

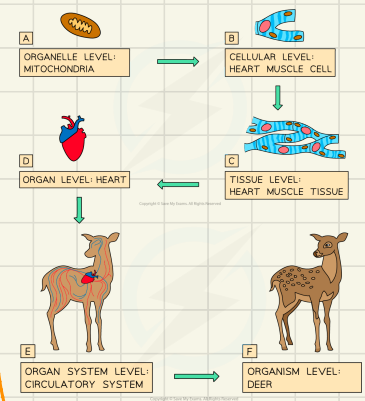
Body system Integration

C3.1.1 - System integration

System integration → when components communicate and coordinate

- ↳ Happens on multiple levels of organization
- ↳ "Different _____ work together to form _____"

emergent property }
 Multicellular organisms can do more than unicellular organisms because of this organization and interactive collaboration.



→ Characteristic that arises from the interaction of individual components within a system

C3.1.2 - hierarchy of subsystems

Tissue: group of 2 ≤ dif. types of cells with specialised structures & func. working together

→ Type I/II pneumocytes in lungs

digestive system (stomach, intestines, pancreas)

Organ: group of 2 ≤ tissues working together to perform a specific function

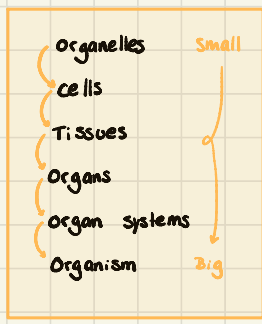
→ Spongy mesophyll tissue / palisade mesophyll tissue in leaf

→ Lung (alveolar tissue, cartilage tissue, ciliated epithelium tissue)

Organ system: group of organs working together to perform a function of life

Organism: a living thing made up of multiple integrated and interdependent systems @ many levels of organization

→ Humans have 11 organ systems



C3.1.3 - Integration of organs → hormonal ; nervous signaling ; transport

↳ Integration requires **Coordination**

1. Communication

- Hormones
- Nervous

2. Transport of materials

- Blood *main*
- Lymph
- Xylem/phloem

Communication:

Endocrine glands
Hormones
 • Chemicals
 • Travel → blood
 • Slower
 • long-term effect (until broken)
 • Any cell w/ receptor

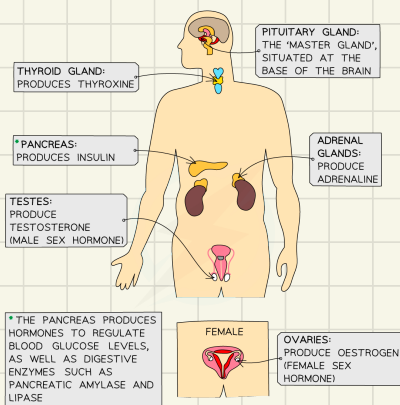
Nervous signals
 • Electrical impulses
 • Specific location
 • Effects muscles/glands only
 • Rapid
 • Very short

Transport of materials ; Energy:

↳ Blood / Circulatory system

carries things from one part to the next

↳ Some systems also pass along intermediate products to the next organ (digestive system)



PNS
 Peripheral Nervous System
 ↳ All nerves in body

CNS
 Central Nervous System
 1. Brain
 2. Spinal Chord

C3.1.4 - The brain as central integration organ

↳ Brain receives info (from sensory organs - touch, smell, vision, taste, hearing)

- Brain processes info
 - Brain stores info
- ↳ and possibly...

↳ Brain may send signals to effector organs

(muscles/glands) if response = required

Brain ⇒ responsible for controlling complex behaviours



C3.1.5 — Spinal cord as a center for unconscious processes

↳ Two parts of the nervous system

1. CNS [Brain / Spinal cord] — major processing centers

2. Nerves — stemming from CNS

→ can process info. independently from brain

↳ Spinal cord tissues

↳ unconscious level

1. White matter

a) Transmit signals from

i. Sensory receptors to brain

ii. Brain to other organs

Transportation post for neurosignaling } yes brain involvement

The SC cannot make conscious decisions. It either passes info to brain or makes unconscious processes.

2. Grey matter

a) Contains cell bodies & synapses

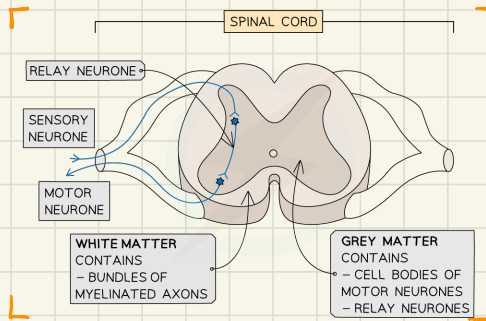
b) Processing info

c) Decision making

d) Unconscious processes only

• Ex. → movement of food through digestive track

No brain involvement
↳ reflexes
↳ directed by spinal cord alone



C3.1.6 — input to Spinal cord through sensory neurons

Sensory receptors → Sensory neurons → CNS → motor neurons → effector organs

if reaction necessary

gather info & send it

through this

to get here

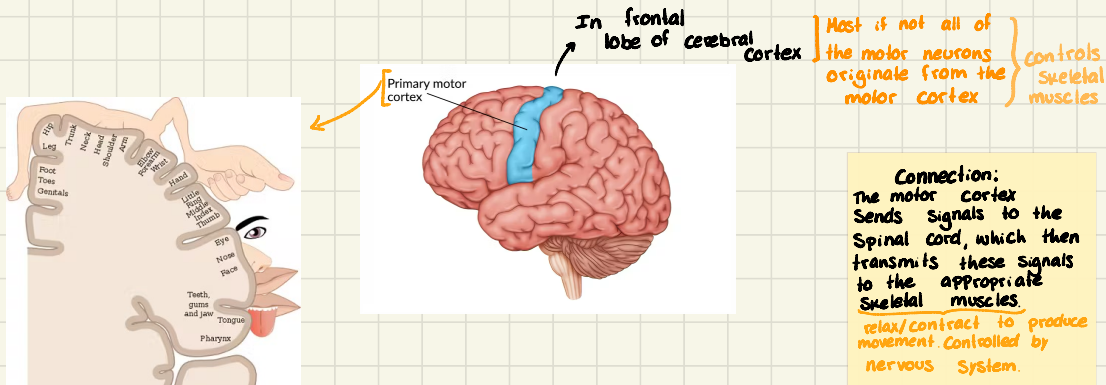
Types:

External:
Touch, Heat
Light

Internal:
Stretch receptors,
Chemoreceptors

C3.1.7 — Output from cerebral hemispheres to muscles through motor neurons

- ↳ Dif. brain parts affect dif organs via motor neurons
- ↳ Many neurons have cell bodies located in the same part of the brain, but their axons & terminals attach to dif. effector organs



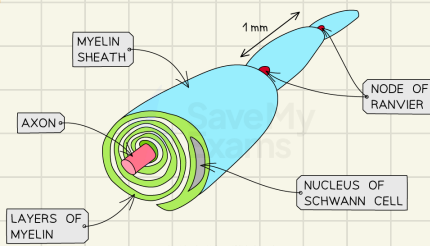
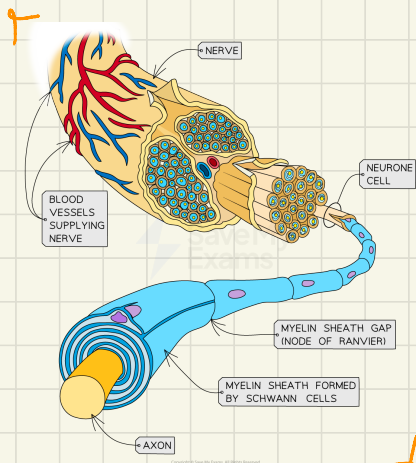
Sensory neurons => relay info. to CNS

Motor neurons => take info. from CNS and transmit signals to muscles/glands/organs

C3.1.8 — Nerves = nerve fibers of sensory/motor neurons

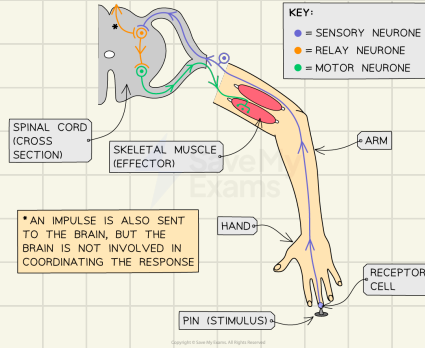
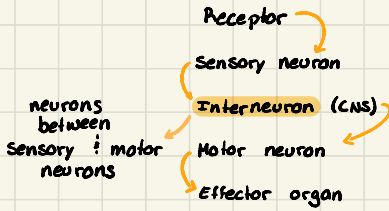
Nerve => bundle of nerve fibers surrounded by a sheath

- ↳ Contains both sensory & motor neurons [Each can only transmit signals one way]



C3.1.9 — Pain reflex arcs

Reflex arc => an involuntary and rapid response to a specific stimulus



Bc. it is a reflex, the CNS component involved = the spinal cord; however, the brain does receive a signal that makes us aware of stimulus. This comes after reflex.

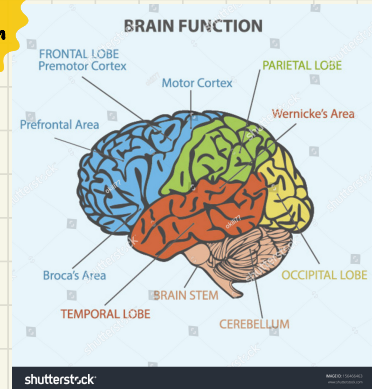
C3.1.10 — Role of cerebellum

Cerebellum

↳ Coordinates timing of muscle contraction

- i. Balance
- ii. Posture
- iii. walking
- iv. Hand / finger movement
- v. Eye movement
- vi. Speech
- vii. Things that require muscle memory

Does not initiate movement but it does coordinate; control it when the motor cortex initiates it.



C3.1.16 — Control of peristalsis by CNS & ENS (digestive system)

1. Voluntary : controlled by CNS

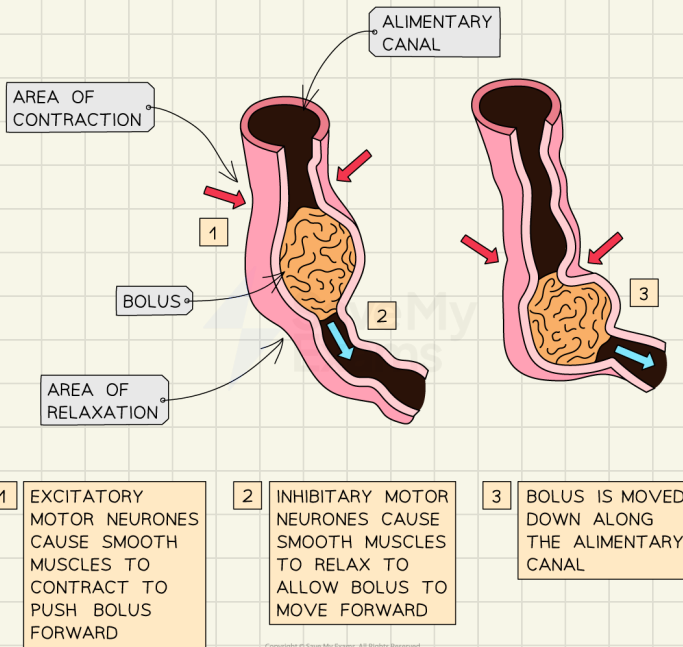
- Initiation of swallowing
- Defecation (later in life) [taking a shit or noi]

2. Involuntary : controlled by ENS (Enteric nervous system)

- Moving food through digestive tract (peristalsis)
- Defecation (early in life)

Peristalsis => muscle contractions that move food through digestive tract

↳ wave-like movement



C3.1.17 — tropic responses in seedlings

Tropism => growth responses to stimuli/factors in external environment

Positive tropism => growing towards the stimulus

Negative tropism => growing away from the stimulus

a) Roots exhibit positive gravitropism
gravity = stimulus

ii) Shoots exhibit negative gravitropism

b) Shoots exhibit positive phototropism
- Stems grow towards light = stimulus
light (photosynthesis)

H₂O

light

gravity

presence of objects

C3.1.18 — Positive phototropism

~~"positive phototropism in shoots is caused by a plant hormone"~~

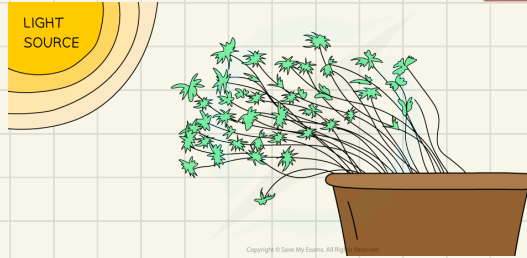
i) When a plant shoot = exposed to light from 1 side, cells on shaded side receive less light

ii) This unequal light exposure triggers redistribution of plant hormone auxin

- Auxin accumulates on shaded side
- Stimulates cell elongation

iii) By bending towards light, plant maximizes photosynthetic rate

Positive phototropism = a response that allows plants to optimize their position



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C3.1.19 — phytohormones

Phytohormone => plant hormone

growth

- promote/inhibit cell division/elongation
- Ex. => gibberellin causes stem elongation

Development

- ↳ promote/inhibit differentiation of plant tissues
- ↳ Ex. => ethylene ripens fruits

Response

to stimuli

- ↳ controls tropisms
- ↳ Ex. => auxin controls phototropism

C3.1.20 — Auxin

Auxin → a phytohormone that controls tropism

+ many other things
in plants

↳ wherever it needs to be present, there needs to be a high [auxin]

- Requires communication & coordination amongst cells

Auxin act as influx carriers

↳ auxin can move cell-to-cell, which is facilitated by

PEA proteins (located in membranes)

- Auxin efflux carriers facilitate the movement of auxin out of the cell

- These are distributed in a strategic manner

• Wherever there is more shade (needs

auxin for [] gradient establishment)

• They may move around membrane

Shoots

Stimulates elongation

Promotes growth

Roots

Inhibits elongation

Limits growth

C3.1.21 — Cell growth via auxin

1. auxin promotes ATPase proton pump synthesis

a) These pump H^+ ions

protein

2. Pumps protons into the apoplast

a) Area between membrane & end of cell wall

3. Lowers pH (acidification)

4. Activates expansins

a) Proteins that loosen bonds between cellulose microfibrils on cell wall

5. @ same time K^+ channels open

a) ↑ [K^+] in cytoplasm

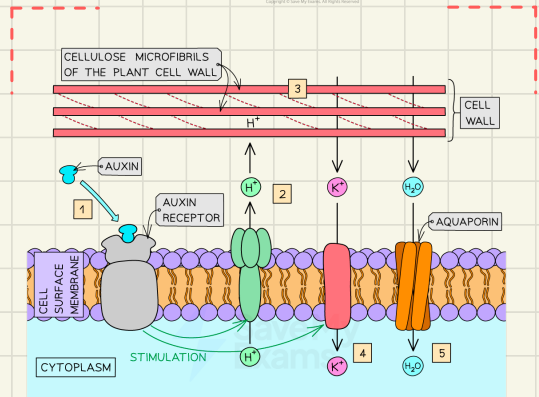
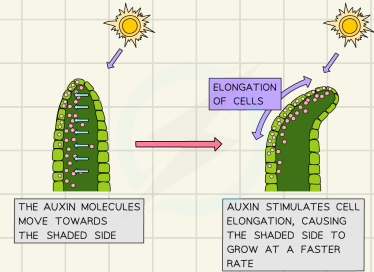
6. Prompts water absorption by osmosis

a) ↑ pressure of cell causing it to stretch

i. made possible by expansin proteins

b) causes bending towards light

c) facilitates phototropism



1. AUXIN MOLECULES BIND TO A RECEPTOR PROTEIN ON THE CELL SURFACE MEMBRANE

2. ATPase PUMPS PROTONS INTO CELL WALL

3. BONDS BETWEEN CELLULOSE MICROFIBRES LOOSENED

4. POTASSIUM ION CHANNEL OPENS. POTASSIUM IONS ENTER CYTOPLASM

5. WATER MOVES DOWN WATER POTENTIAL GRADIENT AND ENTERS CYTOPLASM

C3.1.22 — Interactions between auxin & cytokinin

Cytokinin => another phytohormone; produced in **roots** & transported to **shoots** (through xylem)

Auxin => produced in **shoots** & transported to **roots**

- ↳ Sometimes they work together
 - to accomplish growth @ same time
- ↳ Sometimes they work antagonistically
 - one can inhibit the other

Point:
There are multiple hormones that help make sure root & shoot growth are coordinated depending on stimulus.

- light
- chopping off shoots
- roots find a barrier

C3.1.23 — Fruit ripening & ethylene production

- ↳ Fruit ripens to aid in seed dispersal
 - Becomes more tempting for consumption (that is the goal)
 - Signaled by:
 - ➔ Color change, softening, scent production, sweetening
- ↳ Ripening = coordinated
 - using a phytohormone called **ethylene**
 - It works in a positive feedback loop to ripen fruit
 - ➔ That's why the fruit becomes gradually more ripe
- ↳ Ethylene is a gas
 - It affects nearby fruits
 - Allows them to synchronize together

