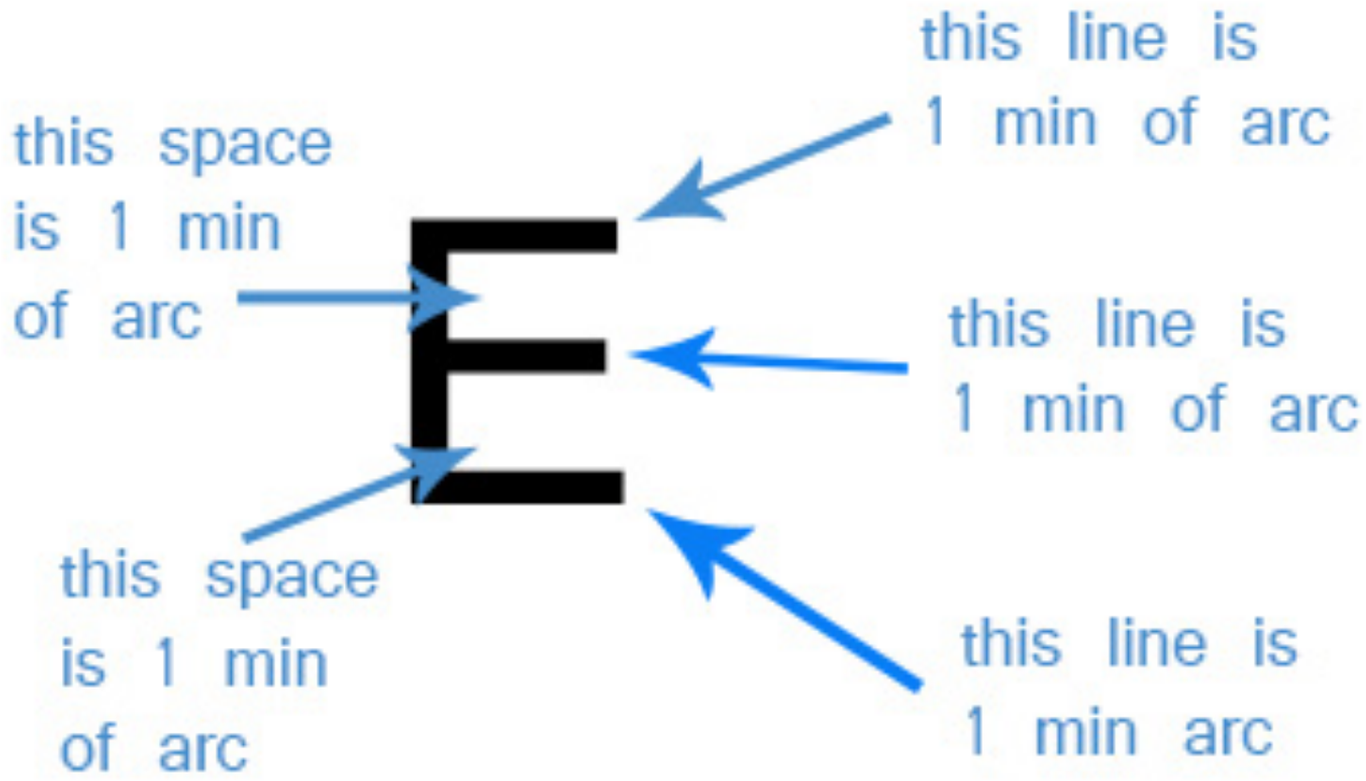


Nagwa Explainer

Defining Acuity

Acuity type	Demonstration	Human limit
Point acuity		1 minute of arc
Grating acuity		1-2 minutes of arc
Letter acuity	**E**	5 minutes of arc
Vernier acuity		10 seconds of arc

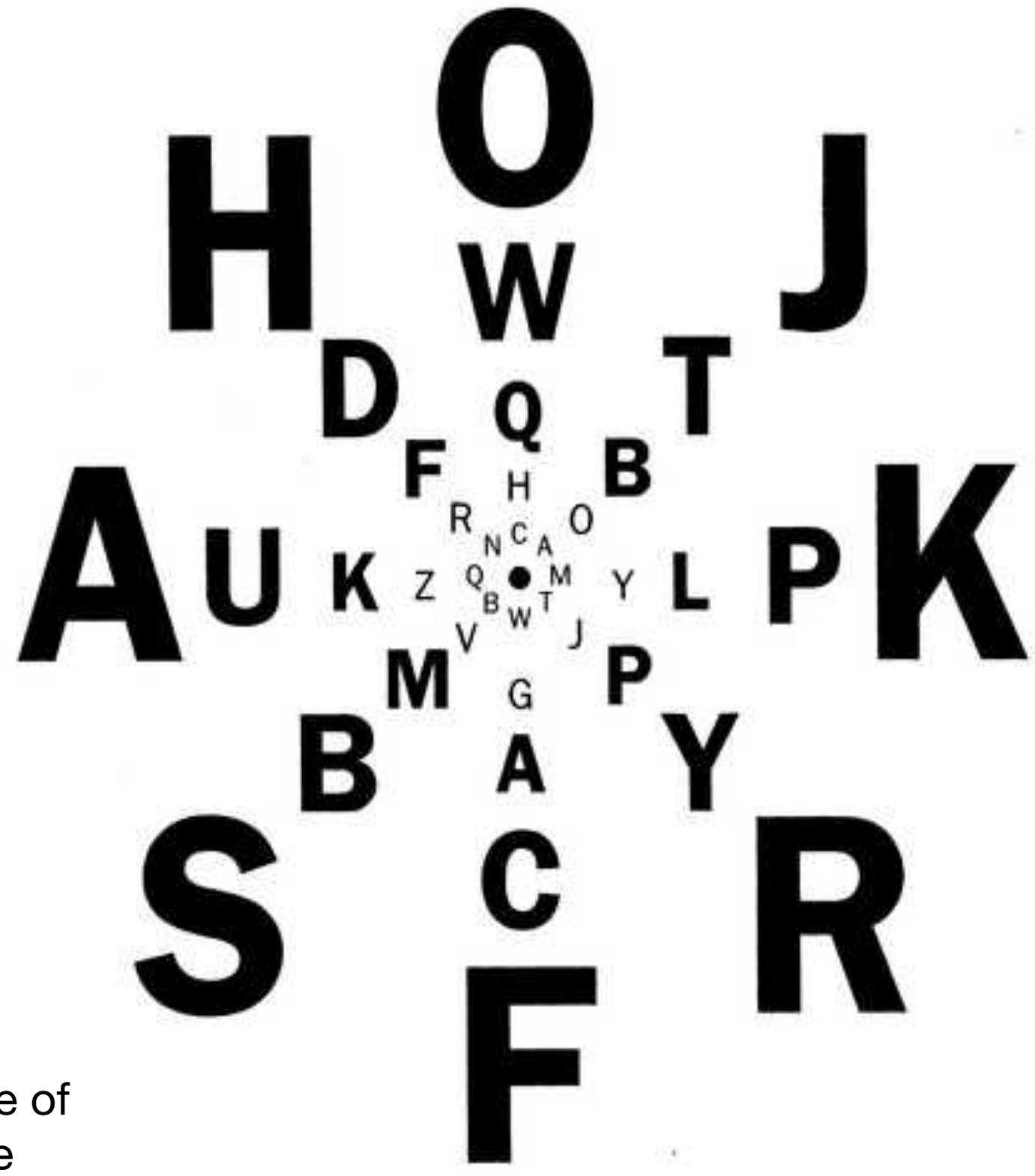
Defining Acuity



20/20 vision: separating 1 minute of arc at 20 feet (20 feet divided by 1 minute subtended by 5 minutes of arc or 20)

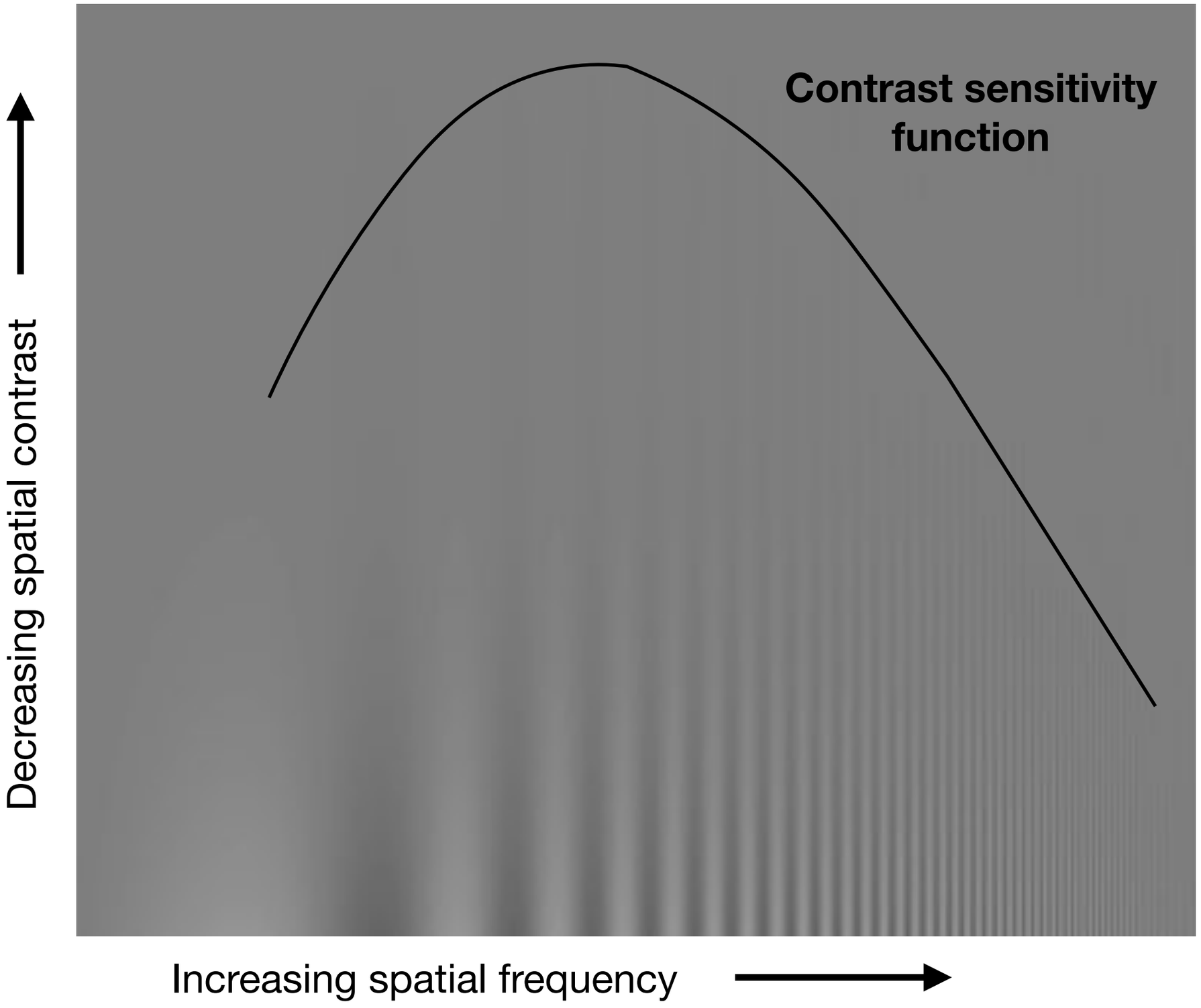
20/20 vision article

Acuity is high centrally and drops of peripherally



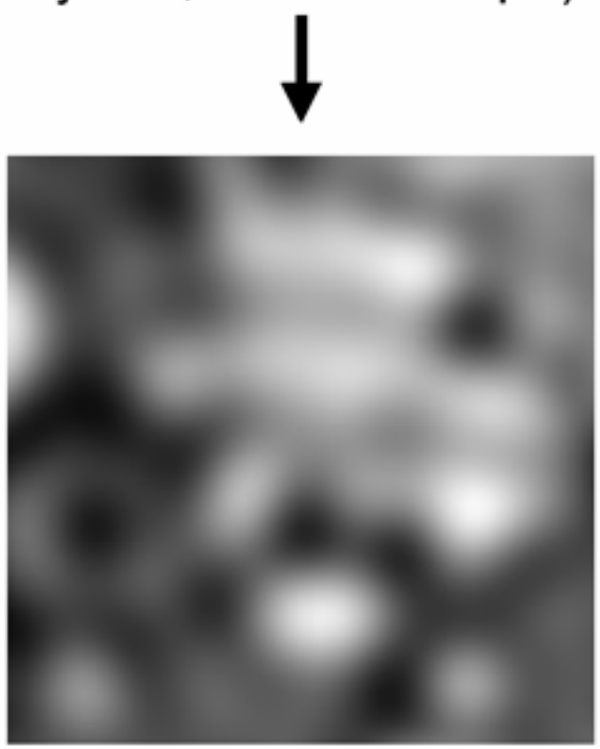
Each letter is the size of equal acuity from the center dot.

Spatial and Contrast Acuity (Ware Fig 2.25)



Spatial Frequency Channels

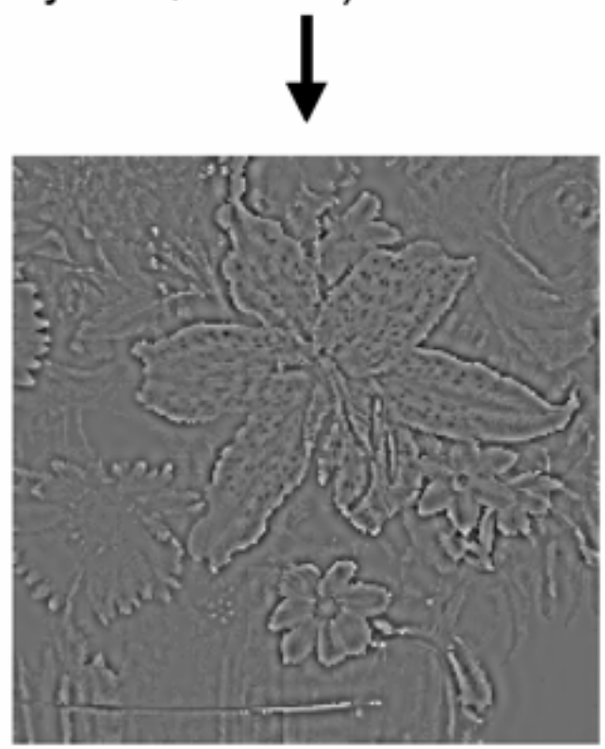
‘Low’ spatial frequency filters encode coarse luminance variations in the world (e.g. large objects, overall shape)



Coarse

Medium

‘High’ spatial frequency filters respond to the fine spatial structure of the world (e.g. small objects, detail)

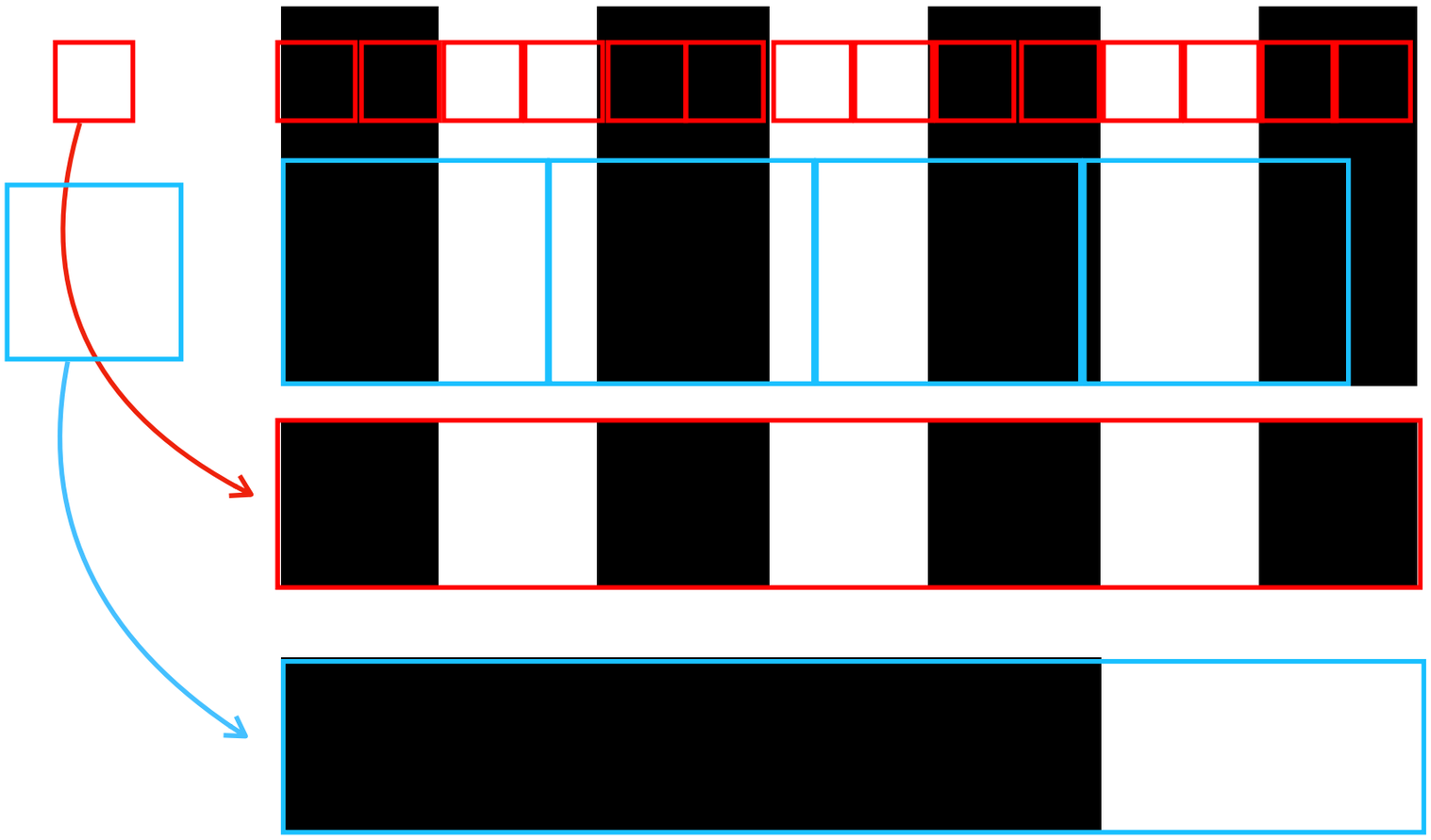


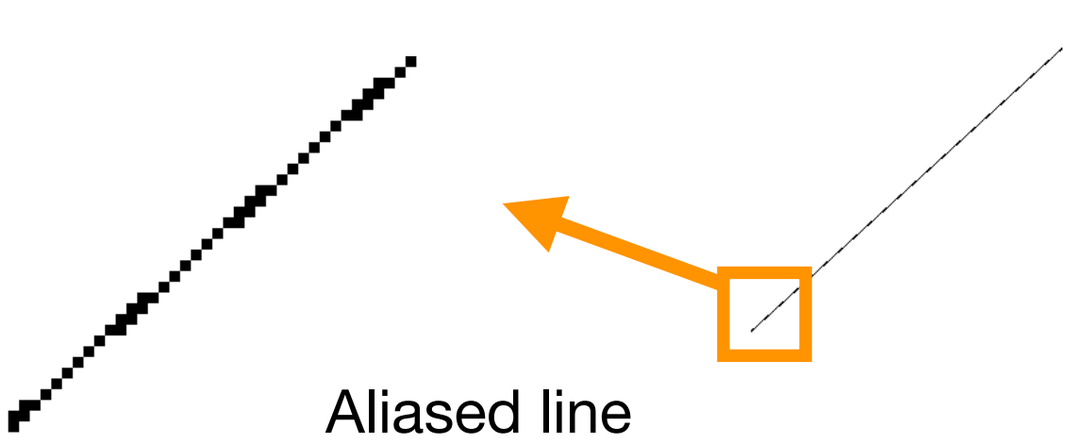
Fine

Image: M. Landy

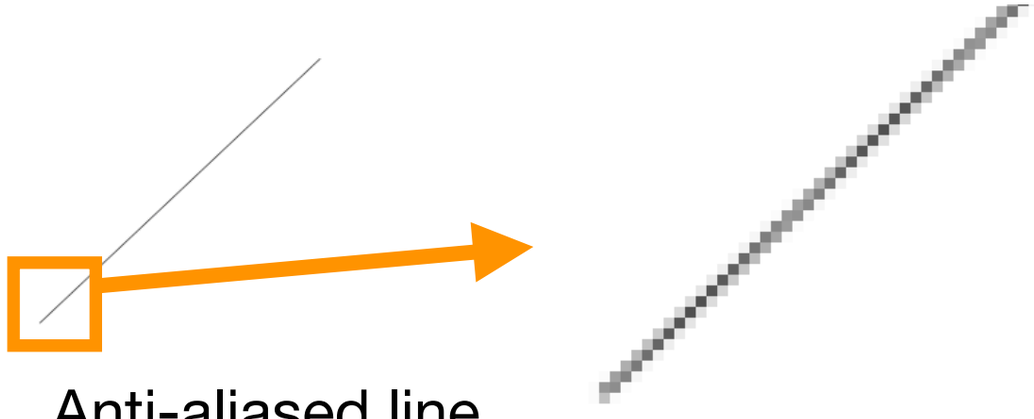
Sampling Frequencies and Aliasing

Nyquist limit - signal can be reconstructed only if sampling is twice the highest frequency of the source.





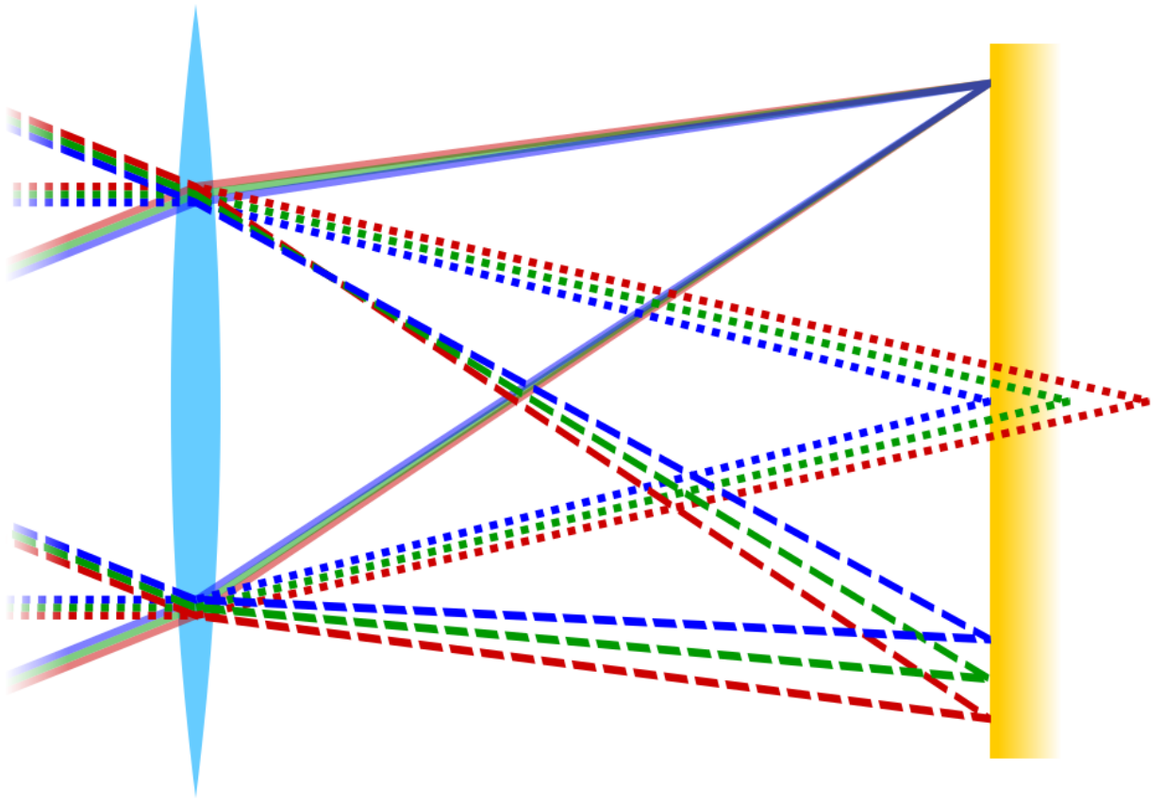
Aliased line

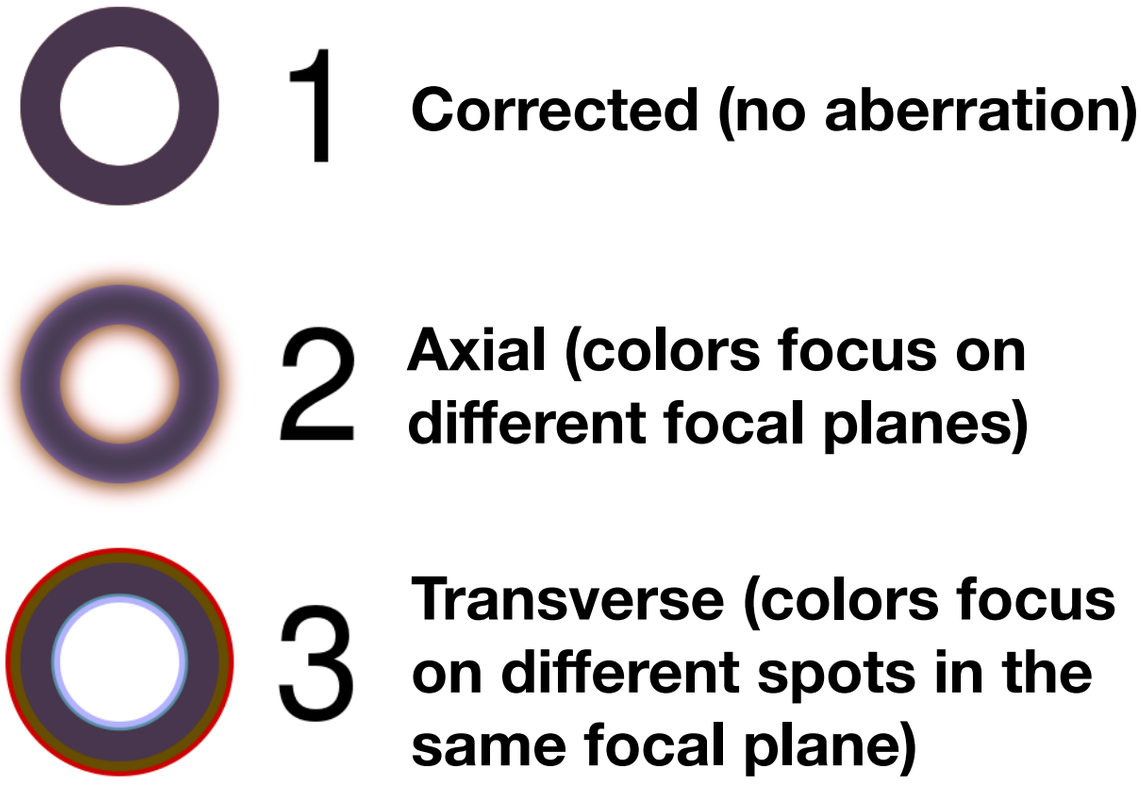


Anti-aliased line

Chromatic aberration (aka color fringing)

Failure of a lens to focus different colored wavelengths of light on the same point. Wavelengths of light have different refractive indices, so bend more traveling through a lens.





Chromatic aberration, Wikipedia

Chromatic Aberration (reproduced from Ware Fig 2.15)

Most people see the red

closer than the blue,

but some see the

opposite effect.

References:

OpenStax. 2017. *Anatomy and Physiology*. OpenStax Publishing. ISBN-10: 1-947172-04-2

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M Landy. Perception Lecture Notes: Spatial Frequency Channels. https://www.cns.nyu.edu/~david/courses/perception/lecturenotes/channels/channels.html

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20/20 Vision: what does it mean? https://www.wehelpchicagosee.com/blog/2012/07/08/20-20-vision-what-does-it-85094