511-2017-10-18-action-l

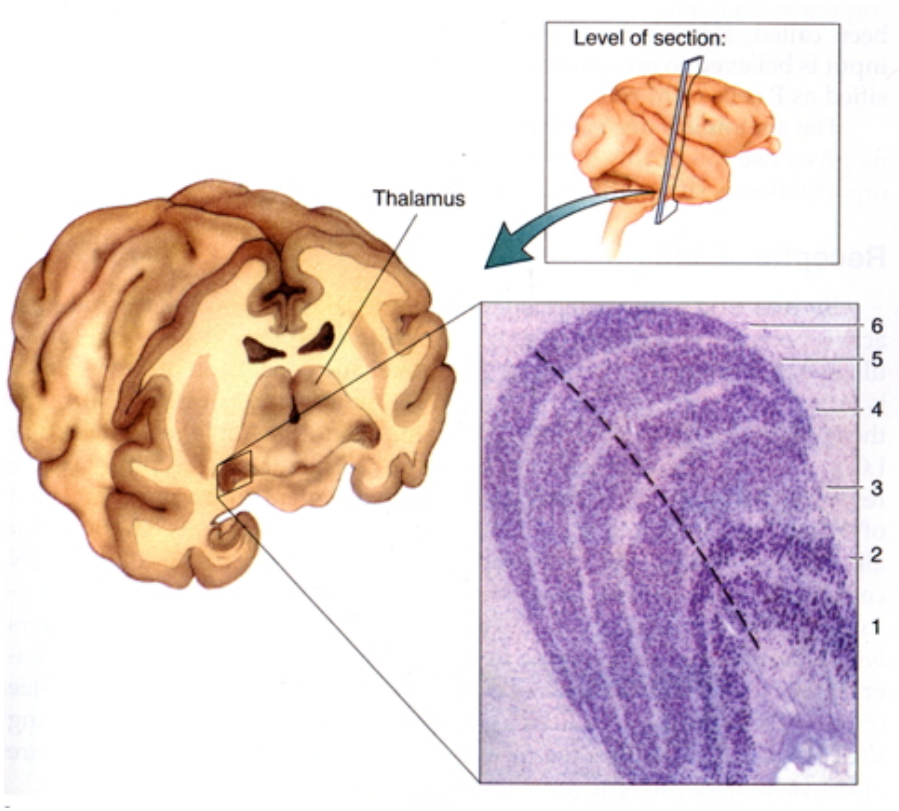
Rick Gilmore

2017-10-17 08:26:39

Today's Topics

- Quiz 2 available now; due by start of class on Wed, 10/25
- Wrap up on vision
- The neuroscience of action

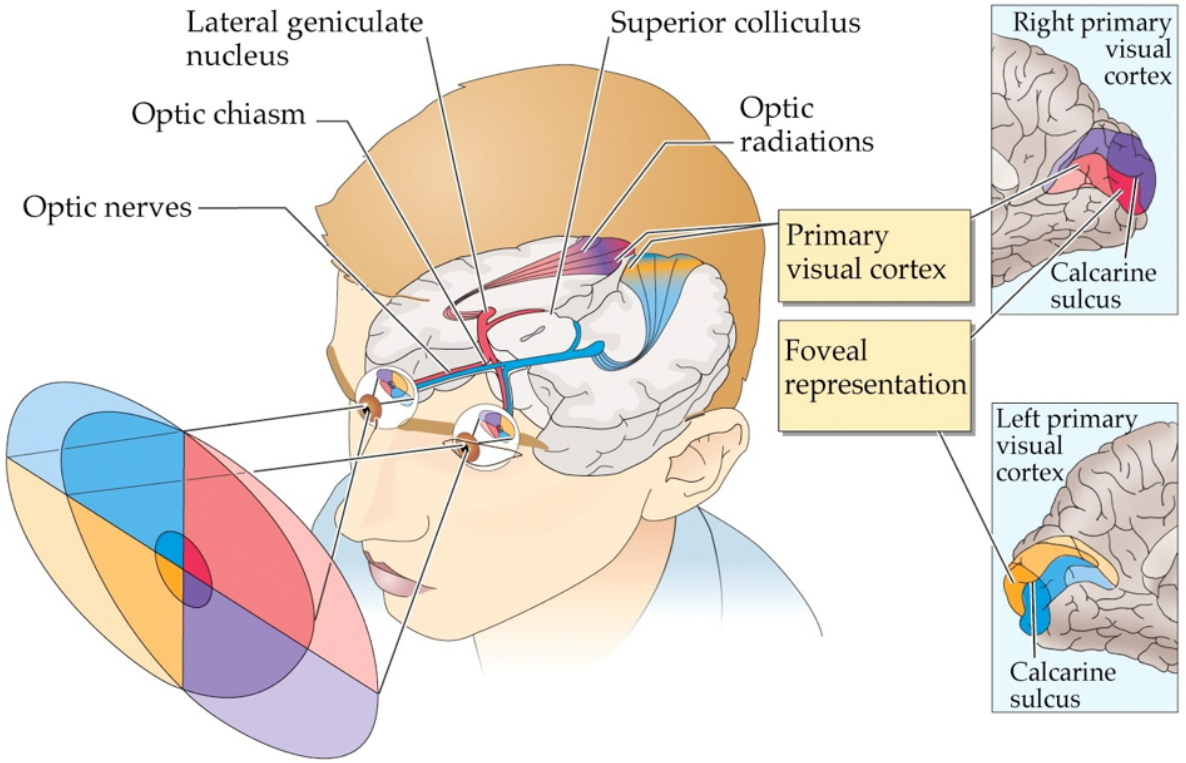
LGN



LGN

- 6 layers + intralaminar zone
  - Parvocellular (small cells): chromatic
  - Magnocellular (big cells): achromatic
  - Koniocellular (chromatic - short wavelength?)
- Retinotopic map of opposite visual field

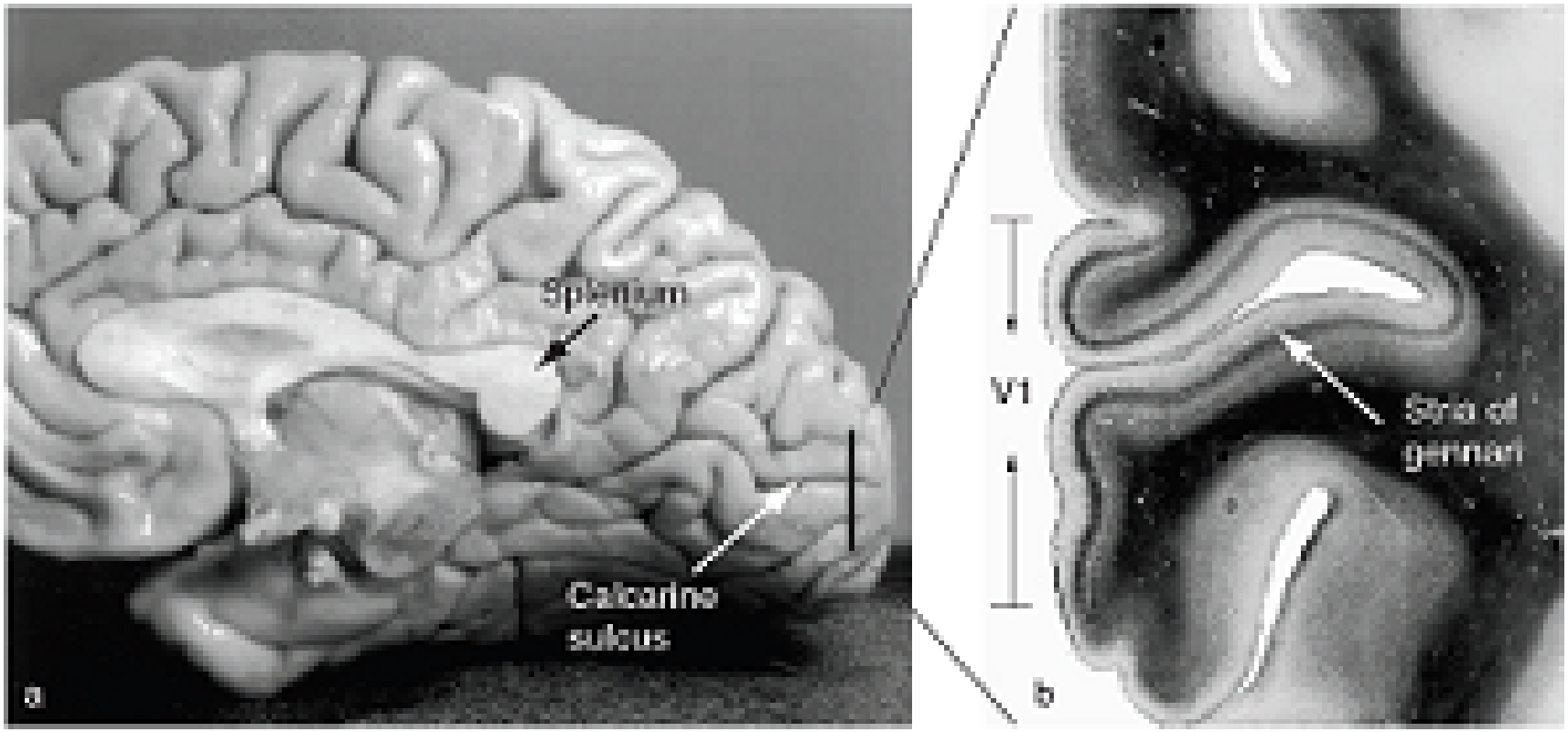
From LGN to V1



From LGN to V1

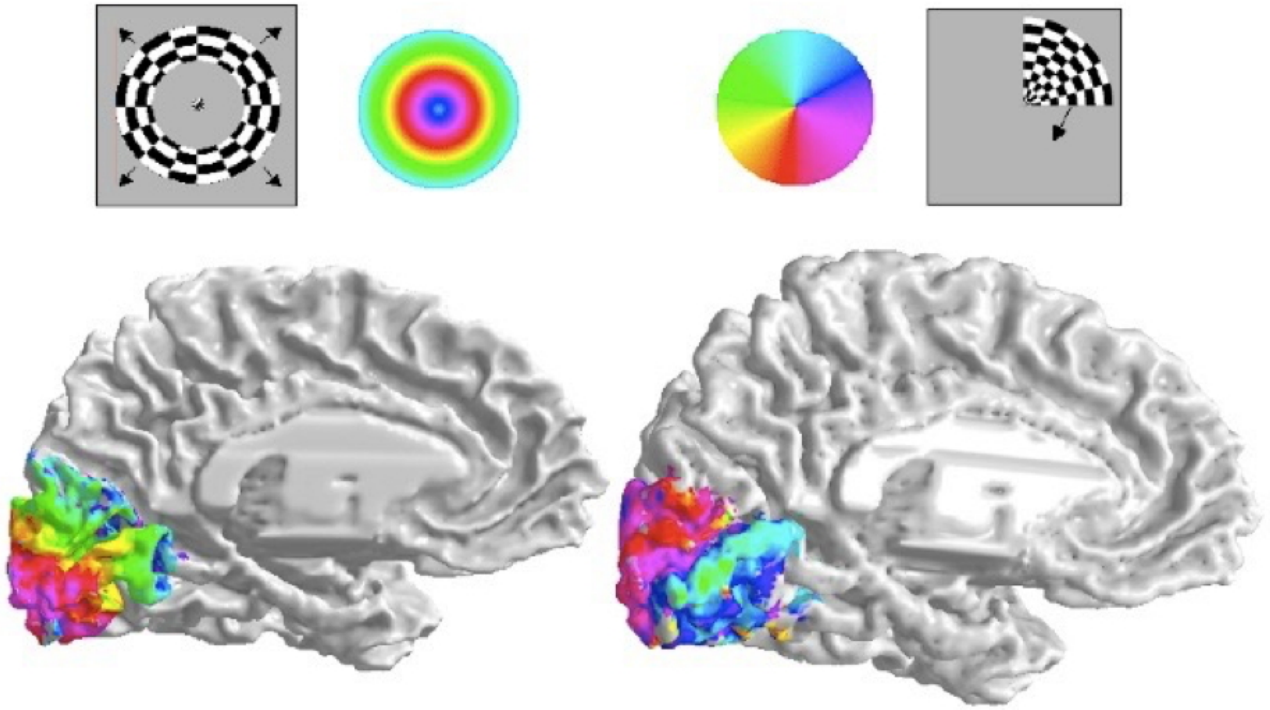
- Via *optic radiations*
- *Primary visual cortex (V1)* in occipital lobe
- Create "stria of Gennari" (visible stripe in layer 4)
- Calcarine fissure (medial occiptal lobe) divides lower/upper visual field

Human V1



http://www.scholarpedia.org/w/images/3/3a/03-Human-V1.png

Measuring retinotopy in V1

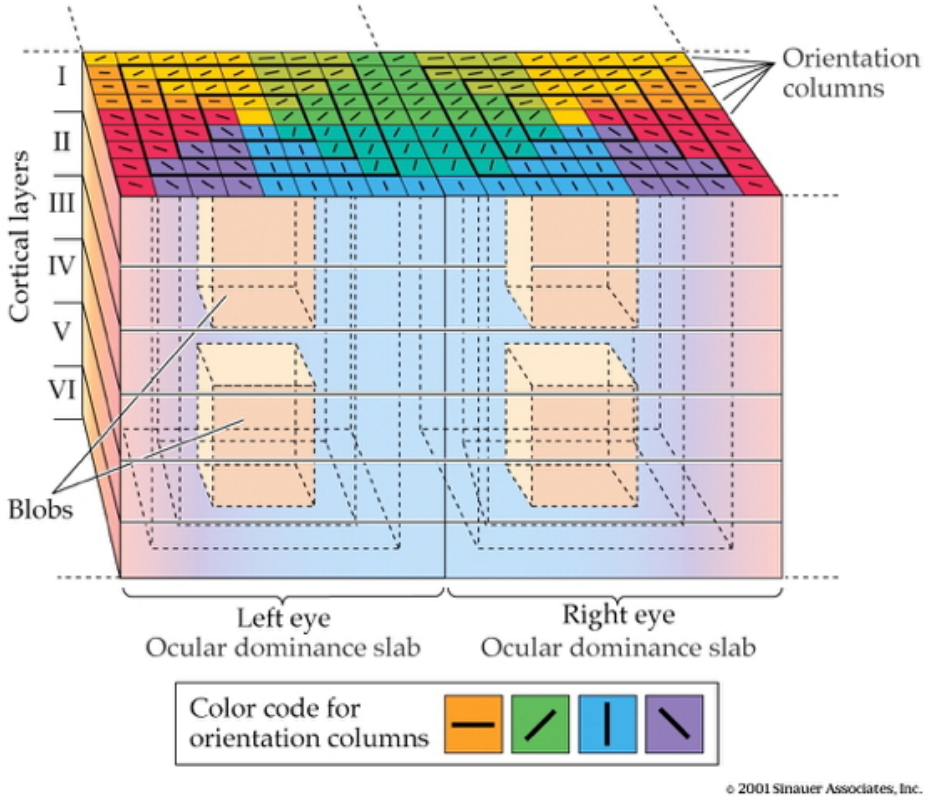


(Dougherty et al. 2003)

Retinotopy in V1

- Fovea overrepresented
  - Analogous to somatosensation
  - High acuity in fovea vs. lower outside it
- Upper visual field/lower (ventral) V1 and *vice versa*

V1 has laminar, columnar organization



V1 has laminar, columnar organization

- 6 laminae (layers)
  - Input: Layer 4 (remember stria of Gennari?)
  - Output: Layers 2-3 (to cortex), 5 (to brainstem), 6 (to LGN)

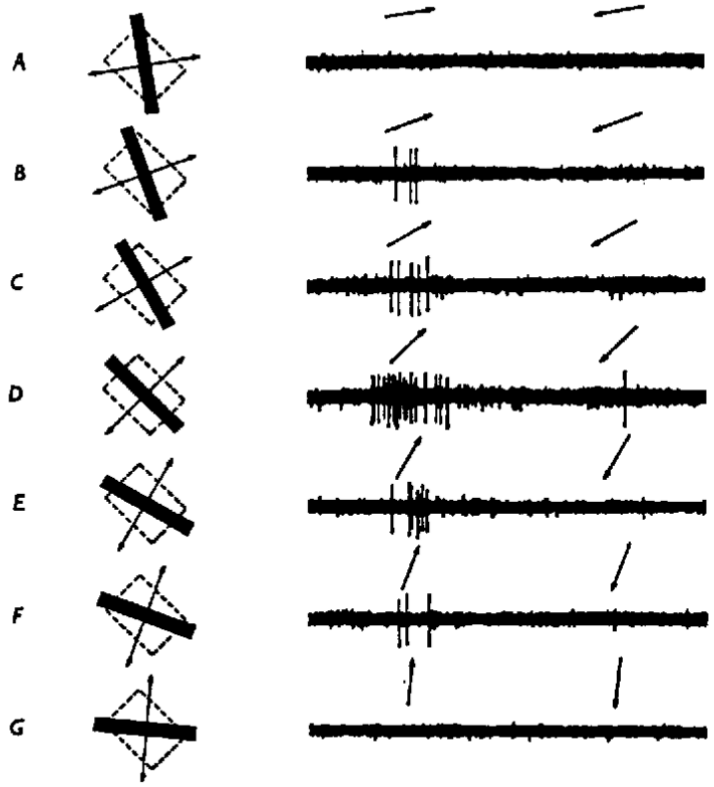
V1 has laminar, columnar organization

- Columns
  - Orientation/angle
  - Spatial frequency

The "accidental" discovery of oriented receptive fields in V1

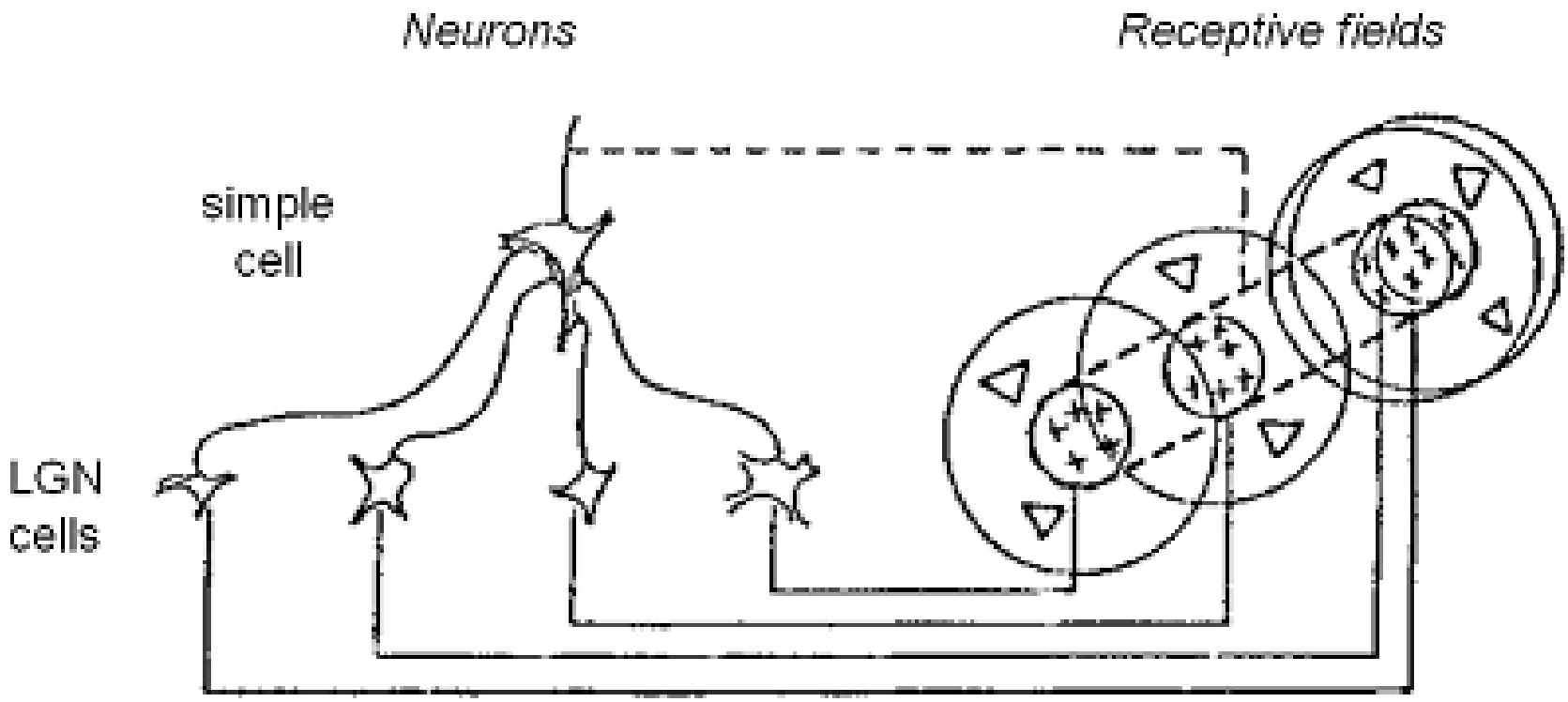
Hubel and Wiesel Cat Experiment

Orientation/angle tuning



https://foundationsofvision.stanford.edu/wp-content/uploads/2012/02/dir.selective.png

From center-surround receptive fields to line detection



Spatial frequency tuning

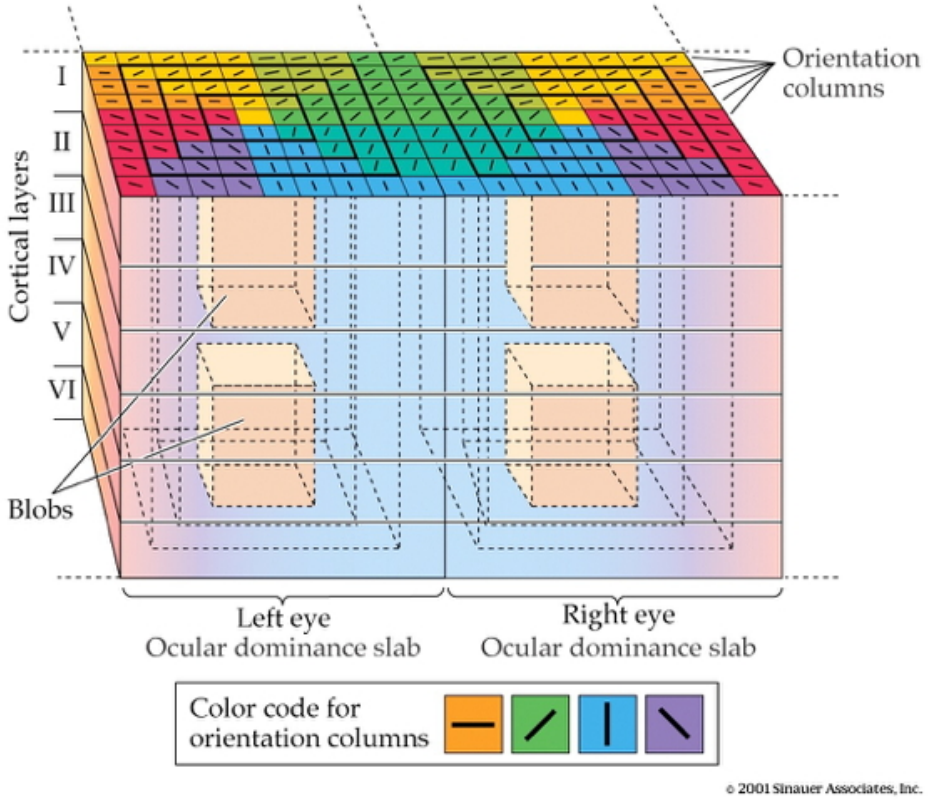
Low == gist || high == details

(Panichello, Cheung, and Bar 2013)

V1 has laminar, columnar organization

- Columns
  - Color/wavelength
  - Eye of origin, *ocular dominance*

Ocular dominance columns

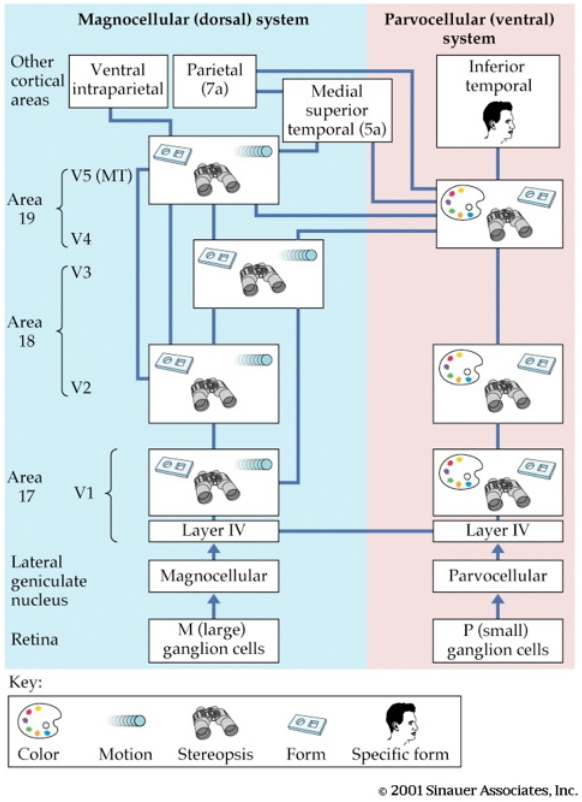


Ocular dominance signals retinal disparity

Cloudy with a Chance of Meatballs 3D Snippet (yt3d:enable=true)

http://www.scholarpedia.org/w/images/9/99/11-Hubel-Wiesel-model.png

Beyond V1


Magnocellular (dorsal) system
Parvocellular (ventral) system
Other cortical areas
Ventral intraparietal
Parietal (7a)
Medial superior temporal (5a)
Inferior temporal
Area 19
V5 (MT)
V4
Area 18
V3
V2
Area 17
V1
Layer IV
Layer IV
Lateral geniculate nucleus
Magnocellular
Parvocellular
Retina
M (large) ganglion cells
P (small) ganglion cells
Key:
Color
Motion
Stereopsis
Form
Specific form
© 2001 Sinauer Associates, Inc.

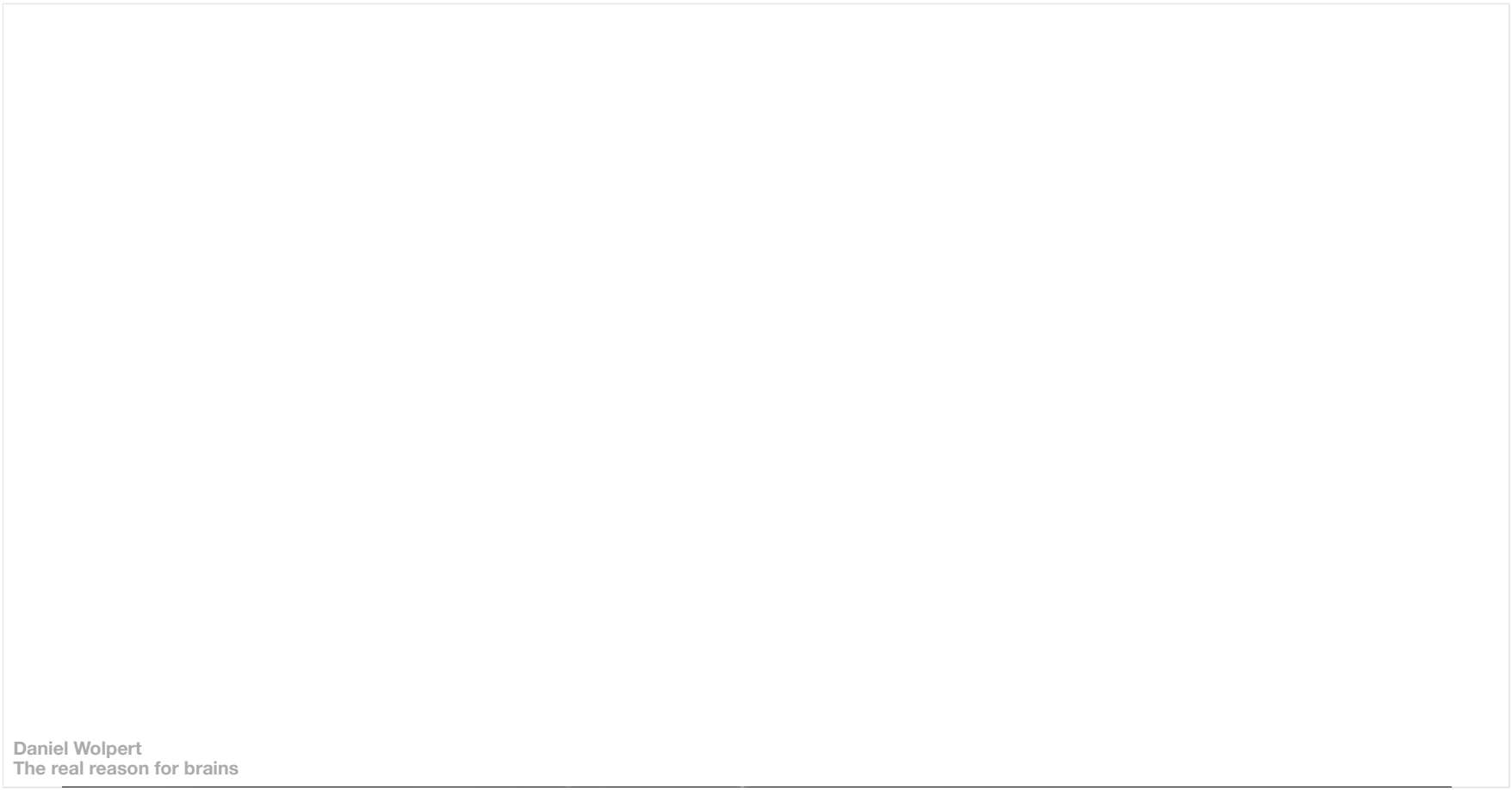
Beyond V1

- Larger, more complex receptive fields
- *Dorsal stream* (where/how)
    - Toward parietal lobe
- *Ventral stream* (what)

What is vision for?

- What is it? (form perception)
- Where is it? (space perception)
- How do I get from here to there (action control)
- What time (or time of year) is it?

The Real Reason for Brains



Daniel Wolpert
The real reason for brains

The neuroscience of action

- What types of actions are there?
- How are they produced?
  - By the muscles
  - By the nervous system

Remember

- Nervous system "output" includes
  - Movements
  - Autonomic responses
  - Endocrine responses

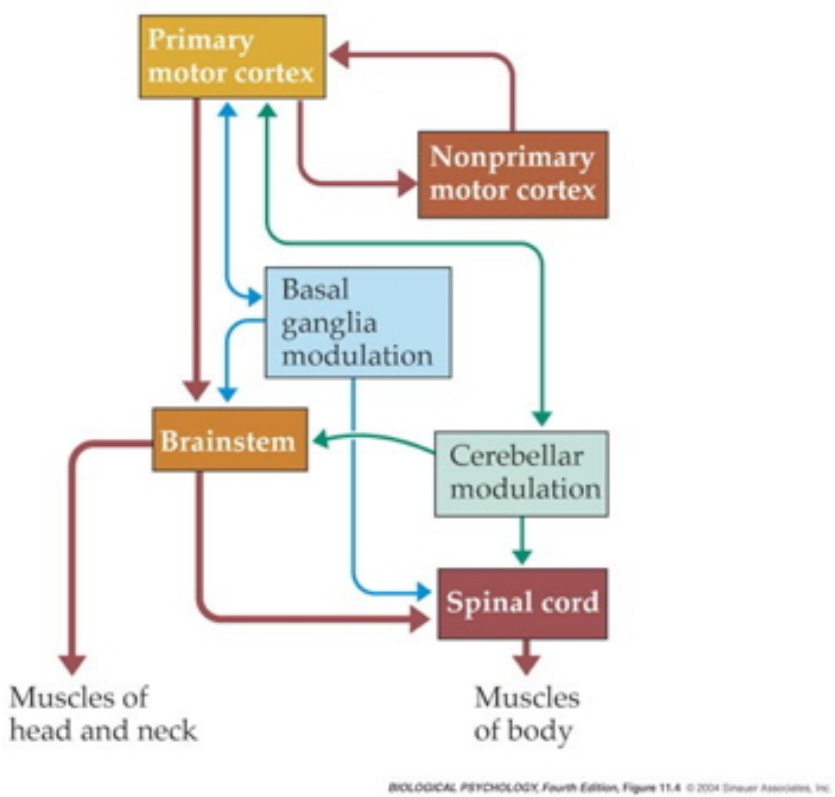
Types of actions

http://www.kidport.com/reflib/science/humanbody/musculars

Types of actions

- Reflexes
  - Simple, highly stereotyped, unlearned, rapid
- vs. Planned or voluntary actions
  - Complex, flexible, acquired, slower
- Discrete (reaching) vs. rhythmic (walking)
- Ballistic (no feedback) vs. controlled (feedback)

Multiple, parallel controllers



Key "nodes" in network

- Primary motor cortex (M1)
- Non-primary motor cortex
- Basal ganglia
- Brain stem
- Cerebellum
- Spinal cord

Muscle classes

- Axial
  - Trunk, neck, hips
- Proximal
  - Shoulder/elbow, pelvis/knee
- Distal
  - Hands/fingers, feet/toes

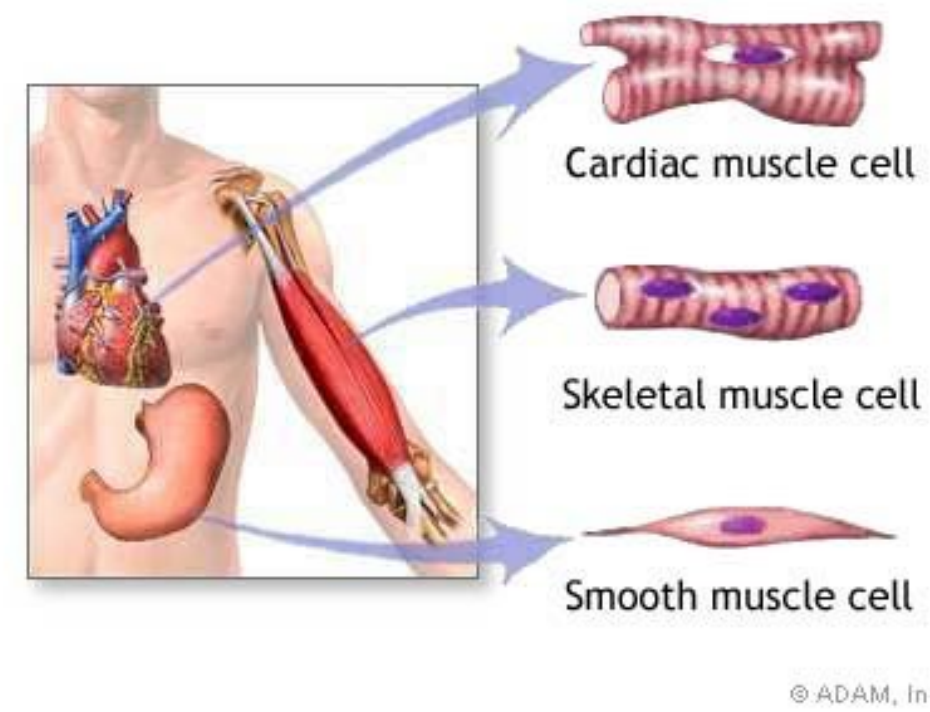
Muscles

http://classroom.sdmesa.edu/eschmid/F08.12a.L.150.jpg

Muscle types

- Smooth
  - Arteries, hair follicles, uterus, intestines
  - Regulated by ANS (involuntary)
- Striated (striped)
  - Skeletal
  - Voluntary control, mostly connected to tendons and bones
- Cardiac

Muscle types

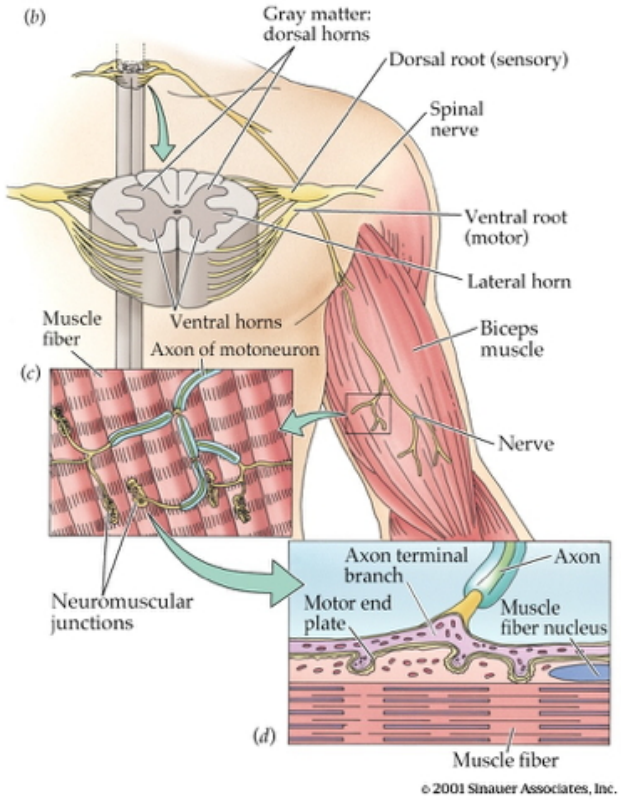


http://graphics8.nytimes.com/images/2007/08/01/health/adam/

How skeletal muscles contract

- Motoneuron (ventral horn of spinal cord)
- Neuromuscular junction
    - Releases ACh

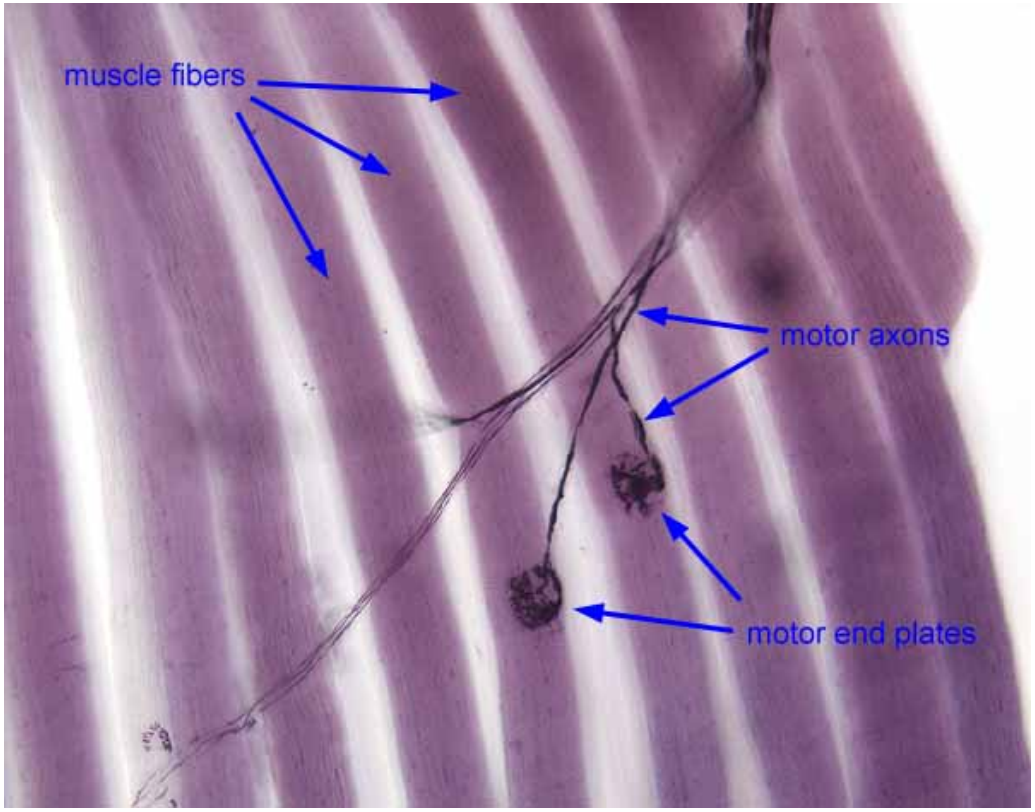
From spinal cord to muscle



How skeletal muscles contract

- Motor endplate
  - Nicotinic ACh receptor
- Excitatory endplate potential
  - Muscle fibers depolarize
  - Depolarization spreads along fibers like an action potential
  - Sarcomeres are segments of fibers
  - Intramuscular stores release Ca++

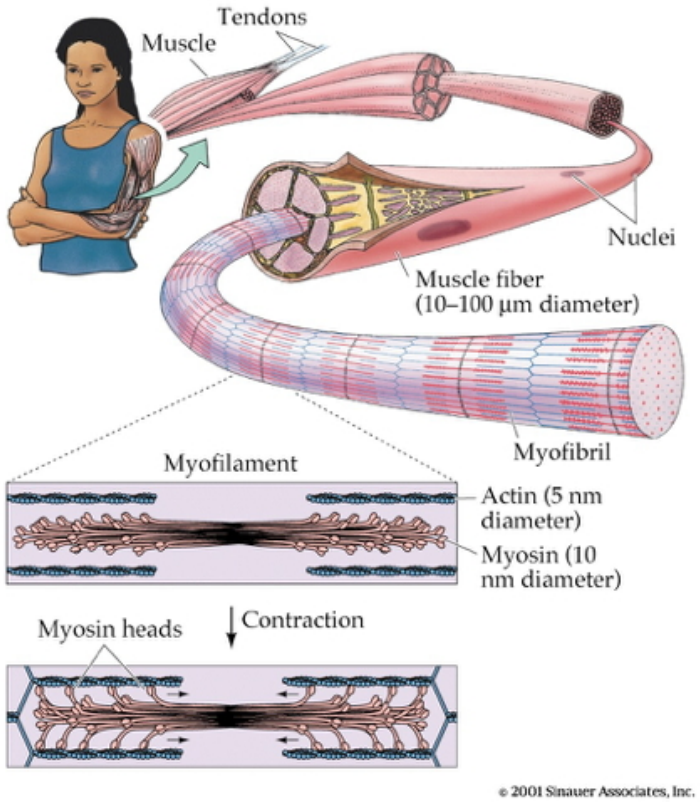
Motor endplate



How skeletal muscles contract

- Myofibrils (w/in sarcomere)
  - Actin & mysosin proteins
  - “Molecular gears”
- Bind, move, unbind in presence of Ca++, ATP

Anatomy of muscle fibers

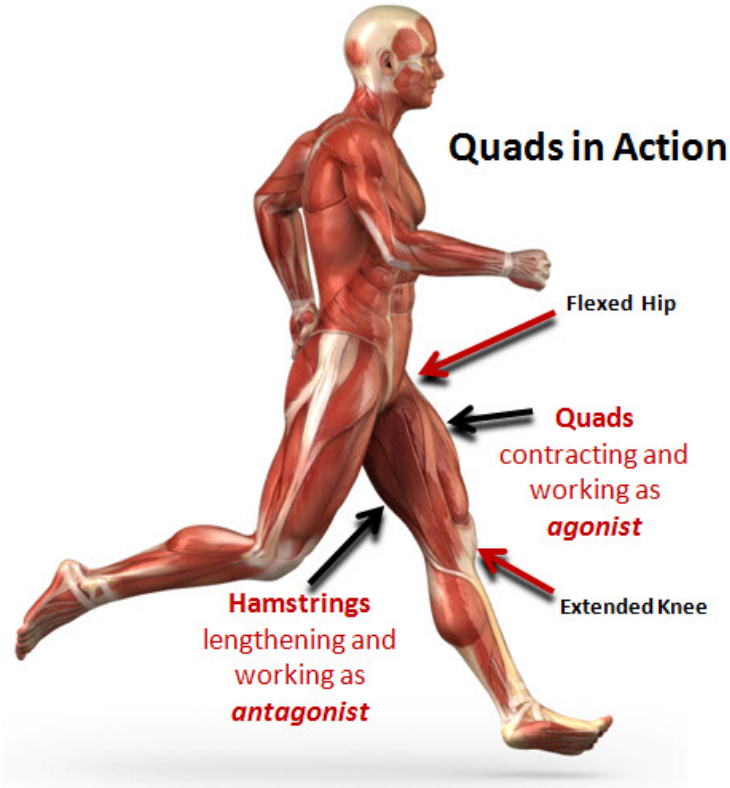


Anatomy of motor endplate

Muscle contraction

Muscle Contraction Process Molecular Mechanism 3D Animation

Agonist/antagonist muscle pairs



http://2.bp.blogspot.com/-TpOC4my_NBc/T0J-MhEv29I/AAAAAAAAF88/dYLv7QzFwmg/s1600/Hamstring-Quad4.jpg

Meat preference?

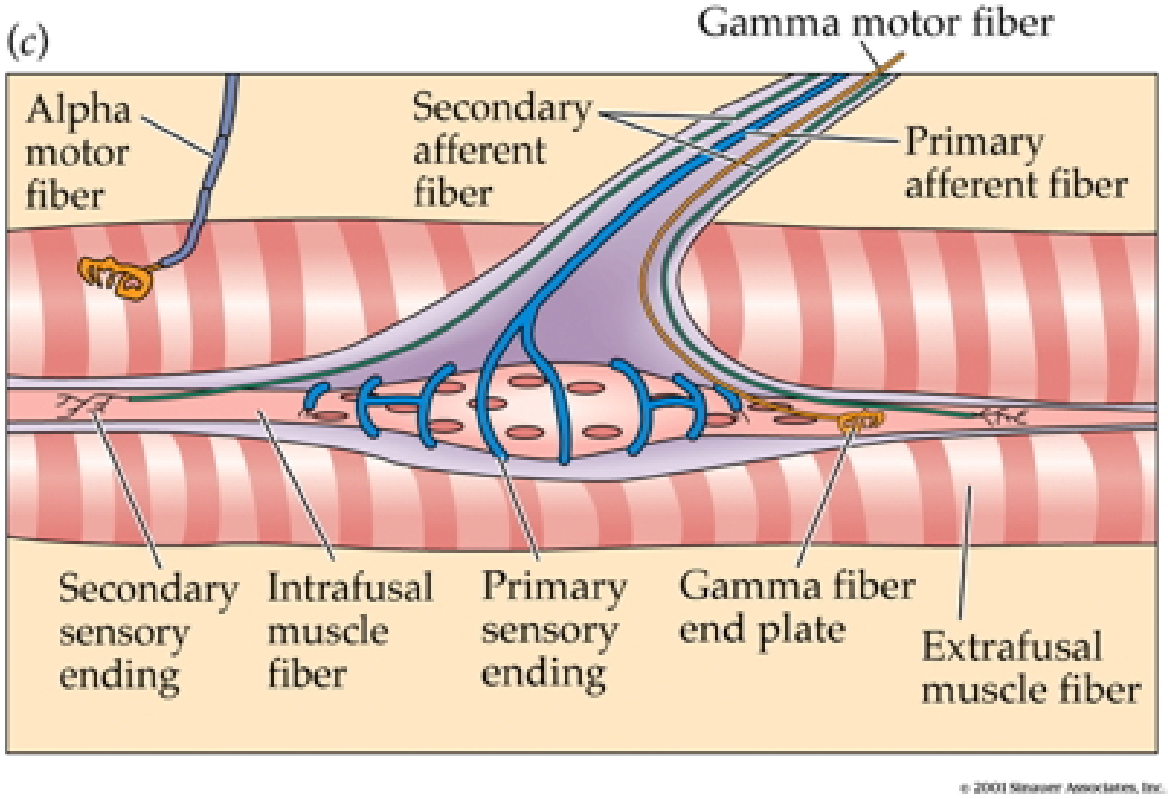
Muscle fiber types

- Fast twitch/fatiguing
  - Type II
  - White meat
- Slow twitch/fatiguing
  - Type I
  - Red meat

Muscles are sensory organs, too!

© Can Stock Photo

Two muscle fiber types



Two muscle fiber types

- Intrafusal fibers
  - Sense length/tension
  - Contain muscle spindles linked to Ia afferents
  - ennervated by gamma (γ) motor neurons
- Extrafusal fibers
  - Generate force
  - ennervated by alpha (α) motor neurons

Next time…

- More on action

References

Dougherty, R. F., V. M. Koch, A. A. Brewer, B. Fischer, J. Modersitzki, and B. A. Wandell. 2003. “Visual Field Representations and Locations of Visual Areas V1/2/3 in Human Visual Cortex.” *Journal of Vision* 3 (10): 1–1. doi:10.1167/3.10.1.

Panichello, Matthew F., Olivia S. Cheung, and Moshe Bar. 2013. “Predictive Feedback and Conscious Visual Experience.” *Perception Science* 3: 620. doi:10.3389/fpsyg.2012.00620.