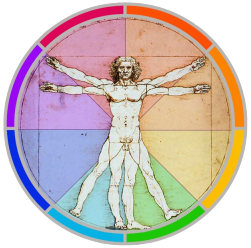
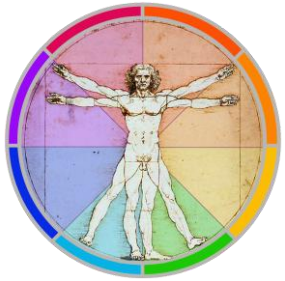
HUBS191 Lecture Material

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.

University of Otago
ŌTĀKOU WHAKAIHU WAKA



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

Dr. Rob Munn, Director of Neuroscience
Department of Anatomy

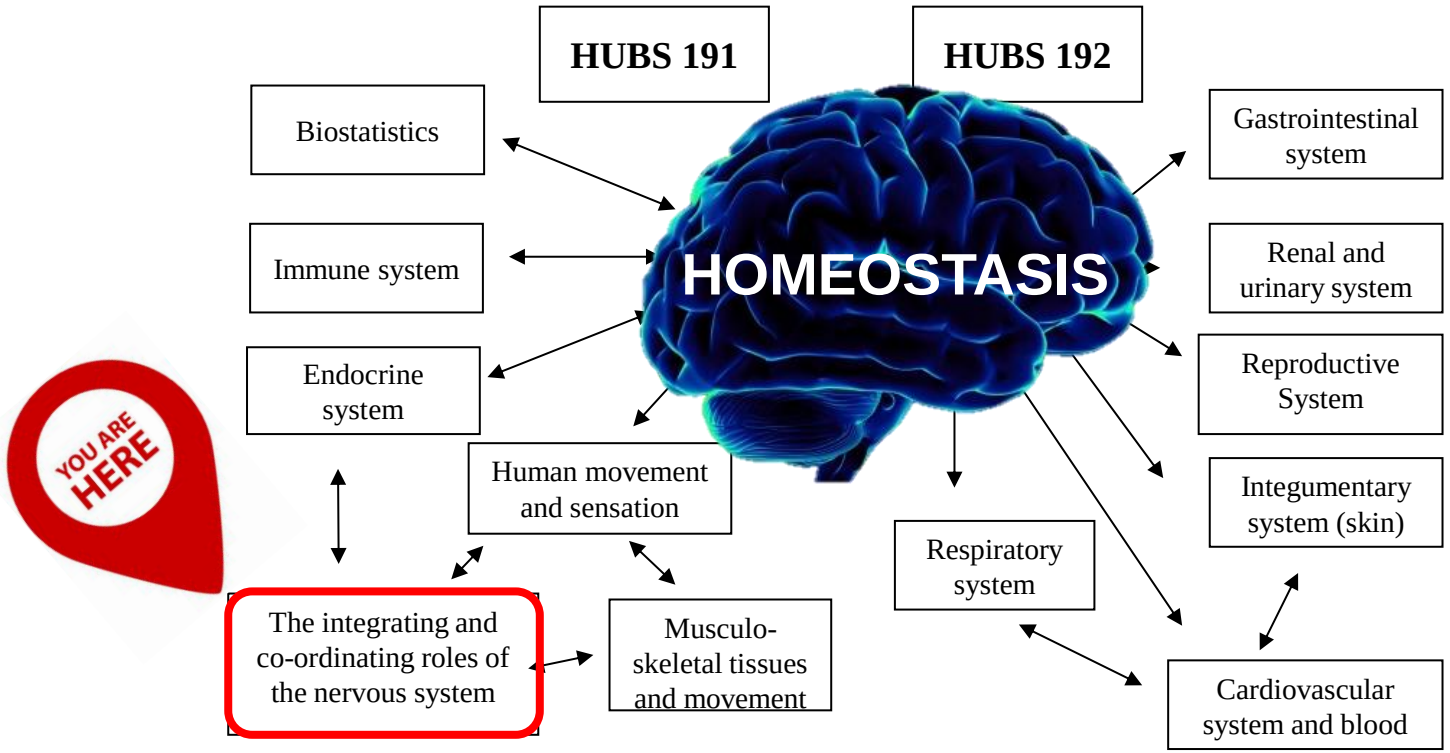
“Integrating and coordinating…”

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


HUBS 191
HUBS 192
Biostatistics
Immune system
Endocrine system
Human movement and sensation
The integrating and co-ordinating roles of the nervous system
Musculo-skeletal tissues and movement
HOMEOSTASIS
Gastrointestinal system
Renal and urinary system
Reproductive System
Integumentary system (skin)
Respiratory system
Cardiovascular system and blood
YOU ARE HERE

Integrating and coordinating - Maintaining homeostasis.

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

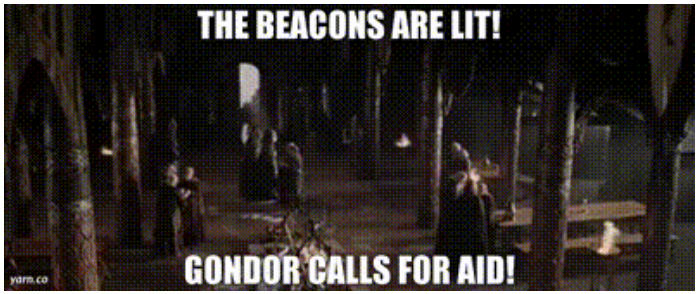
- see food
- smell food

Coordination

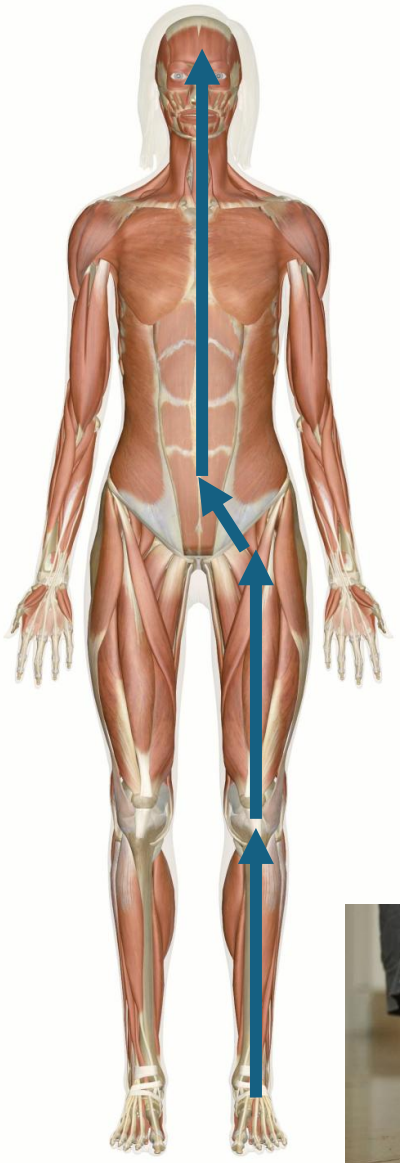
- Preparation for eating
- Cravings for some other type of food
- Thoughts of doing something else

Response

- Order some!
- Go to a different restaurant
- Walk away

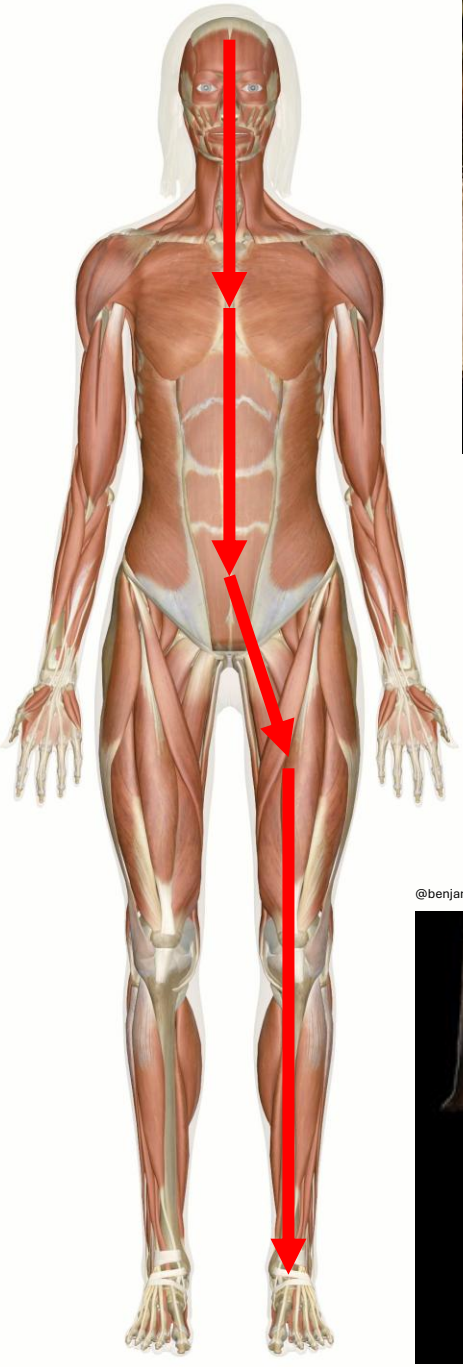


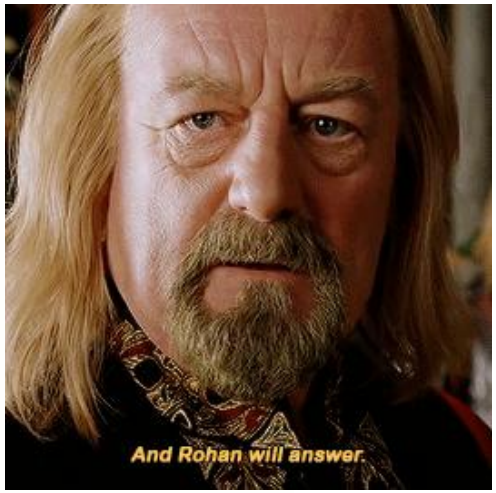
New Line Cinema



New Line Cinema

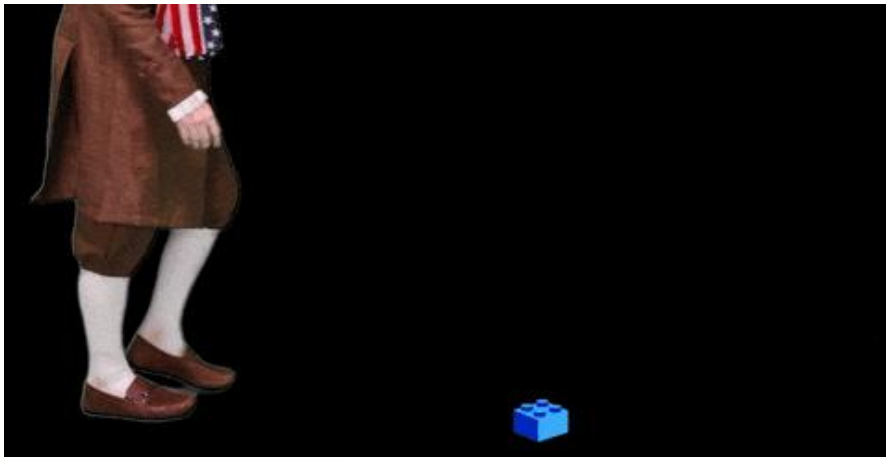
https://www.innerbody.com/image/musfov.html





New Line Cinema

@benjammins



Content of Rob's Neuroanatomy lectures

Lecture 16 – Cells & organization of the nervous system

Lecture 17 – Functional Information Flow

Lecture 20 – Anatomy and Function of the Spinal Cord and Spinal Nerves

Lecture 21 – Meninges and ventricular system

Lecture 22 – Layout of the brain AND 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.

 = Interest and context: Not **directly** examined!

 = KEY CONCEPTS: **Very important!**

Structure of Neuroanatomy Lectures

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

Lecture 16 - Learning objectives

After reviewing and studying this lecture, you should understand and be able to describe:

1. The basic organisation of the nervous system and the cell types therein
2. The general structure of a neuron, and understand how this structure
    a. is functionally related to directional flow of information
    b. varies to give 4 distinct morphologies
3. The five main types of glial cells and their functions, and be able to contrast these with neuronal structure and function
4. The structure of a synapse
5. The concept that an electrical nerve impulse changes to a chemical signal at the synapse
6. The directions of information flow within (into and out of) the nervous system

Basic *anatomical* organisation of the nervous system

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

Consists of

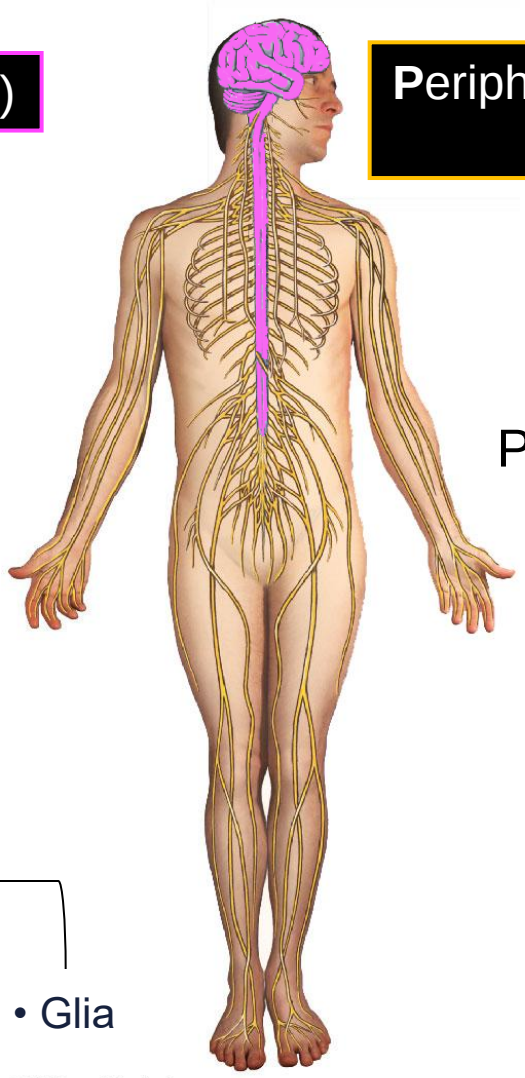
Brain

Spinal cord

Composed of
2 general cell classes

• Neurons • Glia

• Neurons • Glia



Peripheral **N**ervous **S**ystem (**PNS**)
[including ENS]

Consists of

Peripheral nerves & ganglia

Composed of
2 general cell classes

• Neurons • Glia

Modified from: Martini 3rd ed, Fig 11-1, p445

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

I. Neurons (nerve cells)

2 general features →

1. Cells specialised for **transmission of information**

2. Four morphological types

II. Glia (Greek: *glue*)

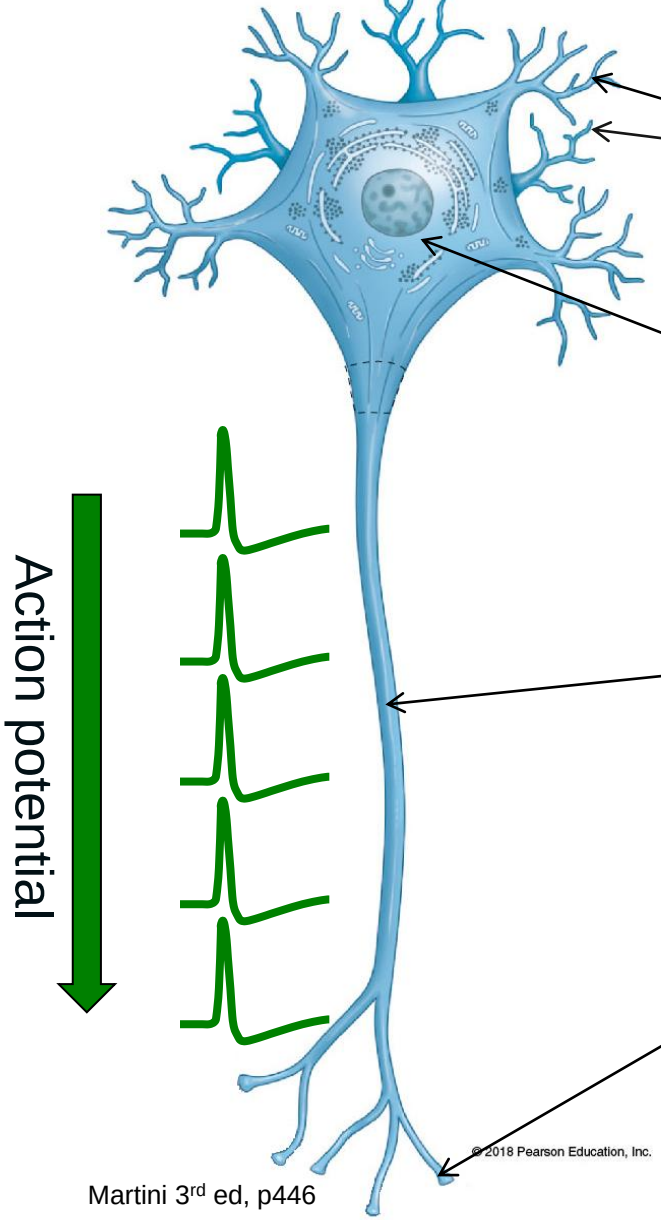
3 general features →

1. Support for neurons

2. **Five** basic types
   a) 4 in CNS, 1 in PNS

3. Each type has a **specific function**

Cells of the nervous system:
(I) Neurons – Structural Components



Martini 3rd ed, p446

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(s) [2 features]
- End (terminus) of the axon
- Neurotransmitter release

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

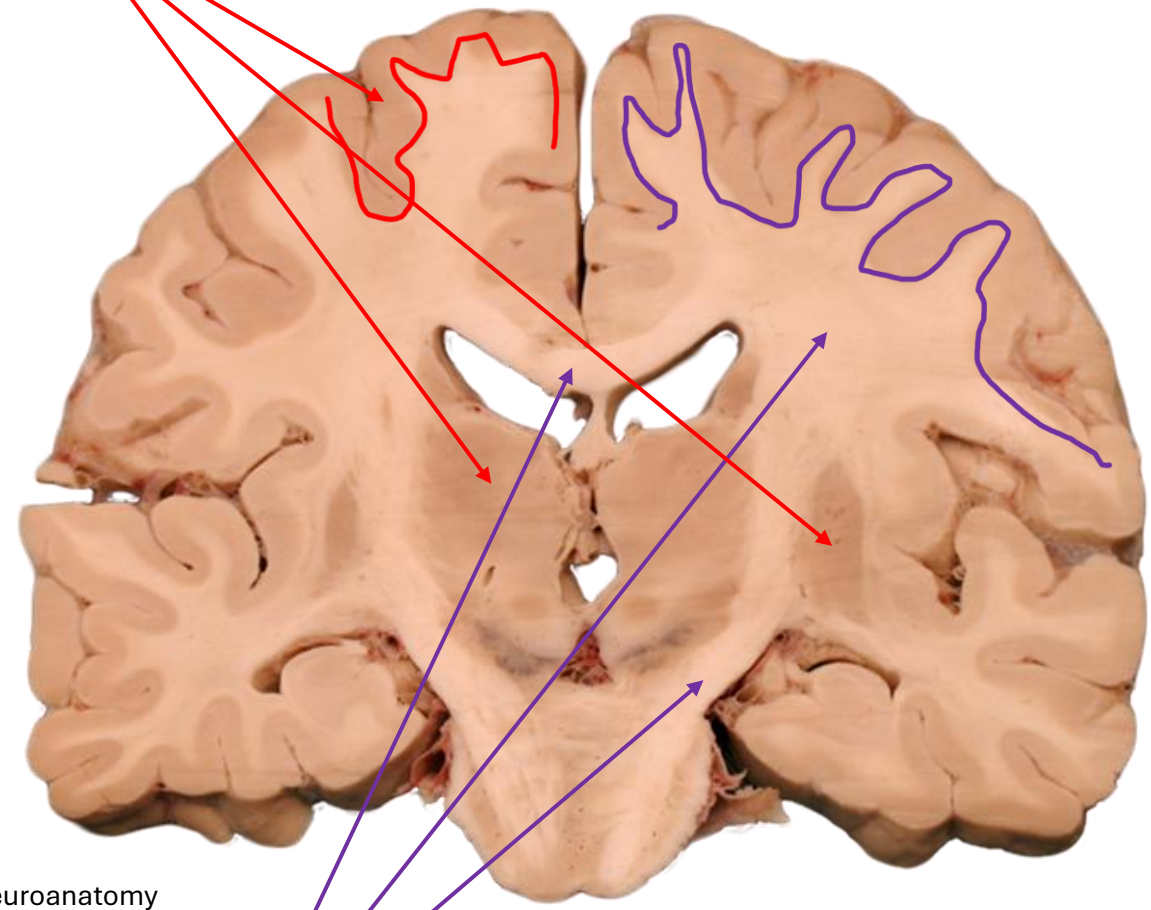
In the CNS...

- Group of cell bodies → a) Nucleus (pl. = Nuclei)
- Bundle of axons → b) Tract
- Group of cell bodies in cerebral cortex or spinal cord → c) Grey matter
- Bundle of axons in cerebral cortex or spinal cord → d) White matter

In the PNS...

- Group of cell bodies → a) Ganglion (pl = ganglia)
- Bundle of axons → b) Nerve

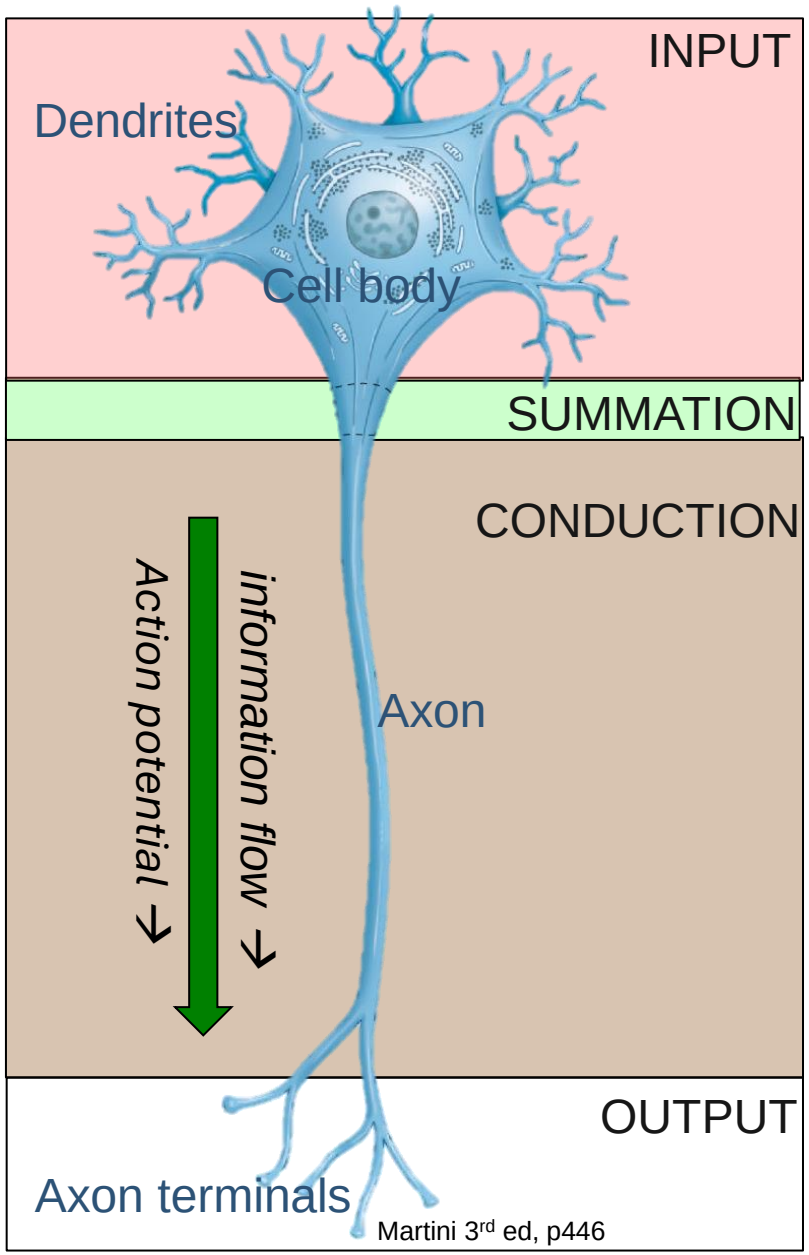
Grey matter – this is where you will find the ***soma*** or cell bodies of neurons



UBC Neuroanatomy

White matter – this is where you will find the ***axons***. These are long fiber tracts

Cells of the nervous system:
(I) Neurons – Functional components (zones)



Input zone:

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

Summation zone

- Structure = Axon hillock
- Summation of inputs

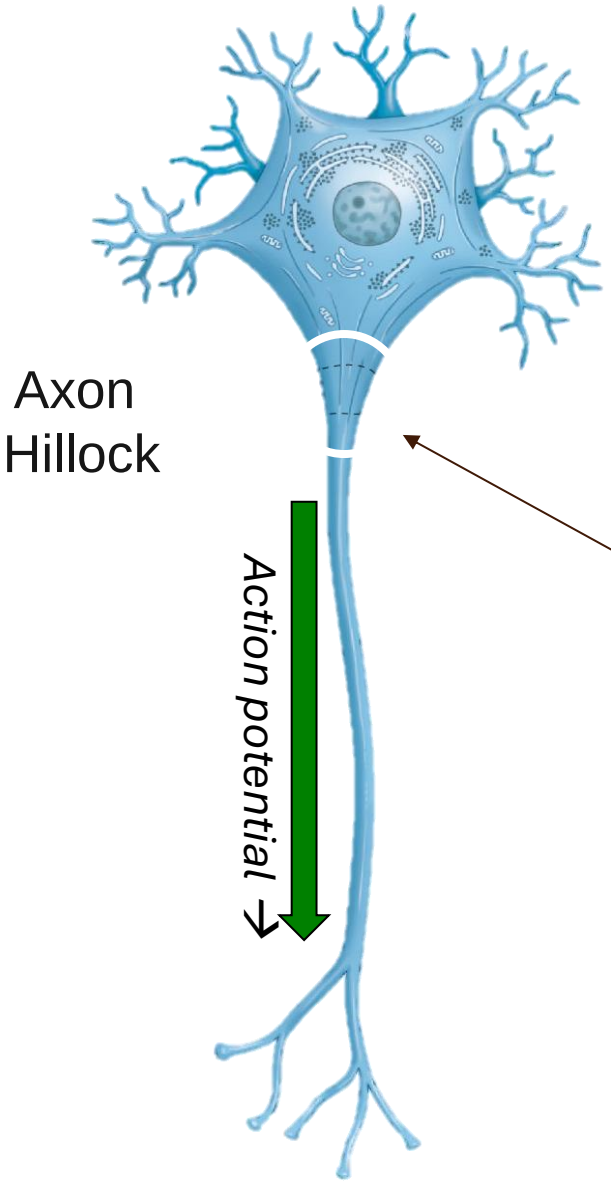
Conduction zone

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

Ouput zone

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

Axon hillock: Anatomical location where inputs are summated before action potential




Hamish's birthday is Tuesday.


Hamish's birthday is tomorrow.

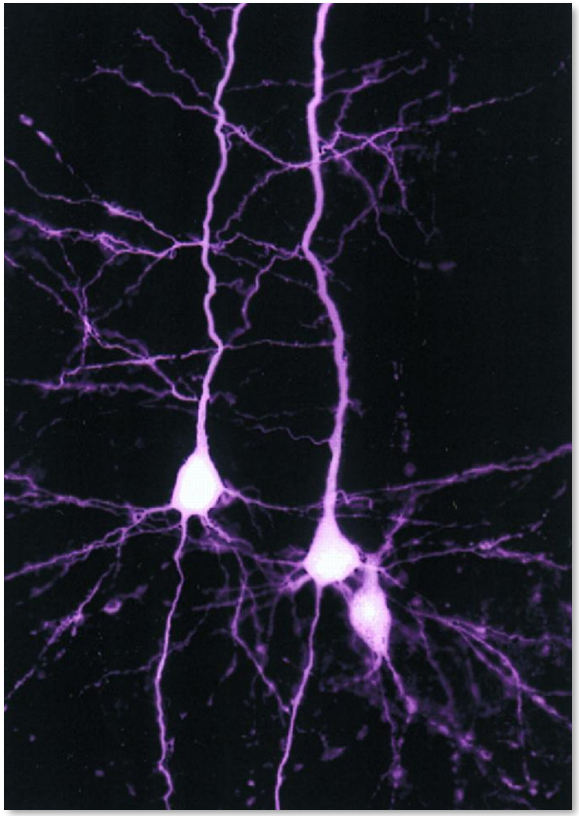

Hamish's birthday is Tuesday.


Hamish's birthday is Tuesday.

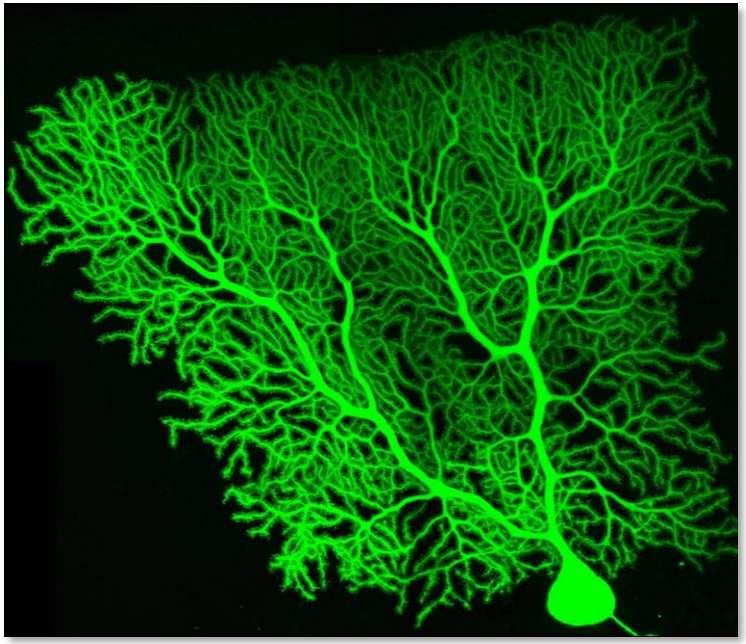
Martini 3rd ed, p446

Cells of the nervous system
(i) Specialised for specific tasks

... so they look different.



http://www.pnas.org/content/95/9/5323/tab-figures-data



http://www.bioquicknews.com/node/4757

https://www.pinterest.nz/pin/436567757604237316/

Atheletes' bodies are specialised for specific tasks...

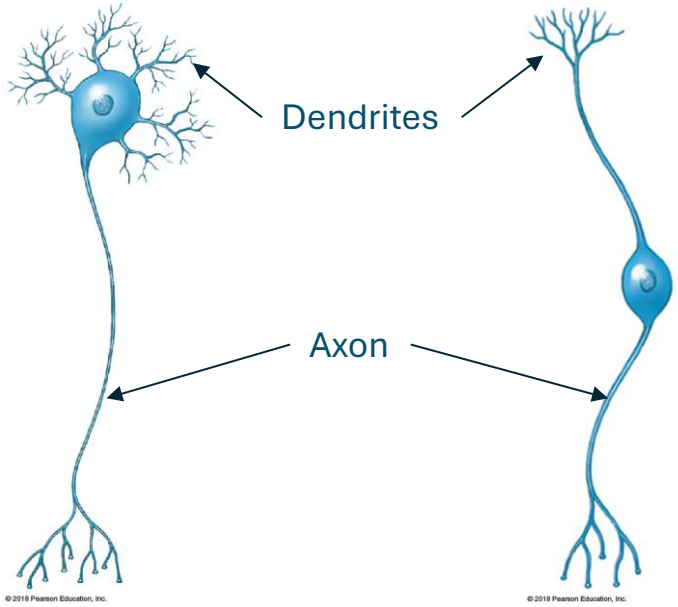
... so they look different.

https://www.insidethegames.biz/articles/1094113/valerie-adams-shot-put-tokyo-2020

https://theconversation.com/can-eliud-kipchoge-run-a-sub-2hr-marathon-it-all-comes-down-to-15-extraordinary-seconds-124981

Cells of the nervous system:
(I) Neurons – 4 Morphological types

1. Multipolar

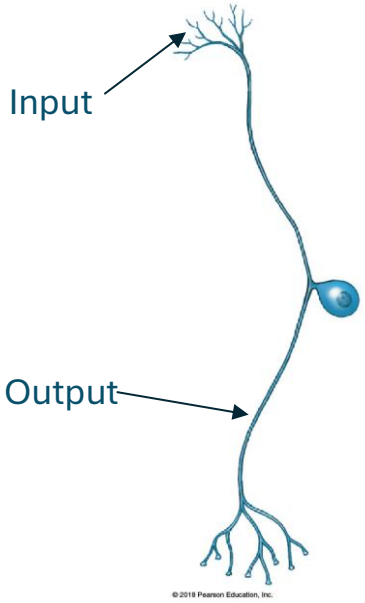


- Multiple processes emanate from the cell body

2. Bipolar

- Two(2) processes emanate from the cell body

3. Unipolar



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

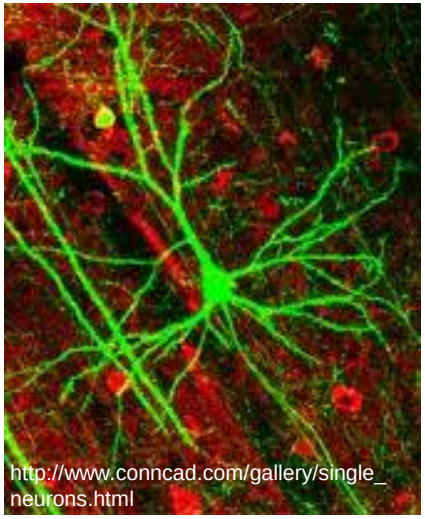
4. Anaxonic (axonless)

- No distinct axon
- All processes look alike

Images from: Martini 3rd ed, p448

Cells of the nervous system:
(I) Neurons – 4 Morphological types

1. Multipolar



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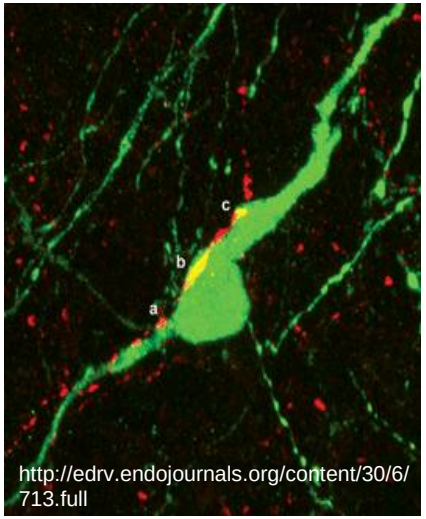
2. Bipolar



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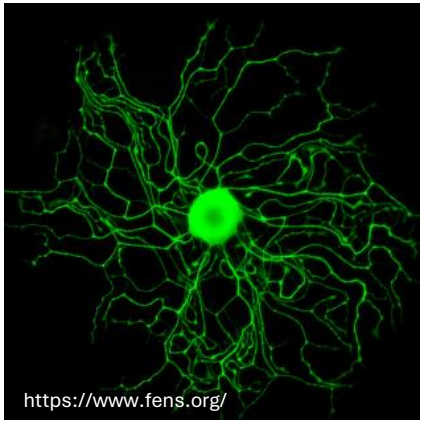
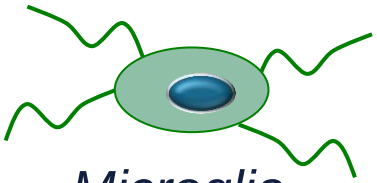


- No distinct axon
- All processes look alike

Cells of the nervous system:
IIa. Central Nervous System Glia

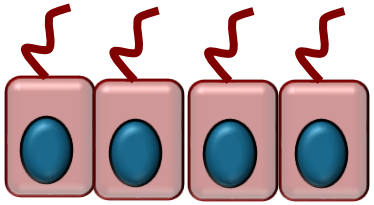
3 features → • Supply nutrients to neurons
• Cover blood capillaries
• Injury response

Astrocytes (Greek: ástron (star) + kytos (container))



Microglia

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



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

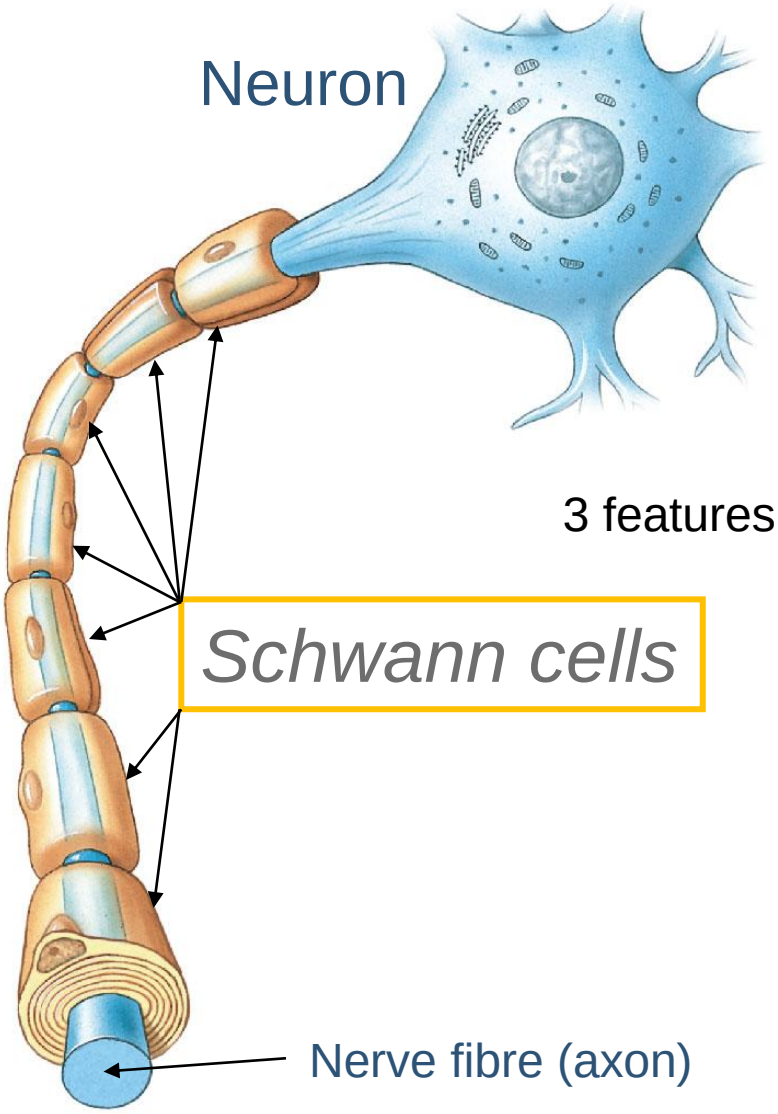
Ependymal cells (Greek: epéndyma (covering))

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

Oligodendrocytes (Greek: Oligos (small, few) + Déndron (tree)

See also: Martini 3rd ed, p450 for a drawing showing all cell types in context.

Cells of the Nervous system:
IIb. Peripheral Nervous System Glia



3 features →

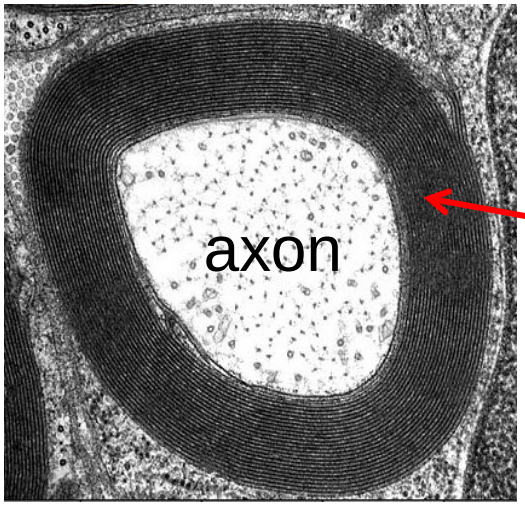
- Support **peripheral** nerve fibres
- Ensheath them with ***myelin***
- Similar to oligodendrocytes (CNS)

Martini 3rd ed, p452

The Myelin sheath

- What is it? →

• Lipid (fat) wrapped around axon



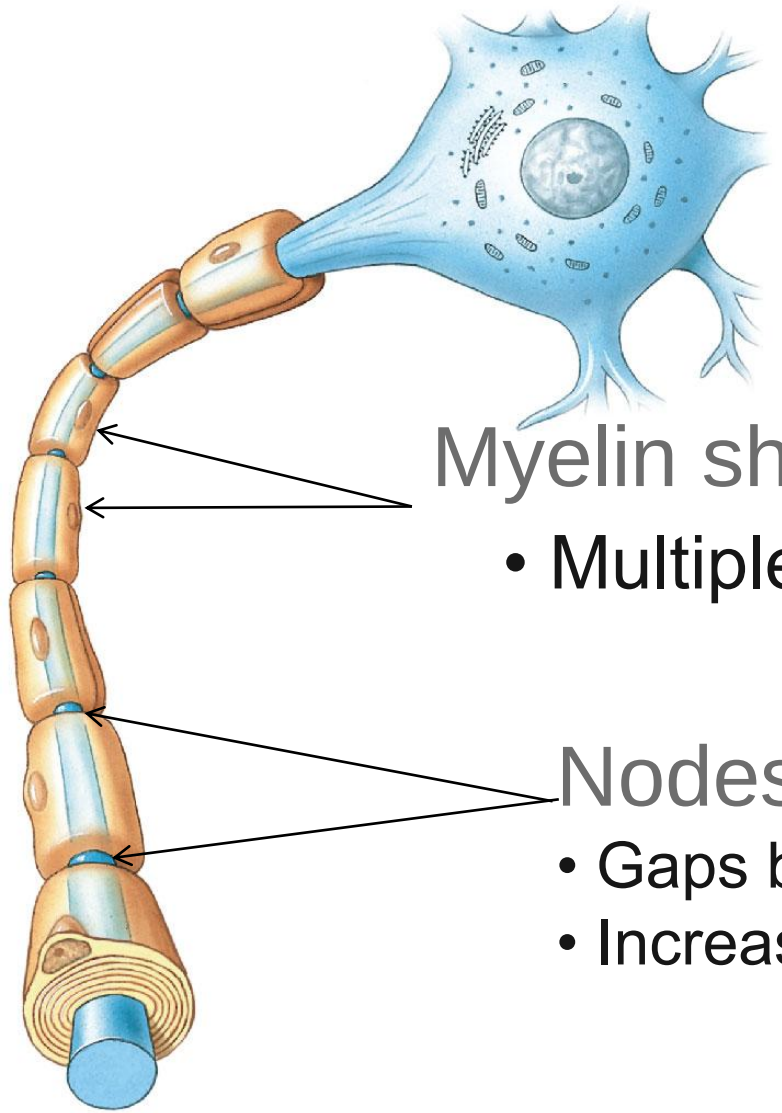
- Where does it come from
  - in the CNS? →
  - in the PNS? →

• CNS **Oligodendrocytes**
• PNS **Schwann cells**

- What is it for?

• **Increases conduction velocity**

Cells of the nervous system:
(II) Myelin Sheath - Basic structure



Martini 3rd ed, p452

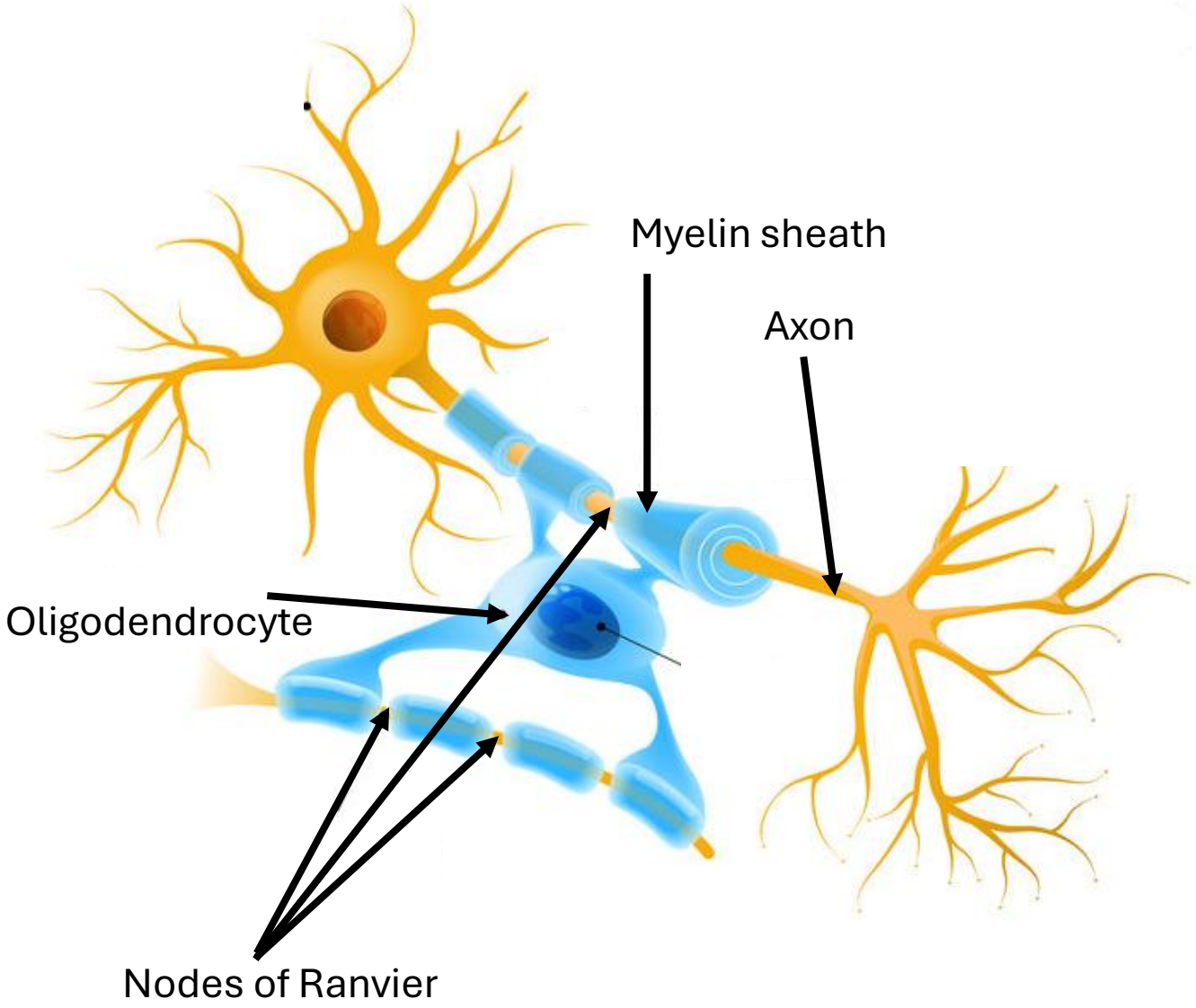
Myelin sheath

- Multiple Schwann cells in line

Nodes of Ranvier

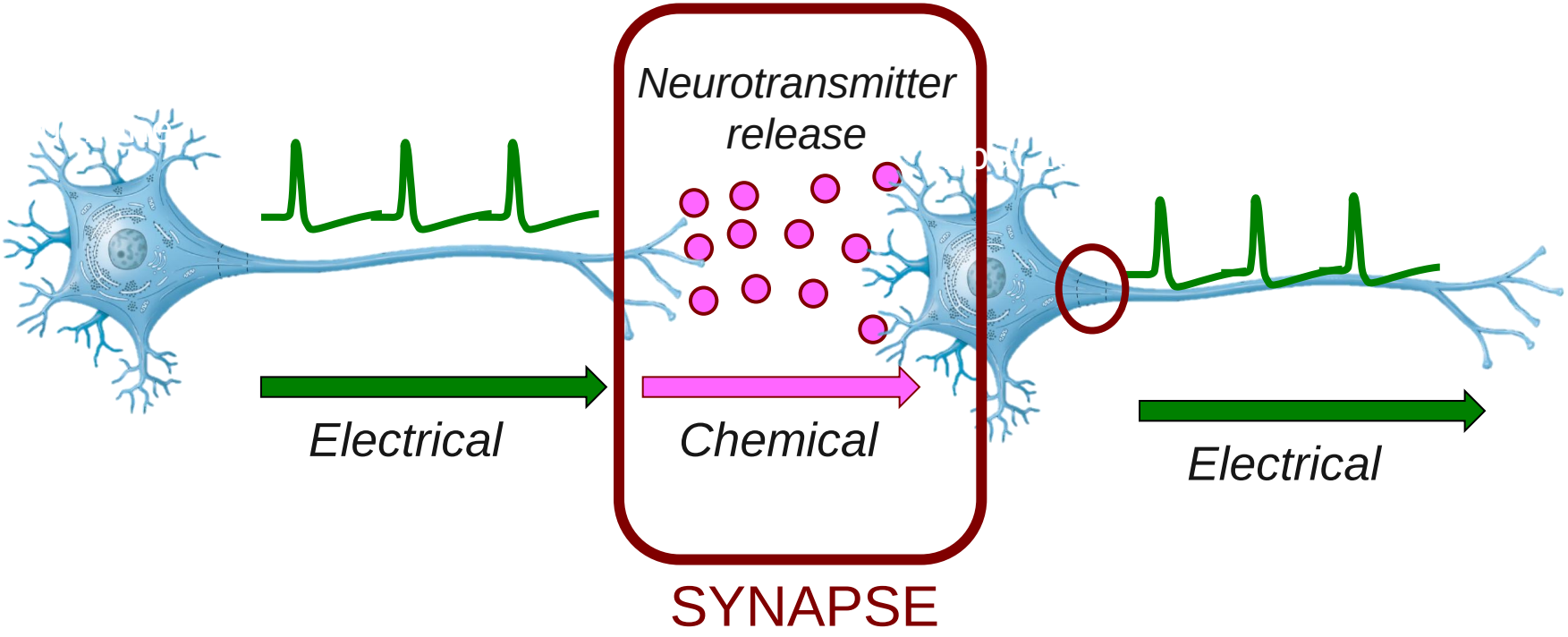
- Gaps between myelin
- Increase conduction velocity

Contrast with an Oligodendrocyte, which associates with more than one neuron



https://www.electrospinning.co.uk/case-studies/myelination-assay/

Learning objectives 4 & 5:
Communication between neurons occurs through a junction called a *SYNAPSE*



Martini 3rd ed, pp 446, 447

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

Electrical → *Chemical* → *Electrical*

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

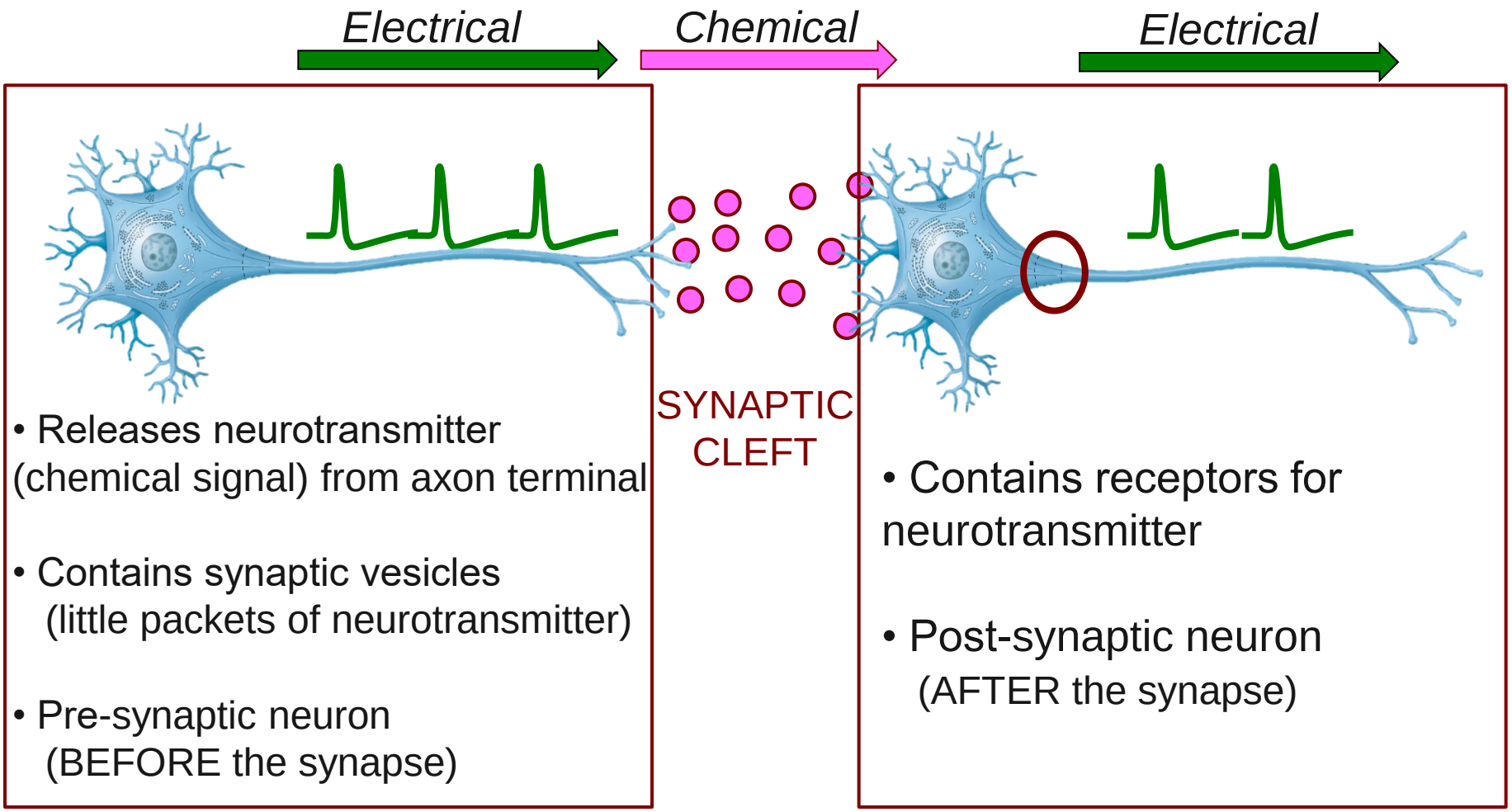
http://www.odt.co.nz/files/story/2010/05/apple_s_iphone__2145914265.jpg

Radio waves

Txt message
(readable words)

Radio waves

Anatomical terms refer to parts of cells involved with a synapse.



Martini 3rd ed, pp 446, 447

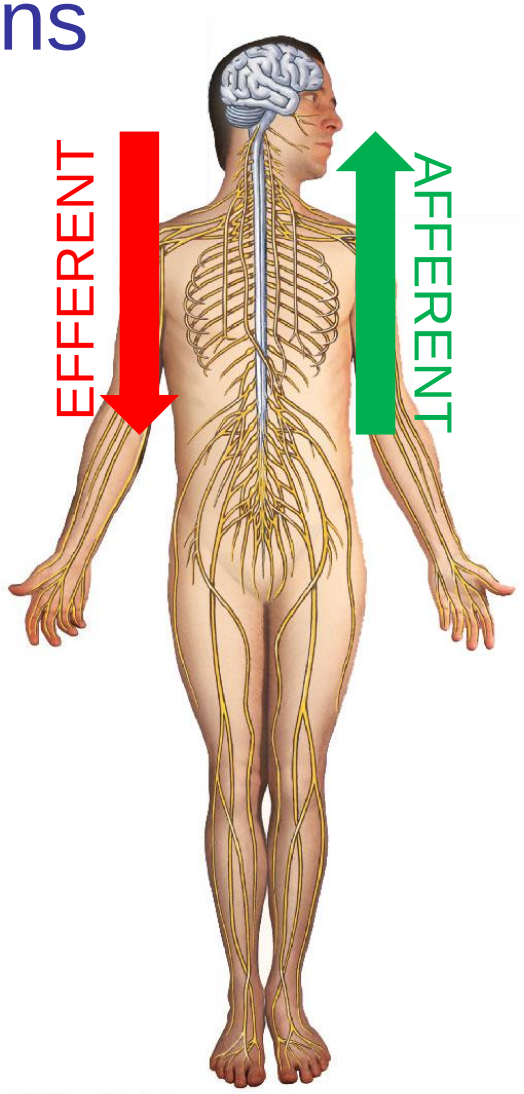
Learning objective 6:
Flow of information in the nervous system: Information goes in ***both*** directions

- 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)

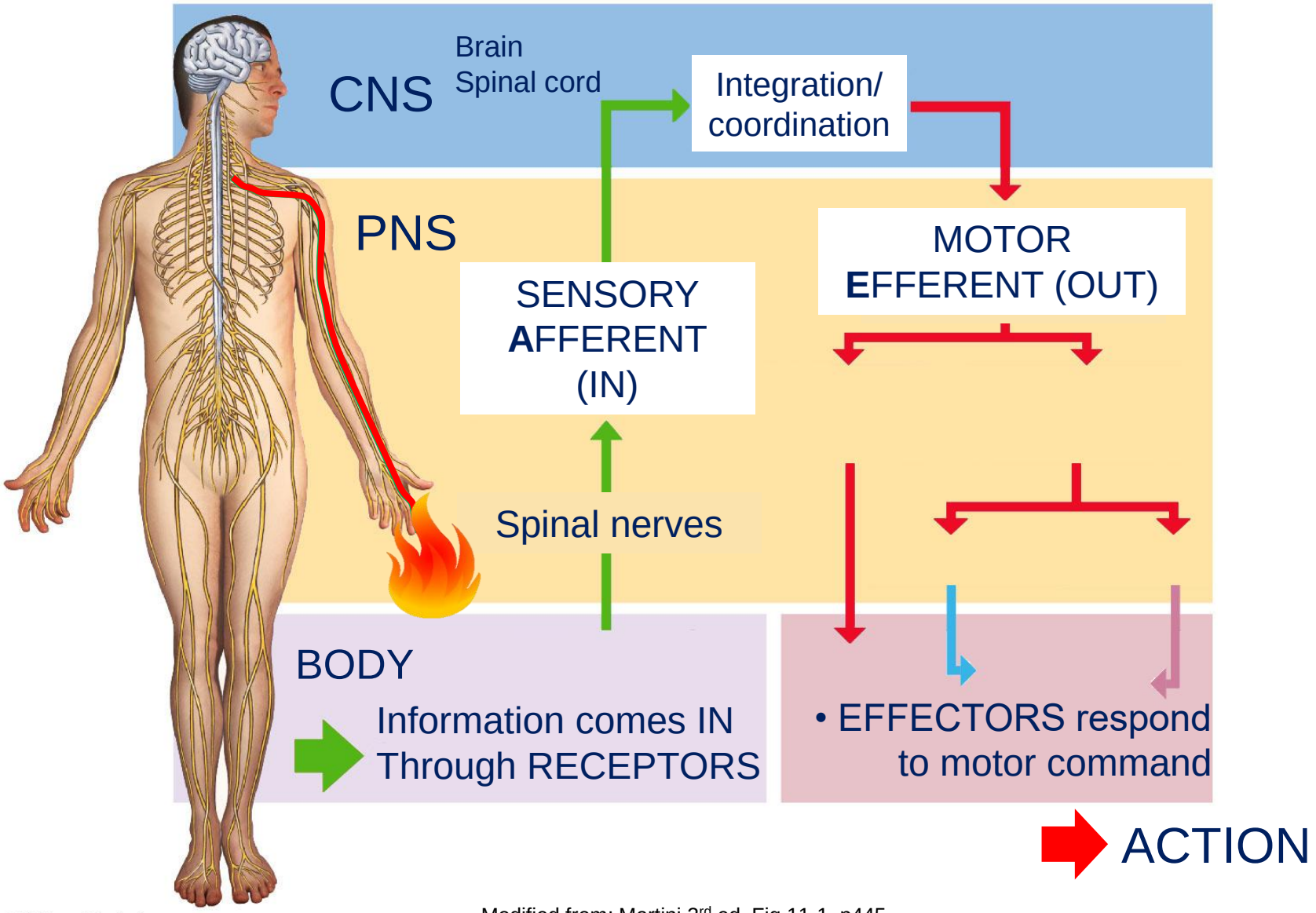


S.A.M.E

Sensory is **A**fferent, **M**otor is **E**fferent

Adapted from Patton & Thibodeau, 8th ed Fig 13-1 (9th ed Fig. 18-1; 7th ed Fig12-1)

Summary: Information flow in the nervous system



Modified from: Martini 3rd ed, Fig 11-1, p445

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

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

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

3. The part of a neuron where summation of inputs takes place is called:
   (A) Axon hillock (B) Node of Ranvier
   (C) Axon terminal (D) Synapse

HUBS191