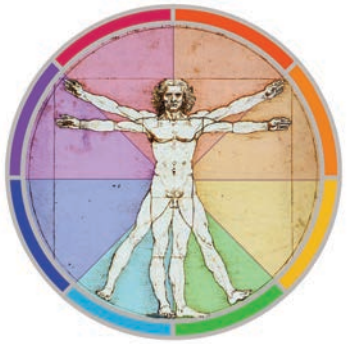
HUBS191 Lecture Material

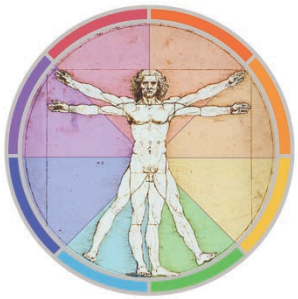
This pre-lecture material is to help you prepare for the lecture and to assist your note-taking within the lecture,

it is NOT a substitute for the lecture !



Please note that although every effort is made to ensure this pre-lecture material corresponds to the live-lecture there may be differences / additions.

Dr Christine Jasoni
Department of Anatomy



HUBS 191

Human Movement and Sensation

Theme 2: Integrating and coordinating roles of the nervous system

Lecture 16: Cells and organisation of the nervous system

24 March 2017

"Integrating and coordinating..."

What does that mean to our nervous system?

1. **Senses environment**
   - Thirsty
   - Cold
   - Hear loud/scary noise

2. **Produces an appropriate response**
   - Drink water
   - Get warmer
   - Prepare to run (flight) or confront it (fight)

Matches sensory environment with our body's needs

http://www.naturalnews.com/031583_mental_illness_America.html

Integrating and coordinating...

Integration (often happens with your knowing it)

- Am I hungry?
- Do I want that kind of food?
- Do I want that much food?

Sensory experience

http://bighub-thaikitchen.blogspot.co.nz/2010/06/hot-spicy-tom-yum-soup.html

- see food
- smell food

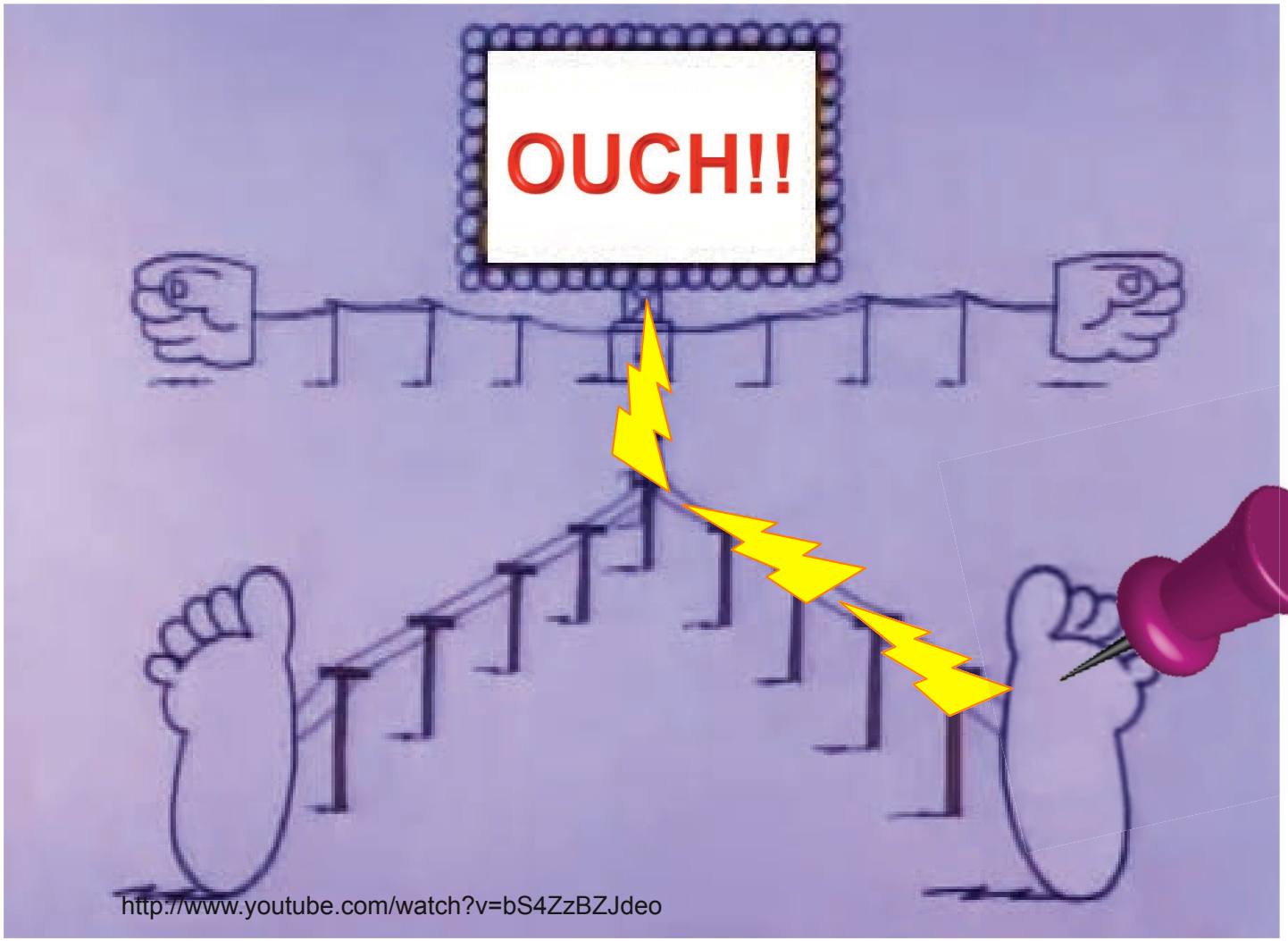
Coordination

- Preparation for eating
- Cravings for some other type of food
- Thoughts of doing something else

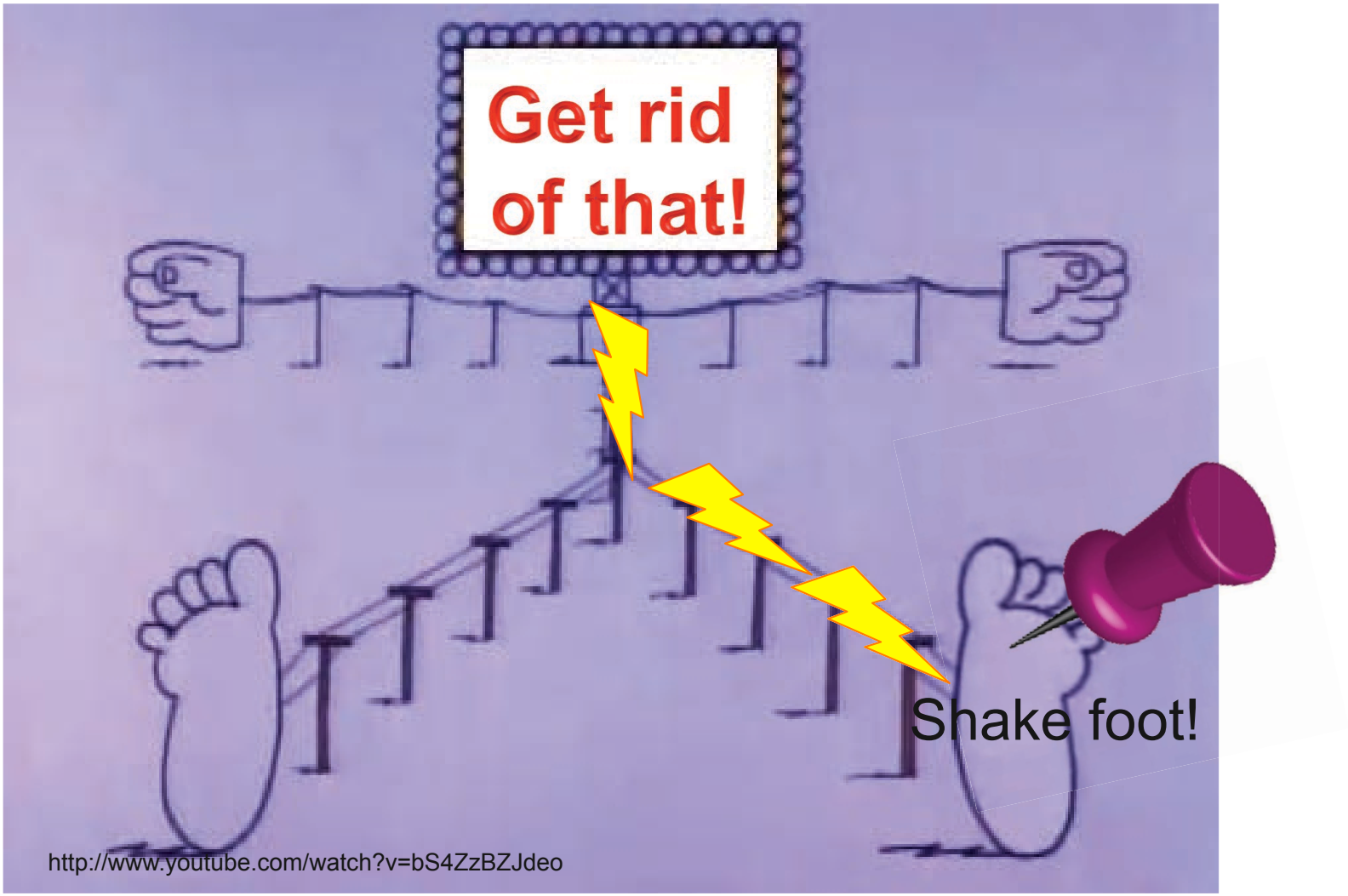
Response

- Order some!
- Go for Indian instead
- Walk away

Integrating...



...and coordinating.



Content of Jasoni lectures (#16-20)

Lecture 16 – Cells and organisation of the nervous system

Lecture 17 – Divisions of the nervous system

Lecture 18 – Anatomy and Function of the Spinal Cord and Spinal Nerves

Lecture 19 – Support and protection of the nervous system

Lecture 20 – Structure and layout of major brain areas; basic sensory and motor pathways

Overall Learning Goal: To understand what the nervous system is, the cells and structures that make it up, how they are organised and connected into circuits that receive information from the world around us, and control what we think, feel, and do.

Structure of Jasoni Lectures

- Intro material – get your head around concepts from a broad perspective
- Specific details you need to know
- Examples and demonstrations (!) to illustrate concepts
  - Multiple examples = repetition for good remembering
  - Demonstrations = for good remembering
- Post-lecture quizzes (Answers in next lecture) – Gives you idea of what kind of material may be on exams.

Lecture 16 - Learning objectives

- Understand the basic organisation of the nervous system
- Name the five main types of glial cells and their functions, and contrast these with neuronal structure and function
- Describe the structure of a neuron, and understand how it is specialised for conduction of nerve impulses
- Describe how the electrical nerve impulse changes to a chemical signal at the synapse
- Understand the directions of information flow in the nervous system

Basic *anatomical* organisation of the nervous system

Central **N**ervous **S**ystem (**CNS**)

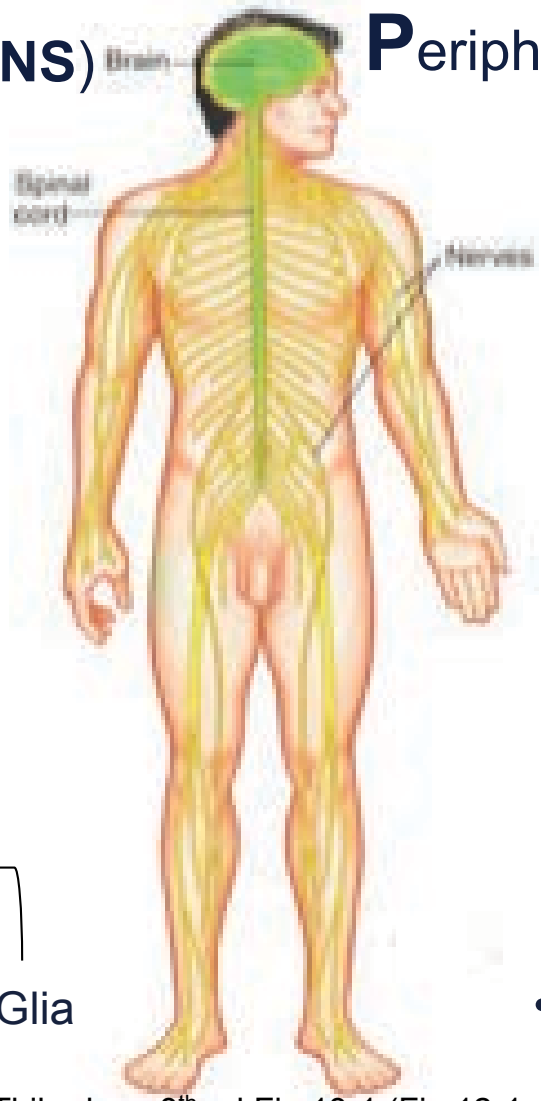
Consists of

Brain

Spinal cord

Composed of
2 general cell classes

- Neurons
- Glia
- Neurons
- Glia



Peripheral **N**ervous **S**ystem (**PNS**)

Consists of

Peripheral nerves

Composed of
2 general cell classes

- Neurons
- Glia

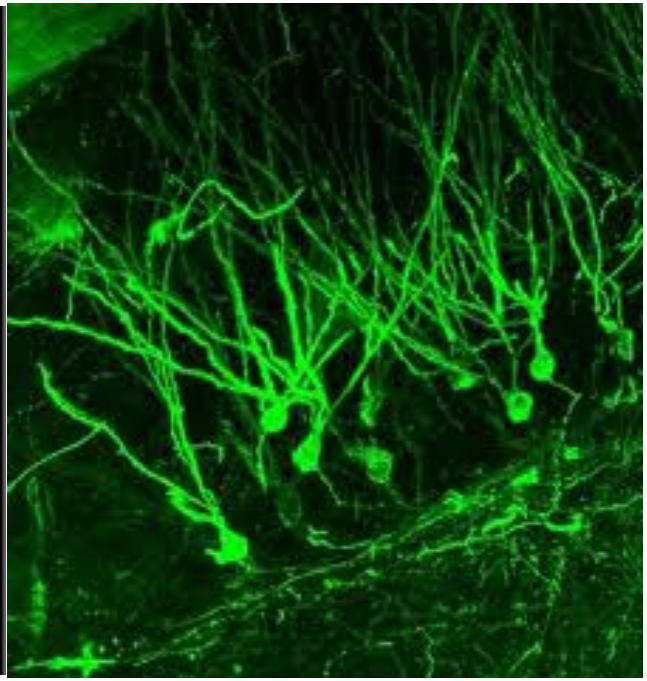
Modified from: Patton & Thibodeau 8th ed Fig 13-1 (Fig 12-1, 7th ed)

Cells of the nervous system
(a) are specialised for specific tasks

... so they look different.

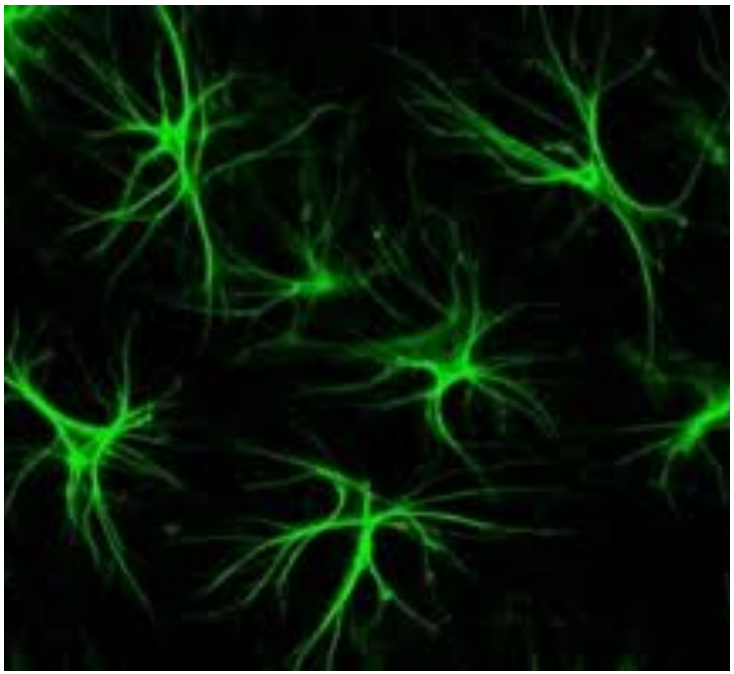
http://www.brains-minds-media.org/archive/222

Purkinje cell (neuron)
from cerebellum



http://www.georgiahealth.edu/medicine/phy/phys_faculty_stranahan.html

Granule cell (neuron)
from hippocampus



http://astrocyte.info/

Astrocyte (glia)
from cerebral cortex

Cells of the nervous system
(a) are specialised for specific tasks

... so they look different.

http://rugbyworldcup.com

Cells of the nervous system:
(b) Come in two main types

I. Glia (Greek: *glue*)

3 general features →

1. Support for neurons
2. Five basic types
   a) 4 in CNS, 1 in PNS
3. Each type has specific function

II. Neurons (nerve cells)

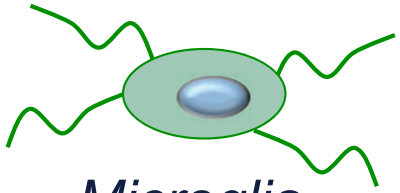
3 general features →

1. Cells specialised for transmission of information
2. Many different types of information
3. Many (thousands!) different types

Cells of the nervous system: Ia. CNS Glia

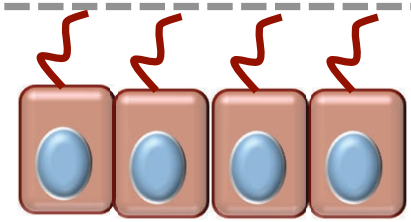
Astrocytes (Greek: star)

3 features →
- Supply nutrients to neurons
- Ensheath blood capillaries
- Transmit information *NEW ROLE*



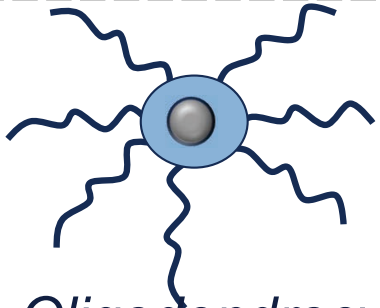
Microglia

2 features →
- Immune cells of the CNS
- Engulf microorganisms and debris



Ependymal cells

2 features →
- Line fluid-filled spaces of brain and spinal cord
- Have cilia (hair-like processes) to circulate CSF

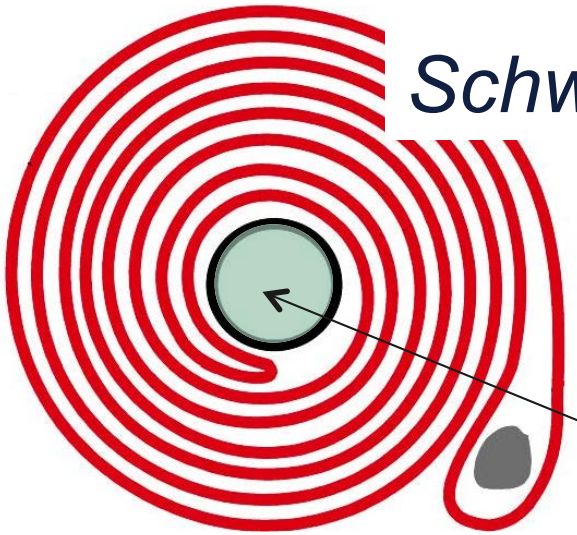


Oligodendrocytes

2 features →
- Support nerve fibres
- Ensheath them with *myelin*

See also: Patton & Thibodeau 8th ed Fig 13-3 (7th ed Fig 12-3)

Cells of the Nervous system: Ib. PNS Glia



3 features →

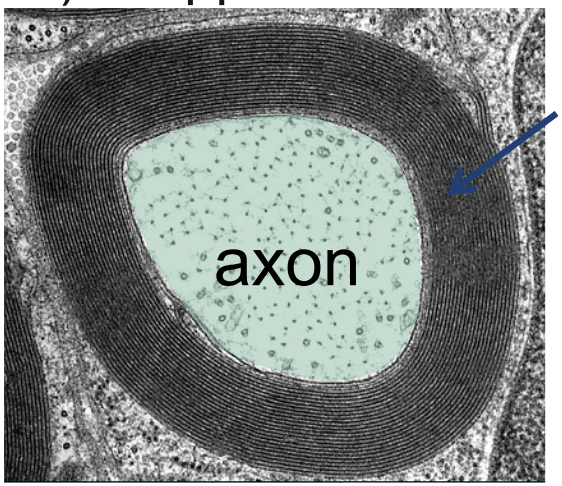
- Support peripheral nerve fibres
- Ensheath them with *myelin*
- Similar to oligodendrocytes (CNS)

See also: Patton & Thibodeau 8th ed Fig 13.3 (7th ed Fig 12-3)

Myelin sheath

- What is it? →

- Lipid (fat) wrapped around axon



See also: P&T 8th ed Fig 13-6B (7th ed Fig. 12-6 B)

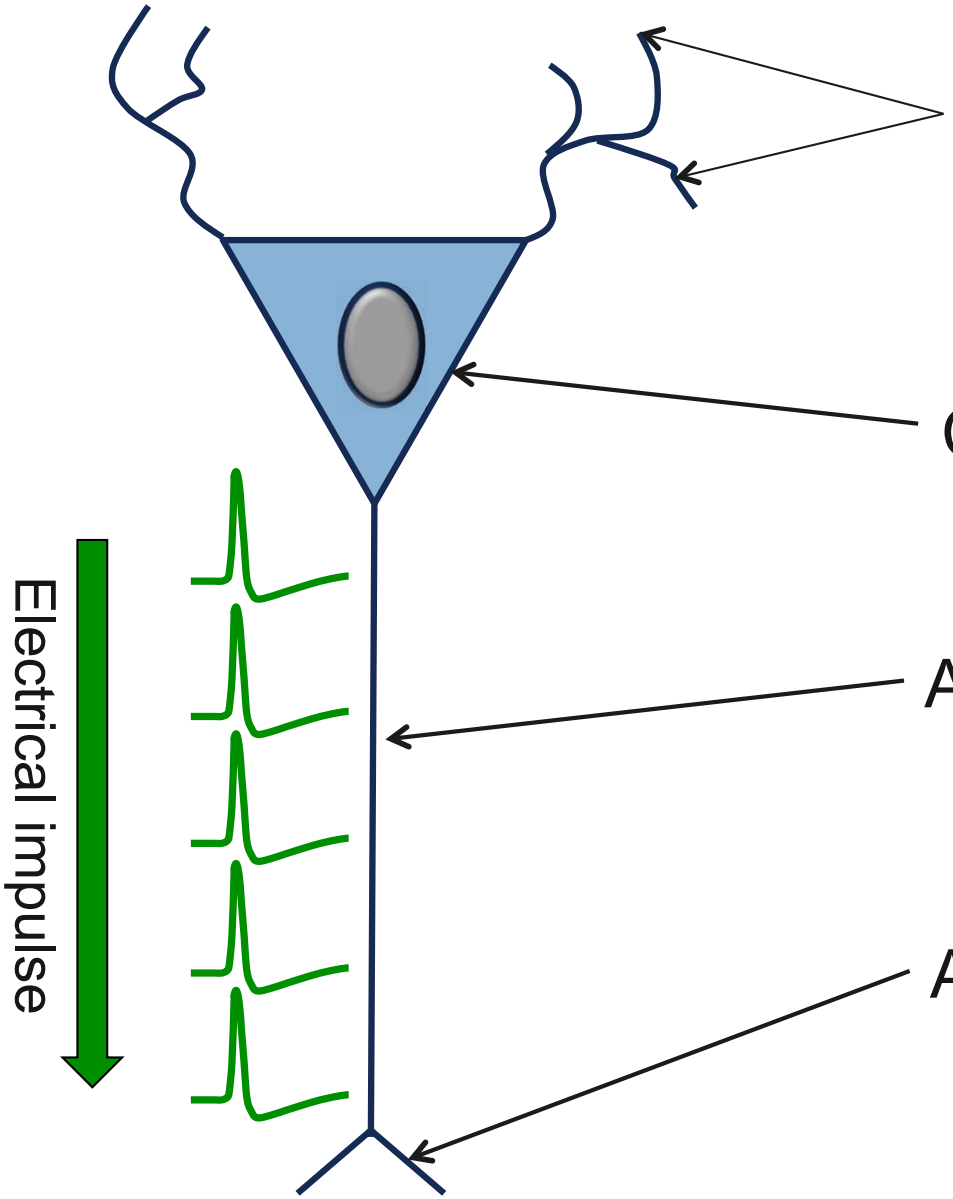
- Where does it come from
  - in the CNS? →
  - in the PNS? →

- CNS oligodendrocytes
- PNS Schwann cells

- What is it for?

- Increases conduction velocity

Cells of the nervous system: (II) Neurons, basic structure



Dendrites (2 features)
- Receive input
- Send info to cell body

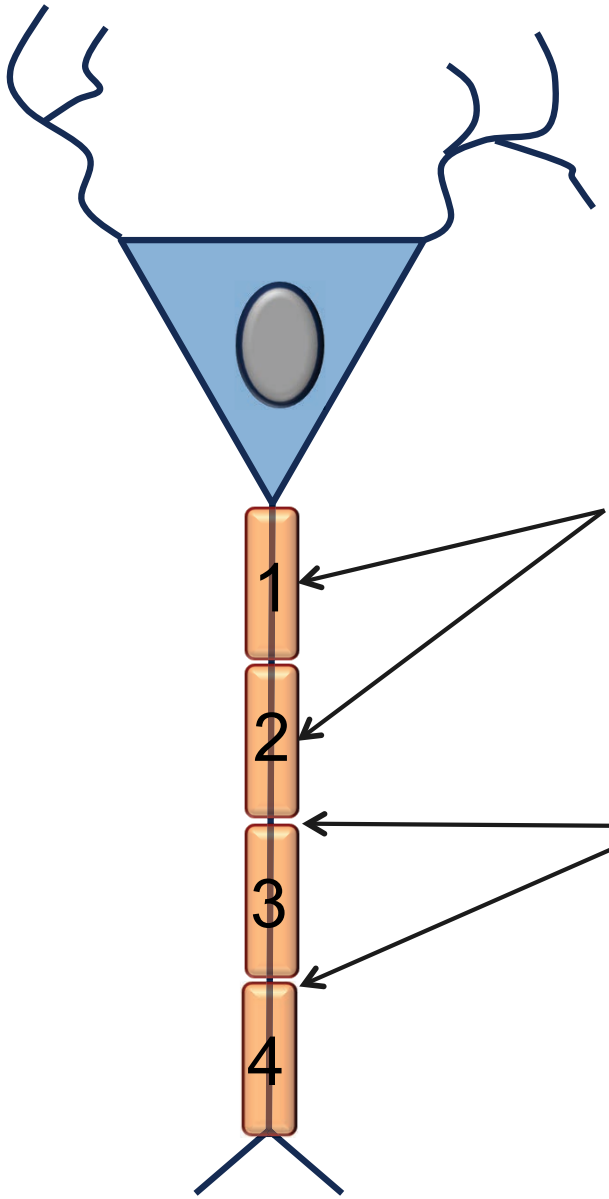
Cell body (2 features)
- Contains nucleus & organelles
- Sums input

Axon (2 features)
- Carries electrical impulses
- May or may not be myelinated

Axon terminal (2 features)
- End (terminus) of the axon
- Neurotransmitter release

See also: Patton & Thibodeau 8th ed Fig 13-5 (7th ed Fig 12-5)

Cells of the nervous system: (II) Neurons, basic structure



Myelin sheath

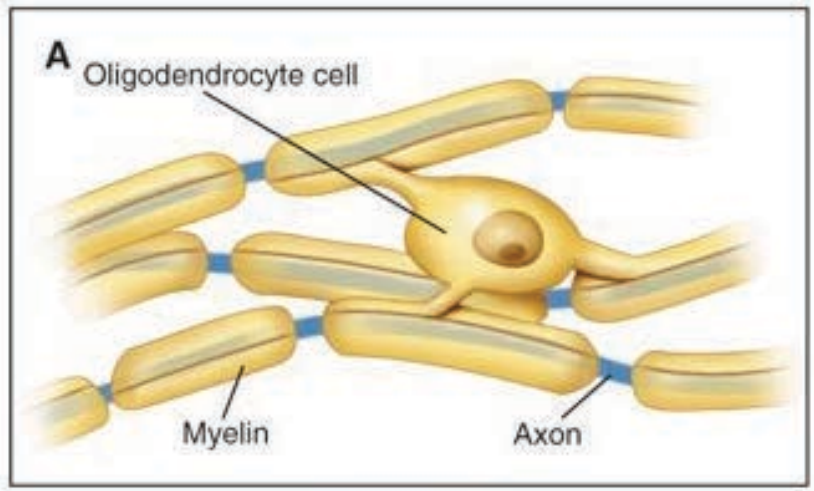
- Multiple Schwann cells in line

Nodes of Ranvier

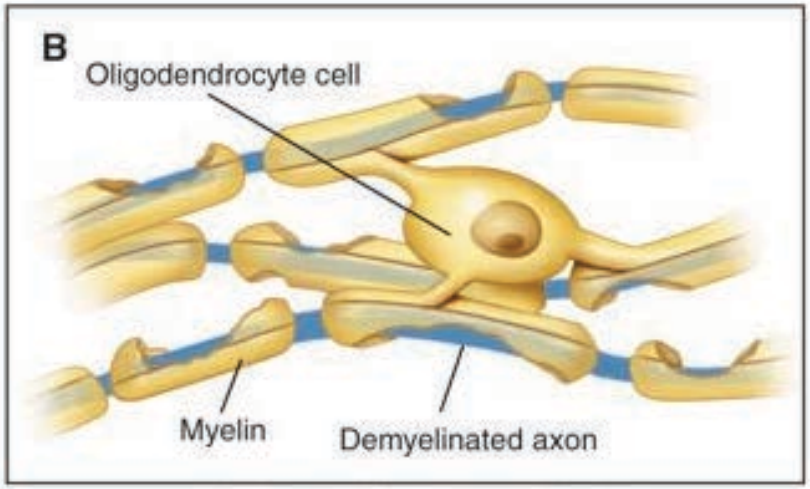
- Gaps between myelin
- Increase conduction

See also: Patton & Thibodeau 8th ed Fig 13-5 (7th ed Fig 12-5)

Clinical correlate ~ Importance of myelination
Multiple Sclerosis



Normal myelin



Myelin partially destroyed by MS

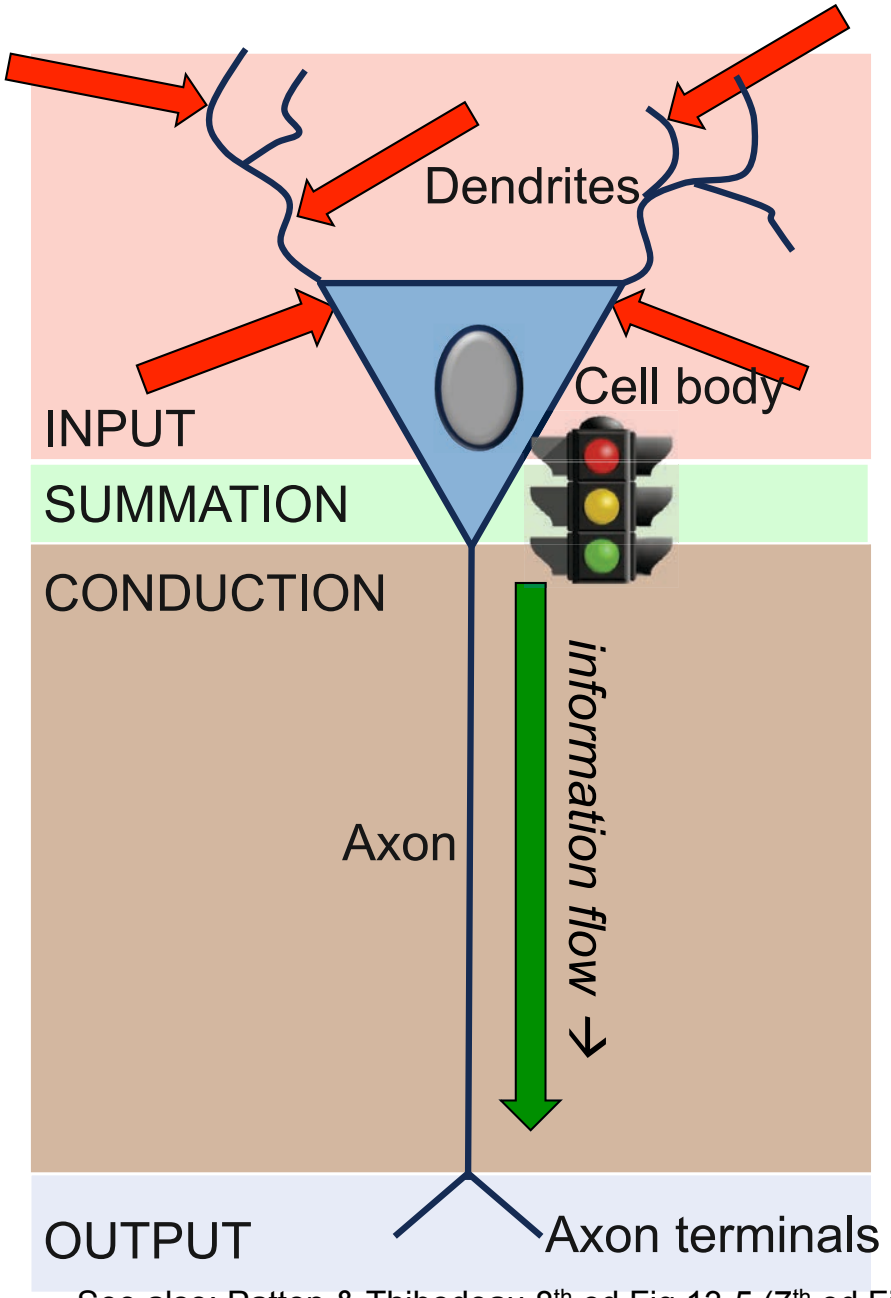
- Demyelination caused by autoimmunity or infection
  - ~ immune system attacks myelin
- Causes impaired nerve conduction
  - ~ weakness, uncoordination, visual and speech impairment

Example: optic nerve demyelination

http://www.mult-sclerosis.org/opticneuritis.html

Patton & Thibodeau 8th ed Box 13-2 (7th ed Box 12-2)

Cells of the nervous system: (II) Neurons, basic structure



Input zone:

- Dendrites, cell body
- Receives *chemical signals* from other neurons

Summation zone

- Axon hillock
- Decision to transmit signal further

Conduction zone

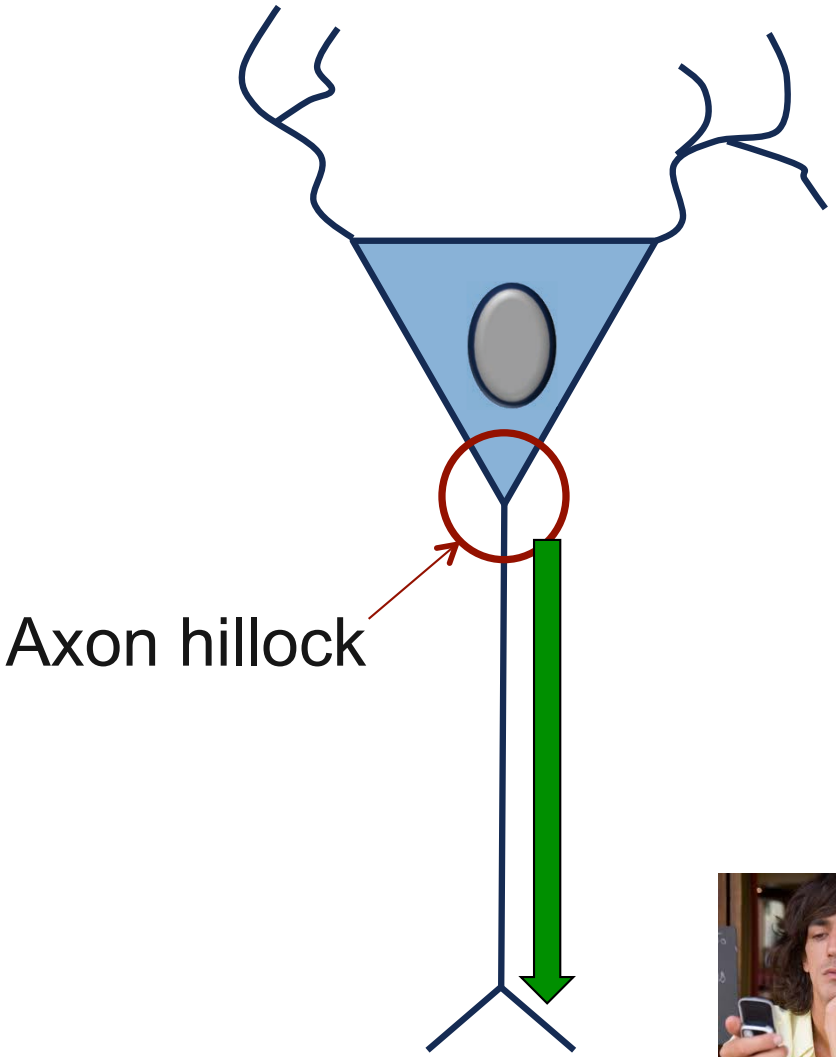
- Axon, may be quite long
- Carry *electrical signals* between brain areas, to and from spinal cord, or to and from peripheral sensory receptors

Ouput zone

- Axon terminals
- Contact with input zone of other neurons
- Release of neurotransmitter = *chemical signal*

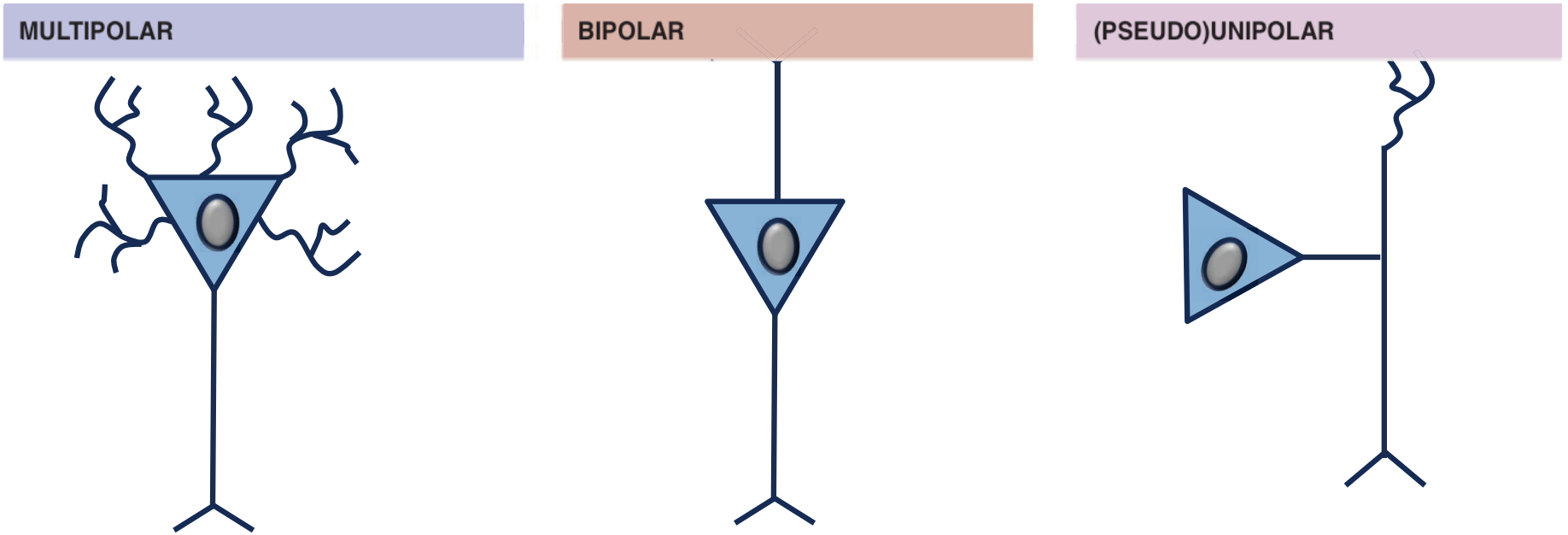
See also: Patton & Thibodeau 8th ed Fig 13-5 (7th ed Fig 12-5)

Axon hillock: Makes decision about whether to pass on information



See also: Patton & Thibodeau 8th ed Fig 13-5 (7th ed Fig 12-5)

Cells of the nervous system: (II) Neurons, morphological types



- Multiple processes emanate from the cell body

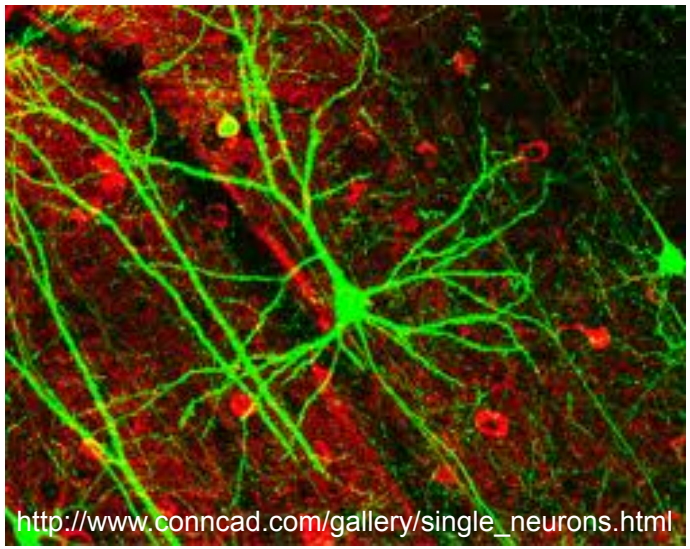
- Two(2) processes emanate from the cell body

- One process emanates from the cell body,
- Then branches into dendrite and axon

See also: Patton & Thibodeau 8th ed Fig 13-9 (7th ed Fig 12-9)

Cells of the nervous system: (II) Neurons, morphological types

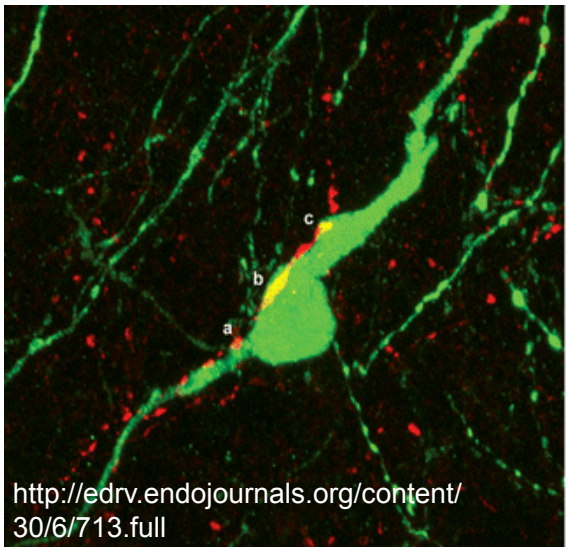
MULTIPOLAR



http://www.conncad.com/gallery/single_neurons.html

- Multiple processes emanate from the cell body
- Multiple dendrites
- Single axon

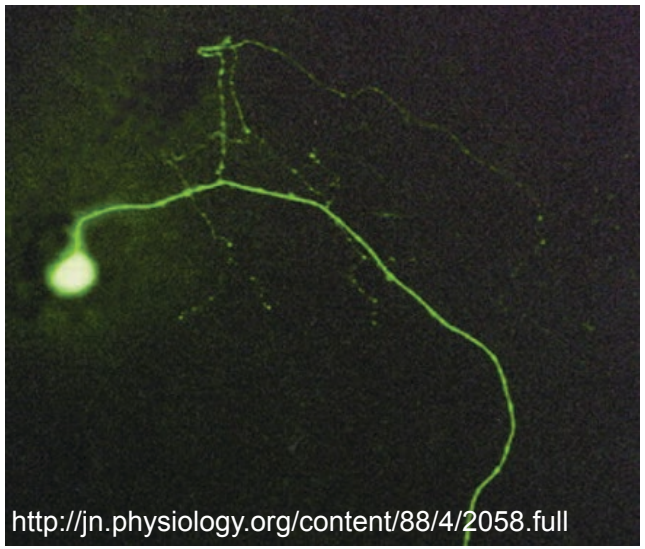
BIPOLAR



http://edrv.endojournals.org/content/30/6/713.full

- Two(2) processes emanate from the cell body
- One functions as dendrite
- One functions as axon

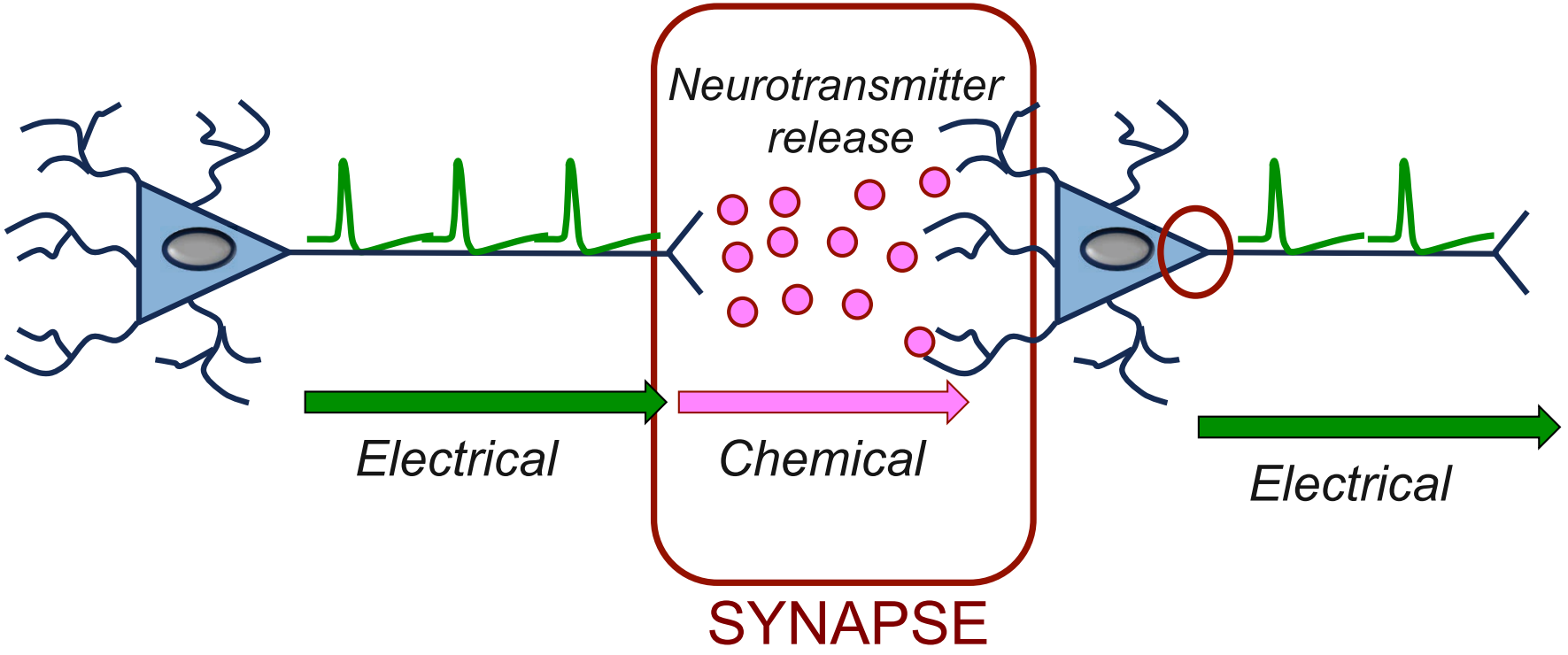
(PSEUDO)UNIPOLAR



http://jn.physiology.org/content/88/4/2058.full

- One process emanates from the cell body,
- Then branches into dendrite and axon

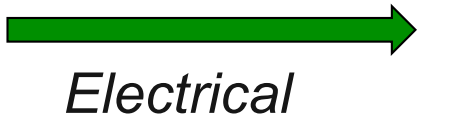
Cells of the nervous system: Communication between neurons occurs through a junction called a *SYNAPSE*



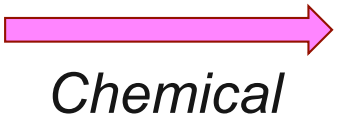
See also: Patton & Thibodeau 8th ed Fig 13-5 (7th ed Fig 12-5)

Information needs to change form when it moves from one thing to the next.

This is not weird!



Electrical



Chemical

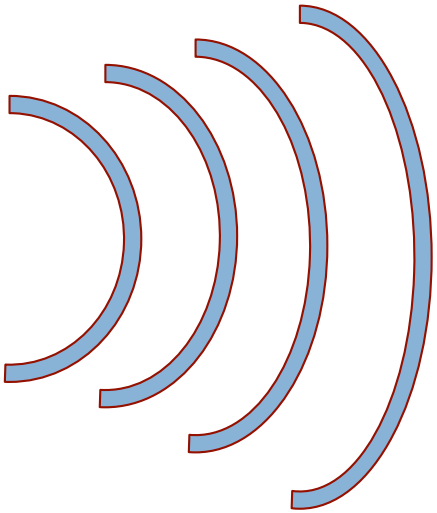
Electrical

http://en.wikipedia.org/wiki/Cell_site

Radio waves

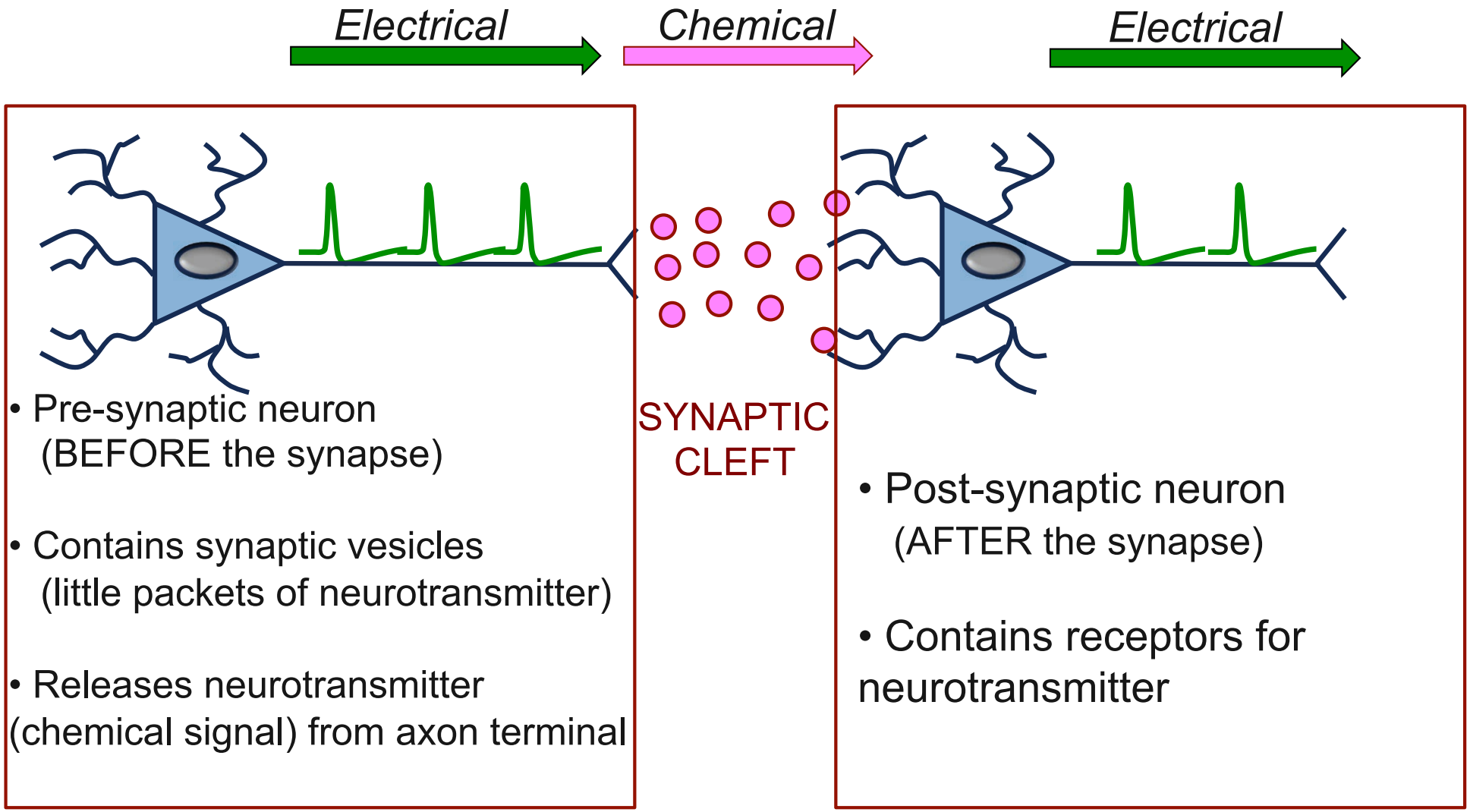
https://www.youtube.com/watch?v=Tx_lyy4-SeY

Txt message
(readable words)



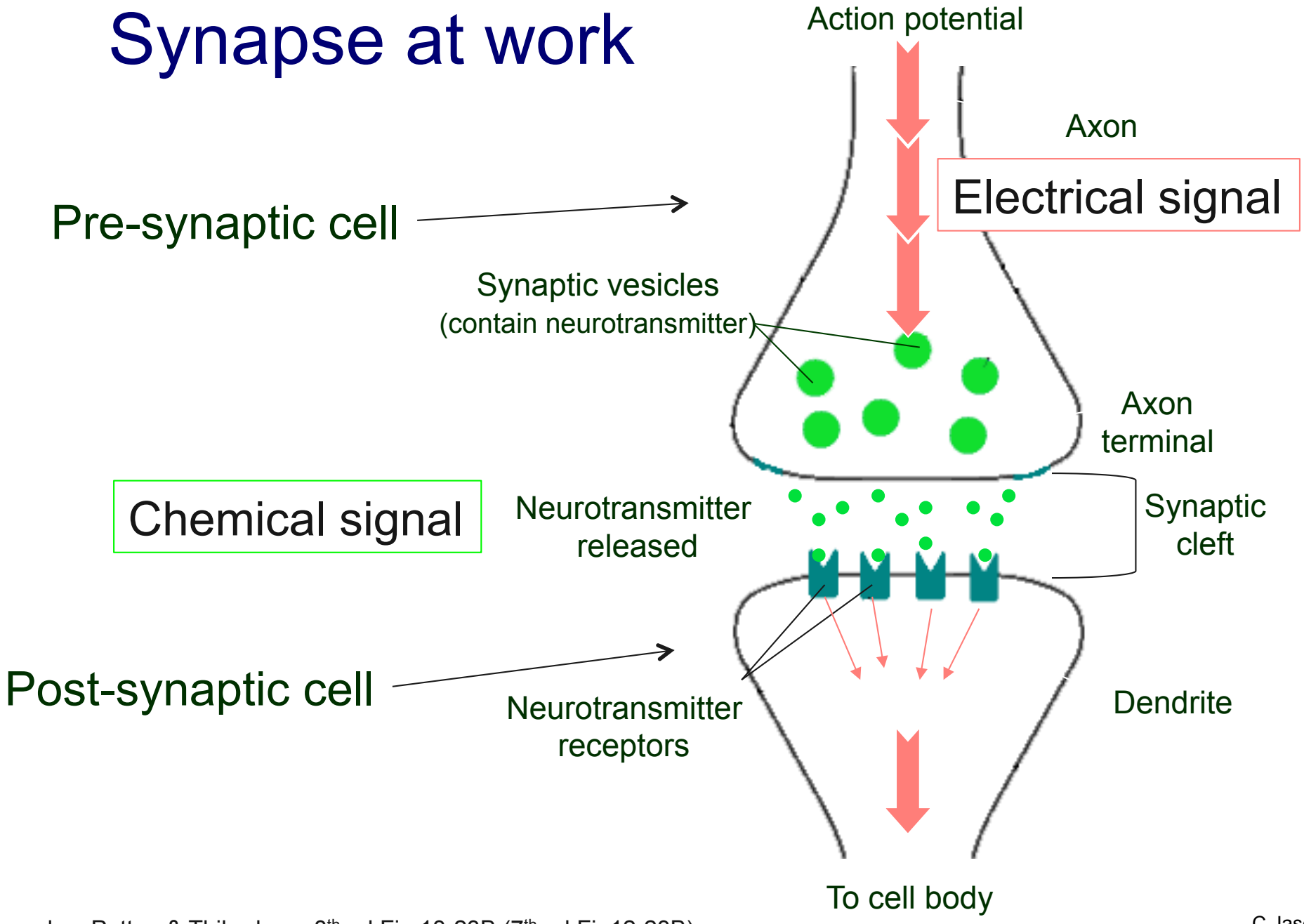
Radio waves

Cells of the nervous system: Communication between 2 neurons occurs through a junction called a *SYNAPSE*



See also: Patton & Thibodeau 8th ed Fig 13-26 (7th ed Fig 12-26)

Synapse at work



See also: Patton & Thibodeau, 8th ed Fig 13-23B (7th ed Fig12-23B)

Synapse types

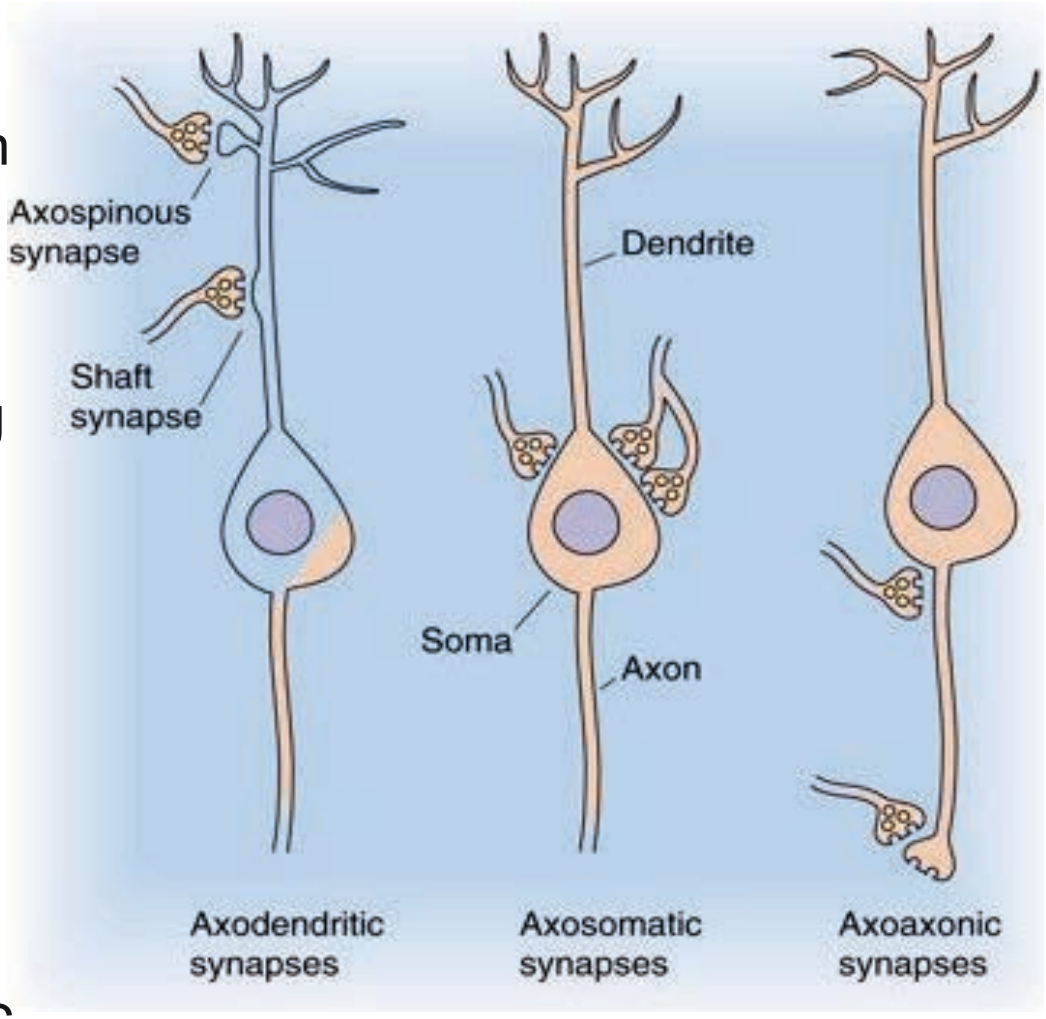
• There are three types of synapses in the nervous system

• Compound name =

1. Region of presynaptic cell making contact (e.g. axon)

2. Region of post-synaptic cell contacted
   - dendrite
   - cell body (soma)
   - axon

• Axodendritic = most common in CNS

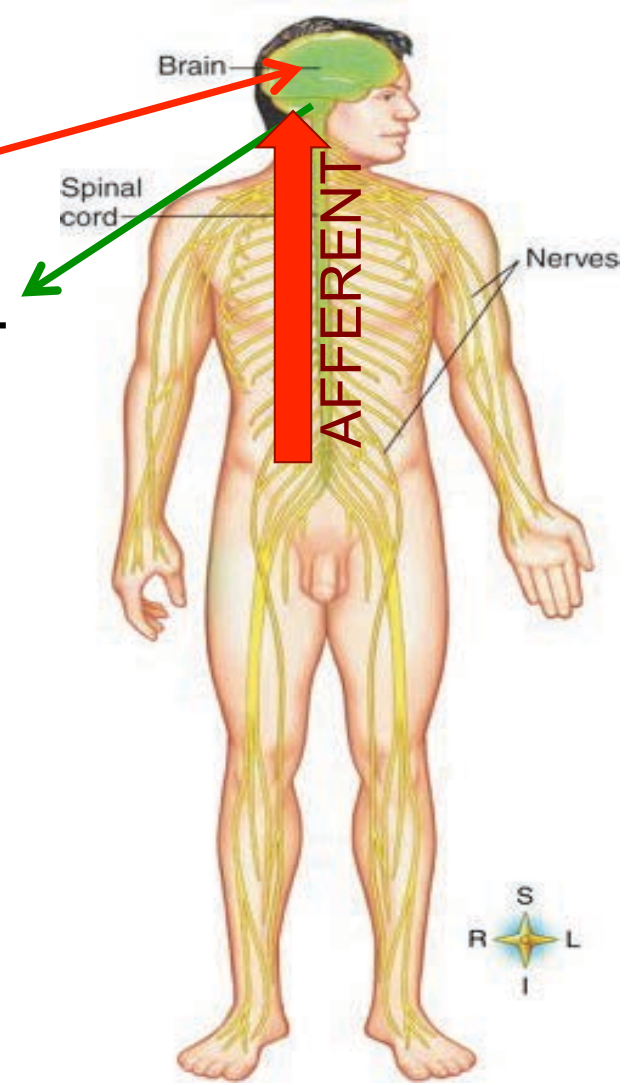


Equivalent figure: Patton & Thibodeau 8th ed Fig 13-24 (7th ed Fig 12-24)

Flow of information in the nervous system: Information goes in ***both*** directions

- Information that goes *INTO* the brain == **AFFERENT**
  - sometimes called ASCENDING

- Response that comes *OUT OF* the brain == **EFFERENT**
  - sometimes called DESCENDING



EXAMPLE:
- Sense something in the environment (afferent)

- Respond to it with appropriate action (efferent)

Adapted from Patton & Thibodeau, 8th ed Fig 13-1 (7th ed Fig12-1)

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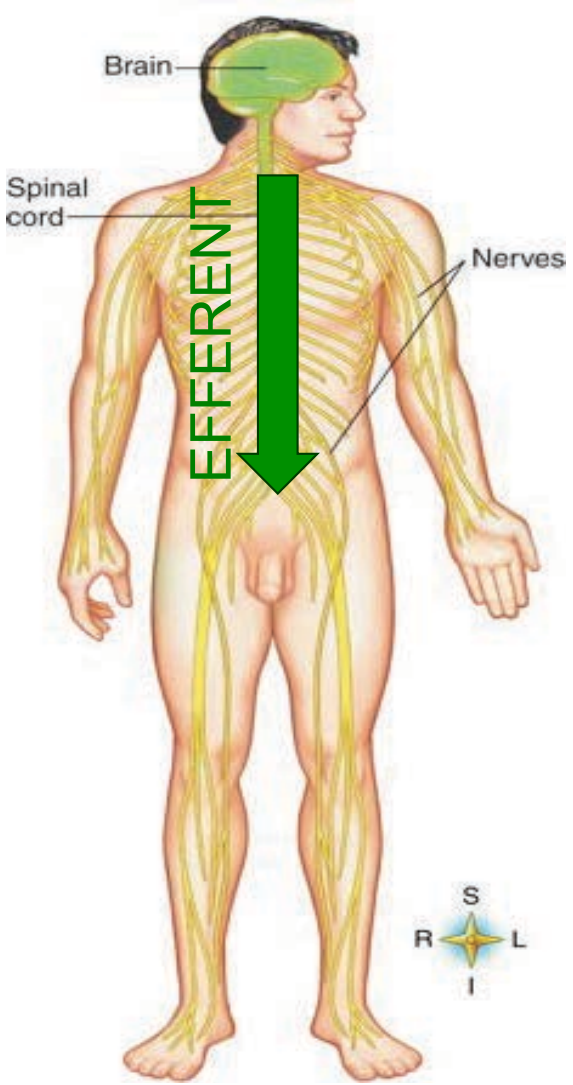

Adapted from Patton & Thibodeau, 8th ed Fig 13-1 (7th ed Fig12-1)

Flow of information in the nervous system: Example of a simple circuit

http://mygreatkid.com/parenting-ideas-and-thoughts/love-logic-and-hot-stoves/

http://yankees.lhblogs.com/2008/11/30/why-the-hot-stove-has-been-so-cold/

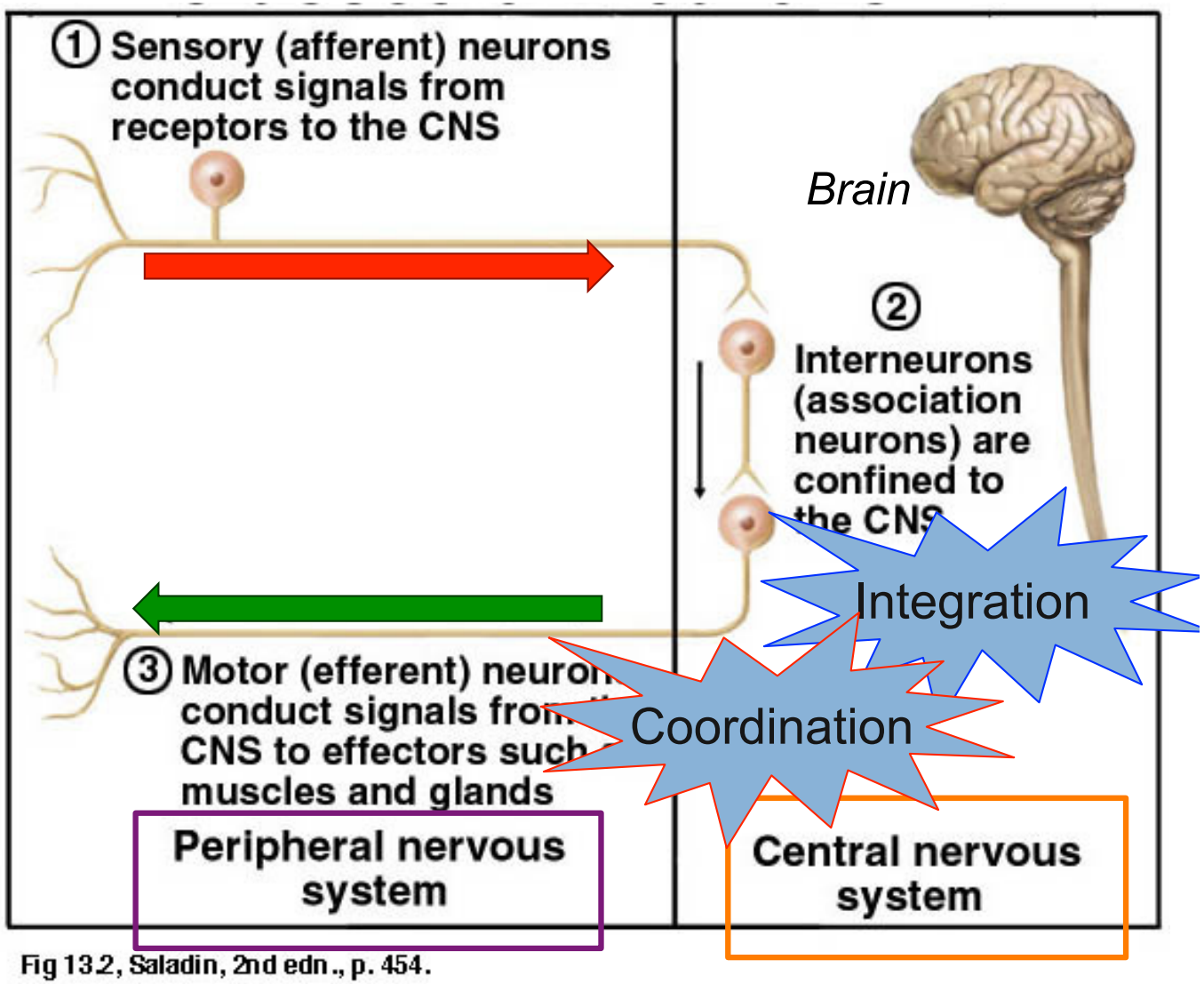

Fig 13.2, Saladin, 2nd edn., p. 454.

See also: Patton & Thibodeau 8th ed Fig 13-10 (7th ed Fig 12-10)

Organisation of the nervous system: Cell bodies and axons are segregated

I. CNS

a) Group of cell bodies → a) Nucleus (pl. = Nuclei)

b) Bundle of axons → b) Tract

c) Group of cell bodies in cerebral cortex → c) Grey matter

d) Bundle of axons in cerebral cortex → d) White matter

II. PNS

a) Group of cell bodies → a) Ganglion (pl = ganglia)

b) Bundle of axons → b) Nerve

Lecture 16: Post-lecture quiz

1. The myelin sheath in the CNS is made by:
   (A) Schwann cells (B) Oligodendrocytes
   (C) Astrocytes (D) Ependymal cells

2. The part of neurotransmission that is carried out through a chemical signal is called:
   (A) Synapse (B) Node (C) Ganglion (D) Action potential

3. Information that travels into the CNS is called:
   (A) Efferent (B) Afferent (C) Ascending
   (D) Descending (E) A & C (F) B & C

4. The part of a neuron that makes the decision about whether to propagate an action potential in response to inputs is called:
   (A) Axon hillock (B) Node of Ranvier
   (C) Axon terminal (D) Synapse

HUBS191