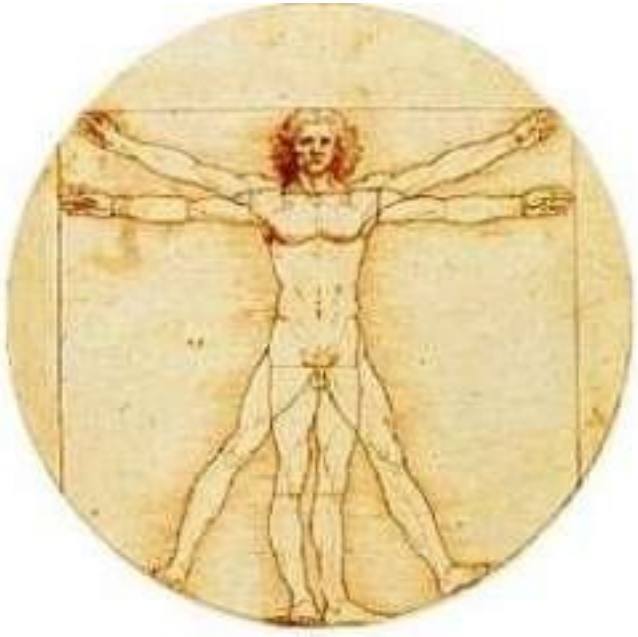
Coordination and Response

Homeostasis: the maintenance of a constant internal environment



The S in MRS GREN

2.77 understand that organisms are able to respond to changes in their environment

M	Movement	All living things move, even plants
R	Respiration	Getting energy from food
S	Sensitivity	Detecting changes in the surroundings
G	Growth	All living things grow
R	Reproduction	Making more living things of the same type
E	Excretion	Getting rid of waste
N	Nutrition	Taking in and using food

SENSITIVITY

A **stimulus** is a change in the environment of an organism.

Animals respond to a stimulus in order to keep themselves in favourable conditions.

Examples of this include:

- moving to somewhere warmer if it is too cold
- moving towards food if they are hungry
- moving away from danger to protect themselves

Animals that do not respond to a stimulus do not survive for long.

Homeostasis

2.78 understand that homeostasis is the maintenance of a constant internal environment and that body water content and body temperature are both examples of homeostasis

All organisms try and maintain a constant internal environment. This is called **homeostasis**.

Examples of homeostasis include:

1) The **regulation** of water levels.
2) The **regulation** of body temperature.

Stimulus > Receptor> Coordination > Effector > Response

2.79 understand that a coordinated response requires a stimulus, a receptor and an effector

- Both systems (Nervous and endocrine systems) respond to **stimuli**

(i.e. events that change the internal environment).

- Both systems have a:

1) **Receptor**, which detects the stimulus.
2) **Effector**, which carries out a response to correct the effect of the stimulus.

The message from detector to effector is carried either via an *electrical nerve impulse* or as *a hormone*, depending which homeostatic system is being used.

STIMULI

2.79 understand that a coordinated response requires a stimulus, a receptor and an effector

Examples of Receptors and Effectors

2.79 understand that a coordinated response requires a stimulus, a receptor and an effector

Receptor	
ORGAN	**RECEPTOR**
Skin	Temperature Receptor
Skin	Pressure / Pain Receptor
Brain (hypothalamus)	Water Concentration Receptor
Eye (retina)	Light Receptors (Rods & Cones)
Effectors	
ORGAN	**EFFECTOR**
Heart	Muscle cell
Skin	Sweat gland
Kidney	Collecting duct walls

STIMULI

2.79 understand that a coordinated response requires a stimulus, a receptor and an effector

Receptors detect Stimuli. Some examples are:

a) Light → Eye (retina)

b) Sound → Ear (hearing)

c) Movement (K.E) → Ear (balance) / Skin

d) Chemical → Nose / Tongue

e) Heat → Skin

Response in Plants

2.80 understand that plants respond to stimuli

Plants also respond to stimuli. As plants don't have nerves their responses are limited to hormones only. Plants respond to the following stimuli:

- **Gravity**: Roots grow towards gravitational pull and stems grow away. This is **Geotropism**.
- **Water**: Roots grow towards water. This is **Hydrotropism**.
- **Light**: Shoots grow towards light. This is **Phototropism**.

GEOTROPISM

2.81 describe the geotropic responses of roots and stems

Shoot tips and Root tips respond to GRAVITY.

- *Shoot tips grow away from gravity (Negative Geotropism)*
- *Root tips grow in the direction of gravity (Positive Geotropism)*

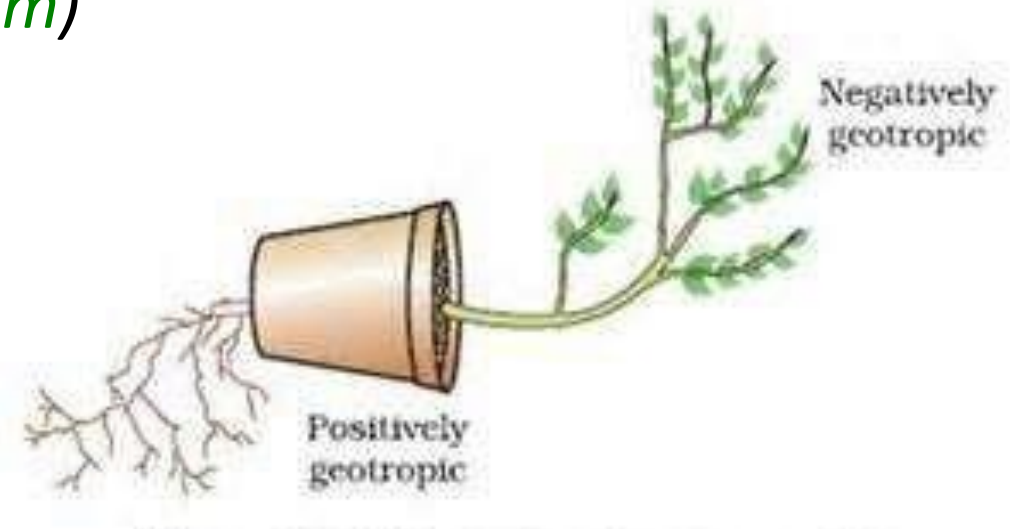


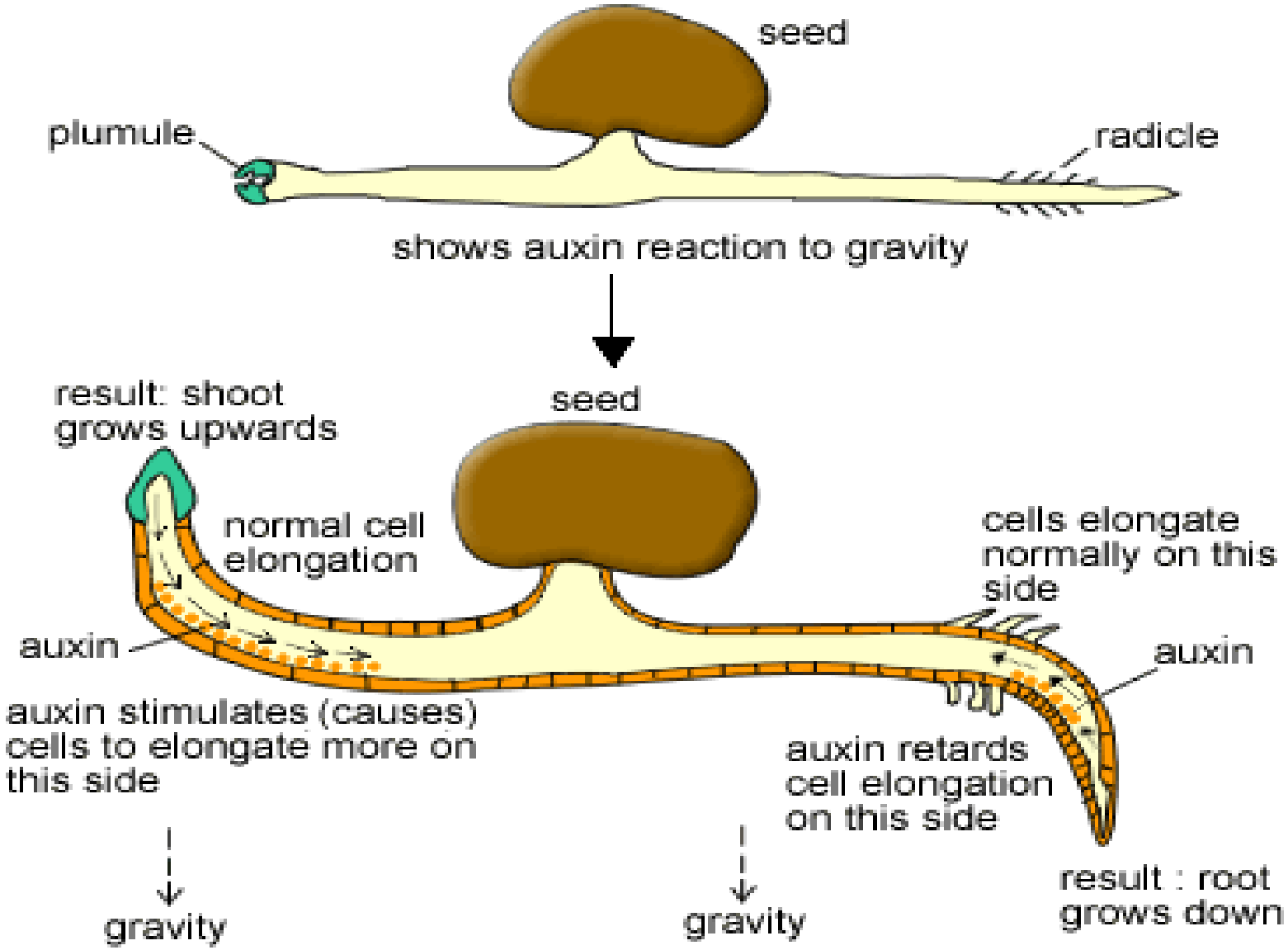
Figure 7.6 *Plant showing geotropism*

WHY

You only need to know that plants respond to a chemical hormone called

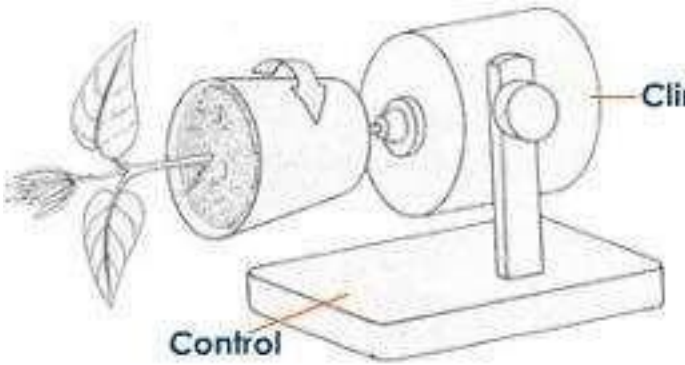
AUXIN

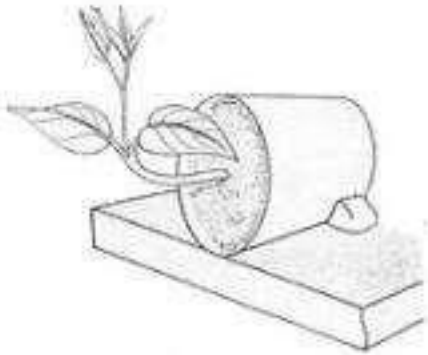
BUT if you want more……

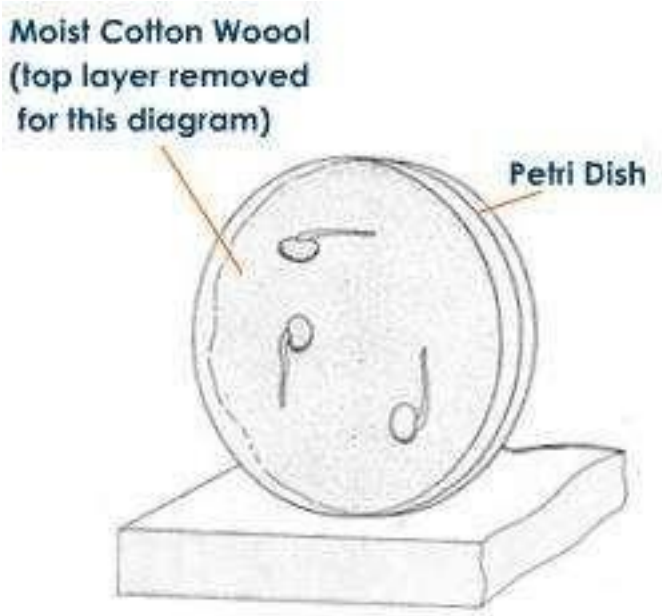


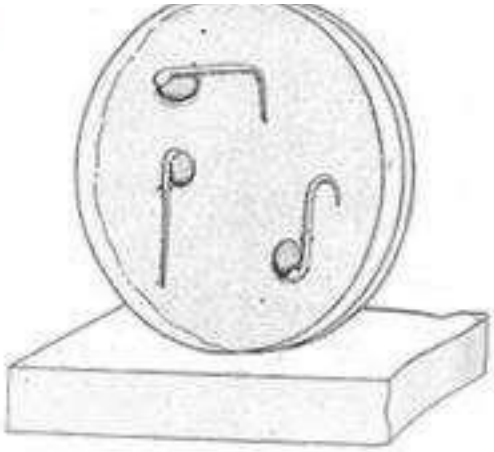
Stems are negatively geotrophic and roots are positively geotrophic.

You do need to know some fun experiments with plants









Result after 2 days

What happens when you grow a plant in space?

Positive Phototropism

2.82 describe positive phototropism of stems

Positive Phototropism is controlled by hormones released by the **growing tip** of the shoot.

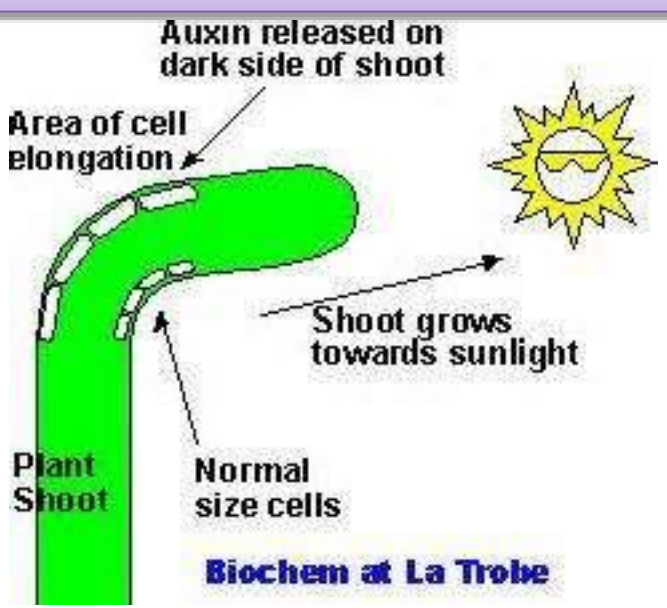
(Only the tip makes the hormone)

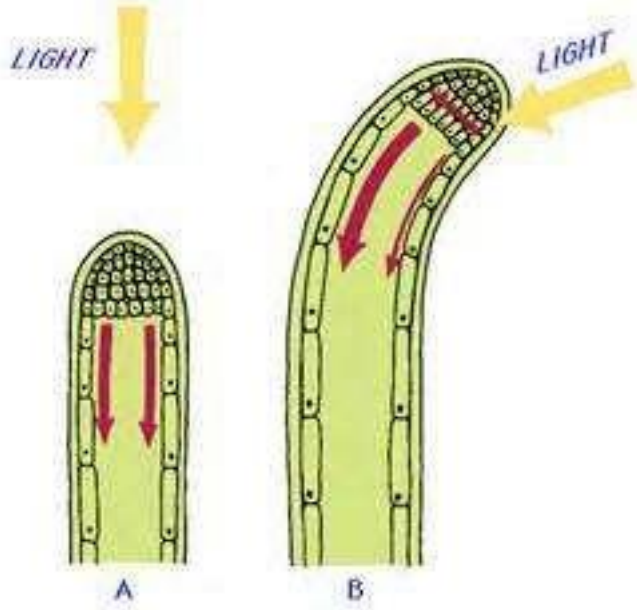
If you remove the tip, the shoot stops stop growing. The hormone made by the tip is called

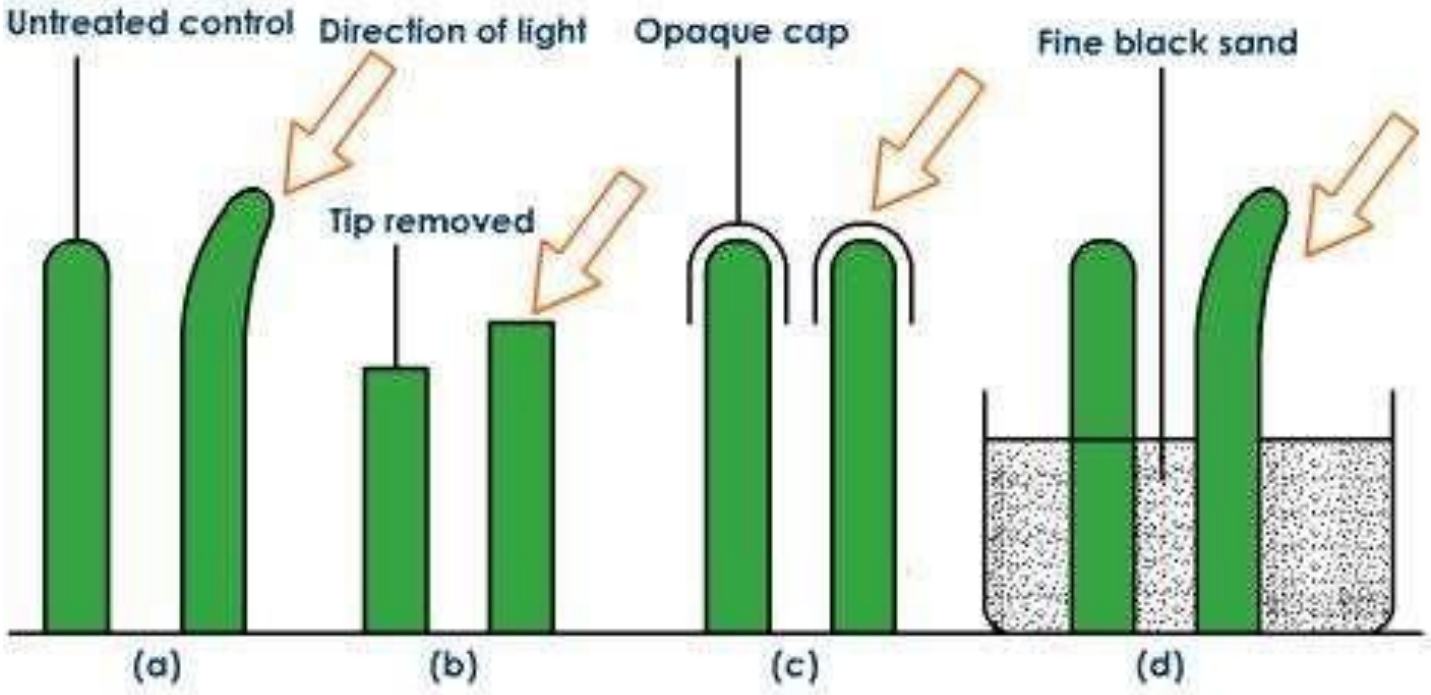
Auxin

(which part of the plant would be controlled by Negative Phototropism?)

PHOTOTROPISM

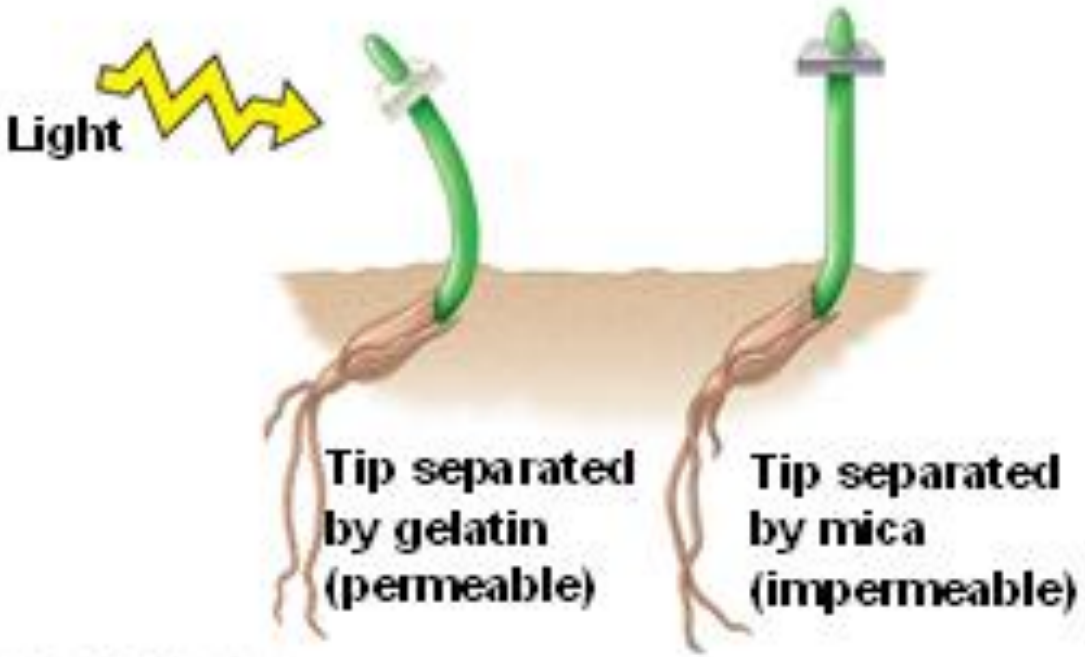

Auxin released on dark side of shoot
Area of cell elongation
Shoot grows towards sunlight
Plant Shoot
Normal size cells
Biochem at La Trobe


LIGHT
LIGHT
A
B


Untreated control
Direction of light
Opaque cap
Fine black sand
Tip removed
(a)
(b)
(c)
(d)

RESULTS

Boysen-Jensen: phototropic response when tip is separated by permeable barrier, but not with impermeable barrier



Response Systems

2.83 describe how responses can be controlled by nervous or by hormonal communication and understand the differences between the two systems

Humans have **two** systems which carry out detection and response:

- **Nervous System** – Chemical electrical system using Neurons

Example: Iris dilation, movement

- **Endocrine System** –Chemical system using proteins called hormones in the blood.

Example: Osmoregulation, Fight or Flight, Menstruation.

Differences

2.83 describe how responses can be controlled by nervous or by hormonal communication and understand the differences between the two systems

Nervous System	Endocrine System
Works by **nerve impulses** *(has chemicals in synapses though)*	Works by **hormones** transmitted in blood stream
Travel **fast** and usually have 'instant' effect	Travel **slowly** and may take longer to show effect
Response is **short** lived	Response is usually **longer** lasting
Impulse act on individual cells (**localised** effect)	**Widespread** effects on different organs (still only work on cells/organs with correct receptors)

Nervous System

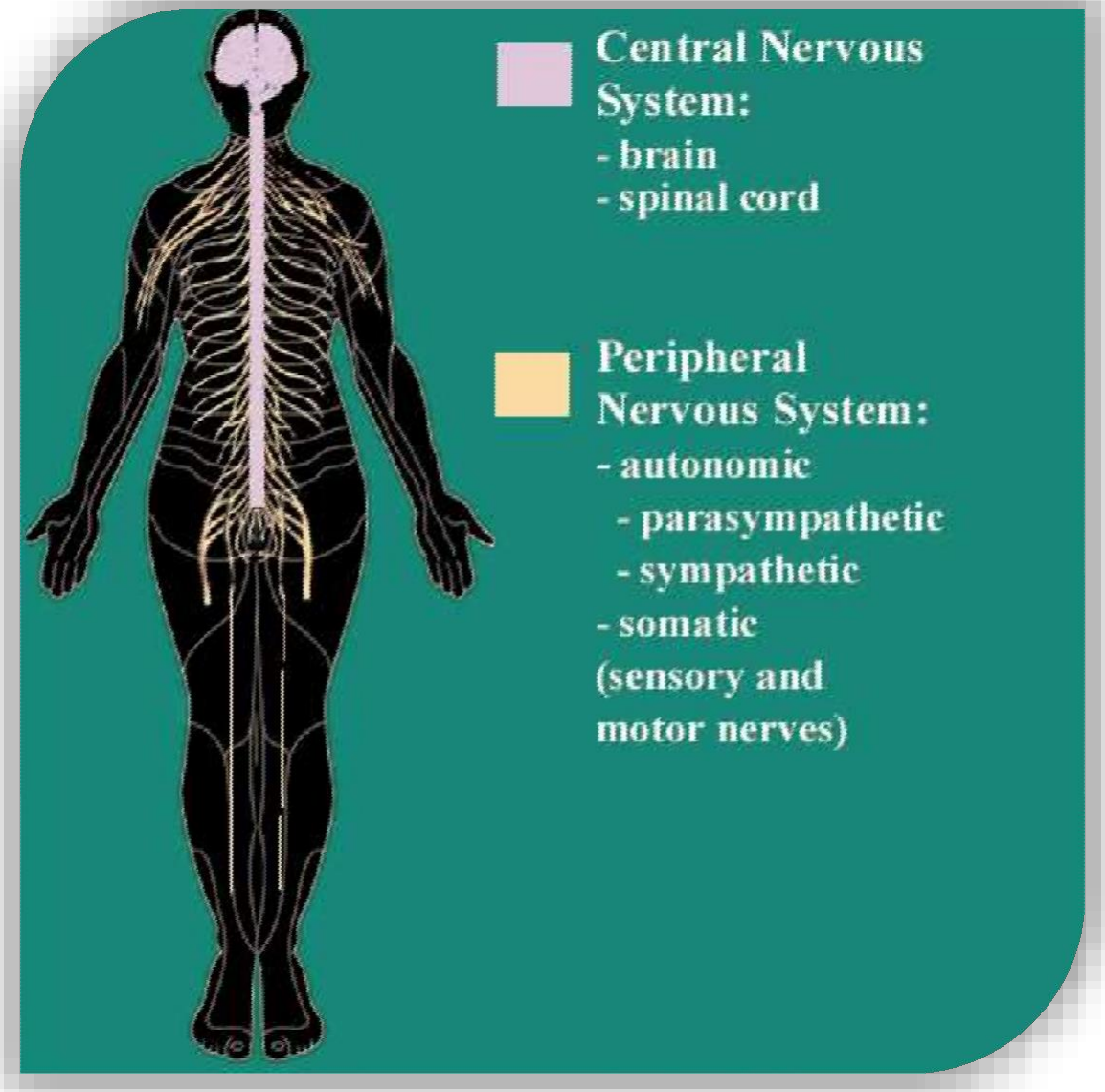
2.84 understand that the central nervous system consists of the brain and spinal cord and is linked to sense organs by nerves

The Central Nervous System (CNS) consists of

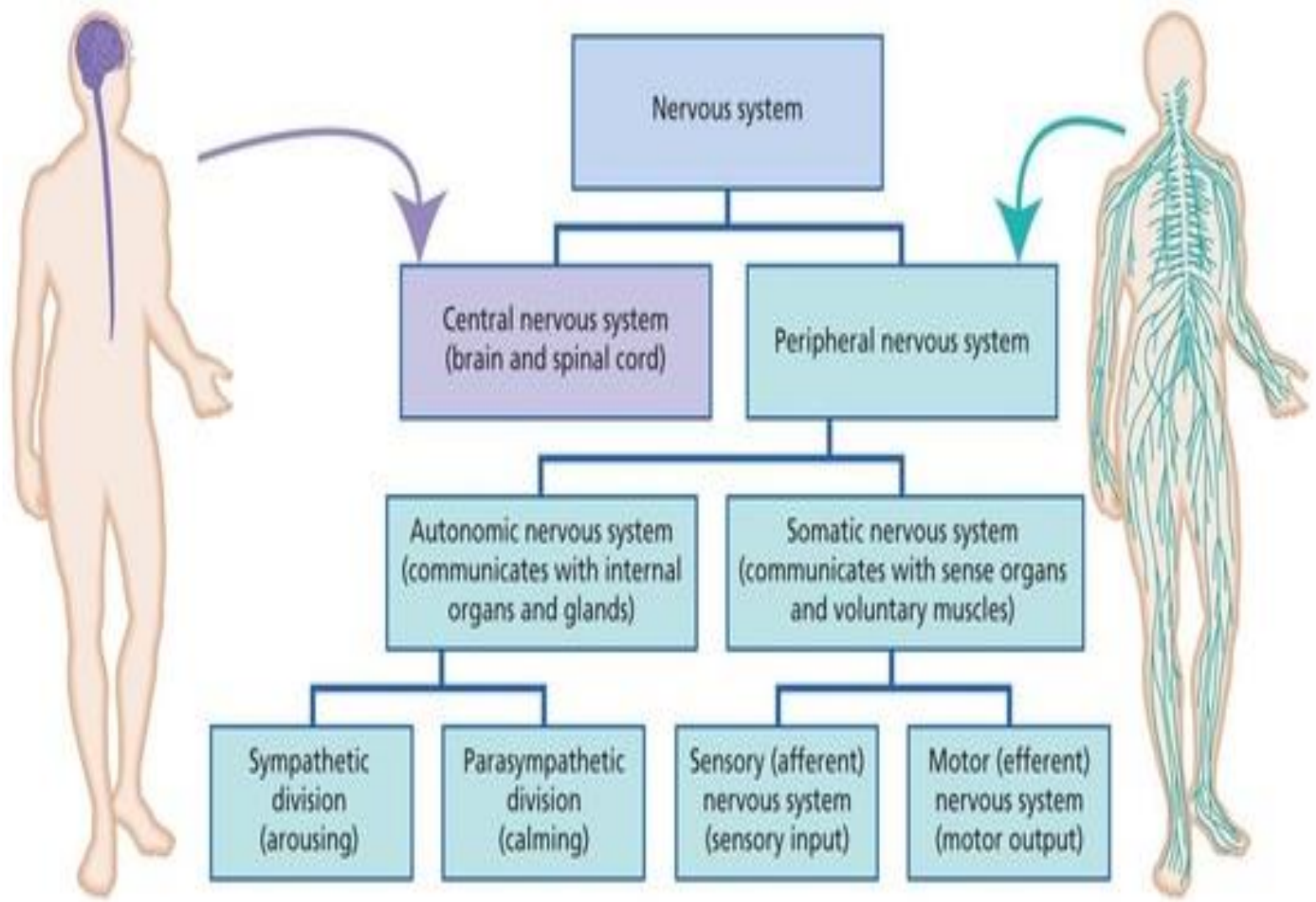
1) the **brain**
2) the **spinal cord**

There are also Peripheral Nerves System (PNS)

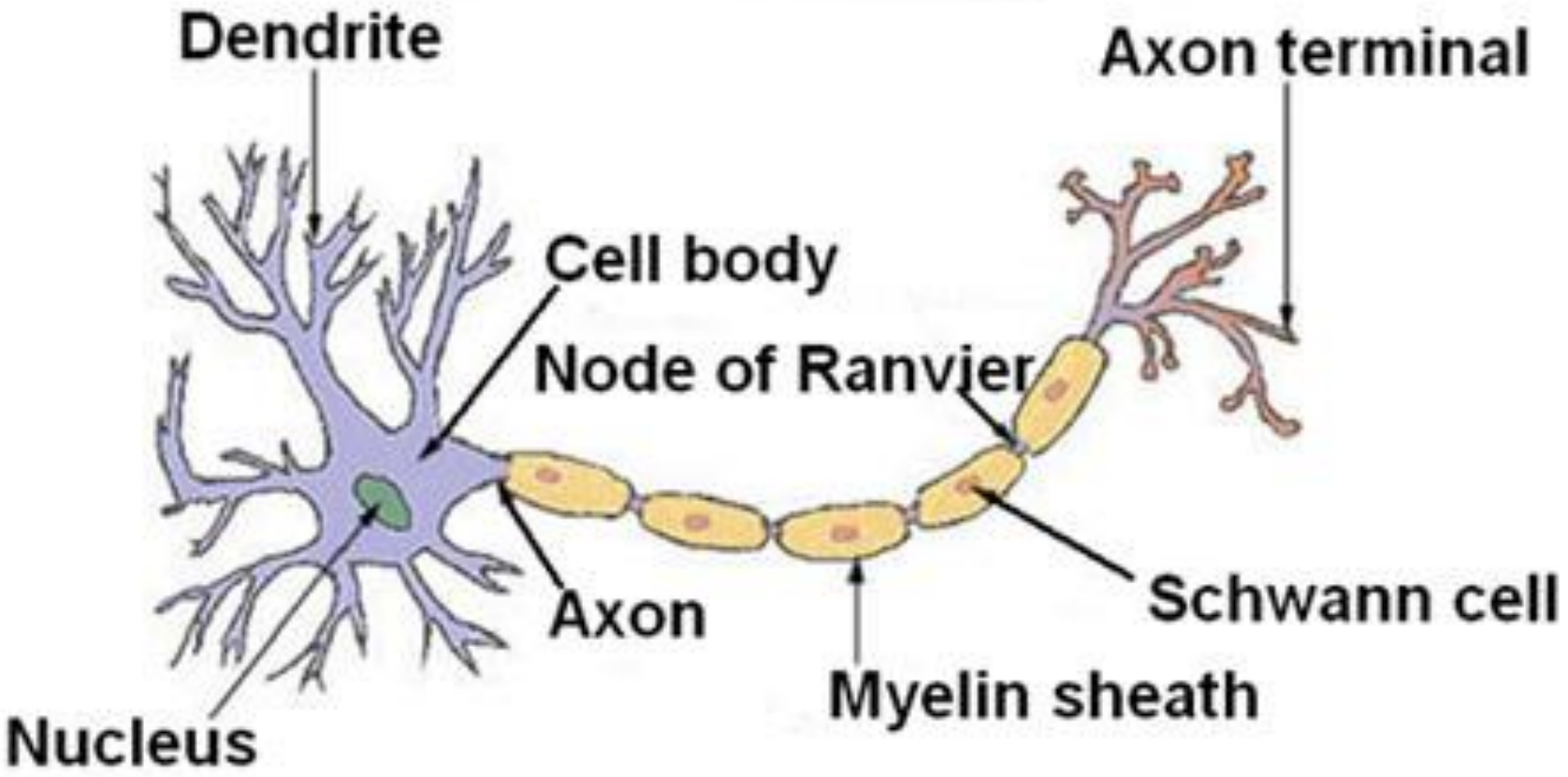
1) Sensory Nerves/organs (e.g. pain receptors in skin, or photoreceptors in the eye)
2) **nerves** that link brain and sense organs
3) Motor Nerves



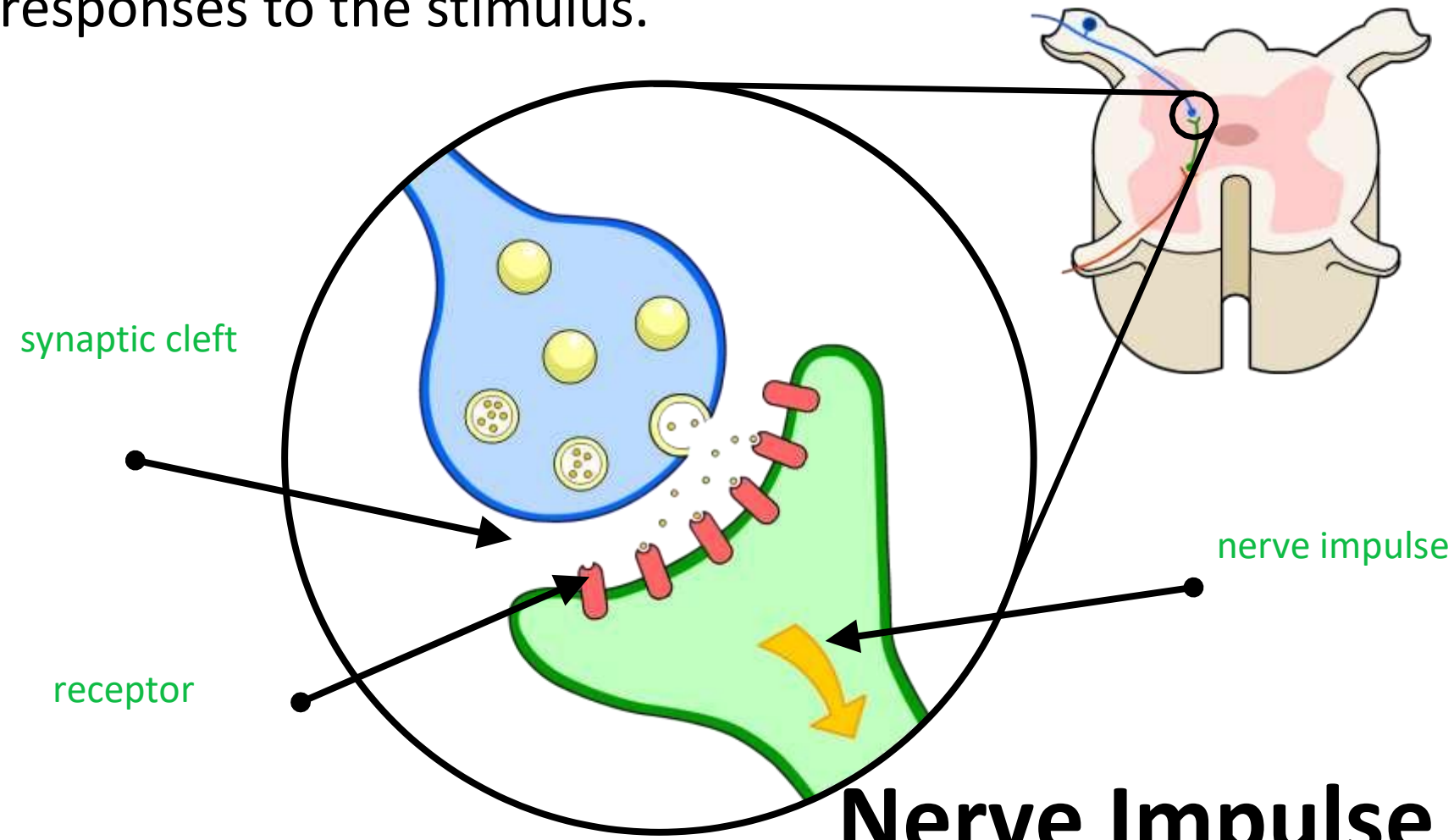
2.85 understand that stimulation of receptors in the sense organs sends electrical impulses along nerves into and out of the central nervous system, resulting in rapid responses



Structure of a Typical Neuron



Stimulation of the sense organs results in an electrical signal (a **nerve impulse**) being sent along the nerve to the brain. Nerve impulses are very quick (~120m/s), allowing rapid responses to the stimulus.



Nerve Impulse

DIFFUSION AGAIN??

2.85 understand that stimulation of receptors in the sense organs sends electrical impulses along nerves into and out of the central nervous system, resulting in rapid responses

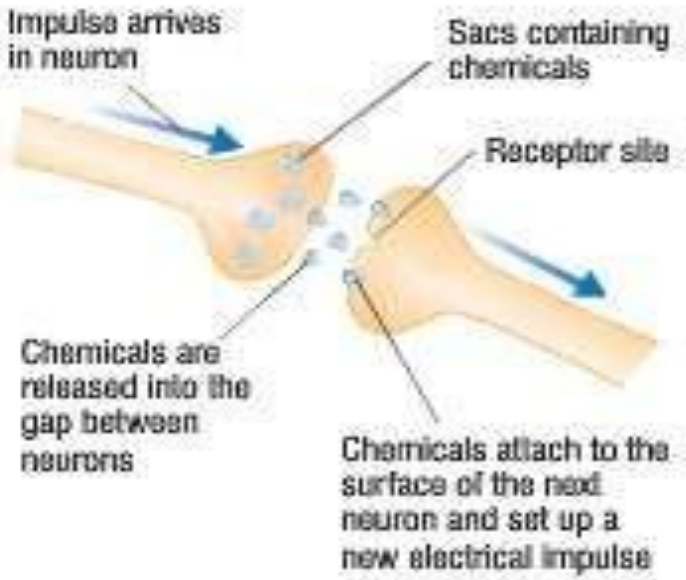
(You do not have to know the terms just the ideas)

1) An electrical impulse travels along a nerve ending.

2) This triggers the nerve-ending of a neuron to release **chemical messengers** called neurotransmitters. E.g., Acetyl choline, GABA etc.

3) These chemicals **diffuse** across the synapse (the gap) and bind with receptor molecules on the membrane of the next neuron.

4) The receptor molecules on the second neuron bind only to the **specific chemicals** released from the first neuron. This **stimulates** the second neuron to transmit the electrical impulse.



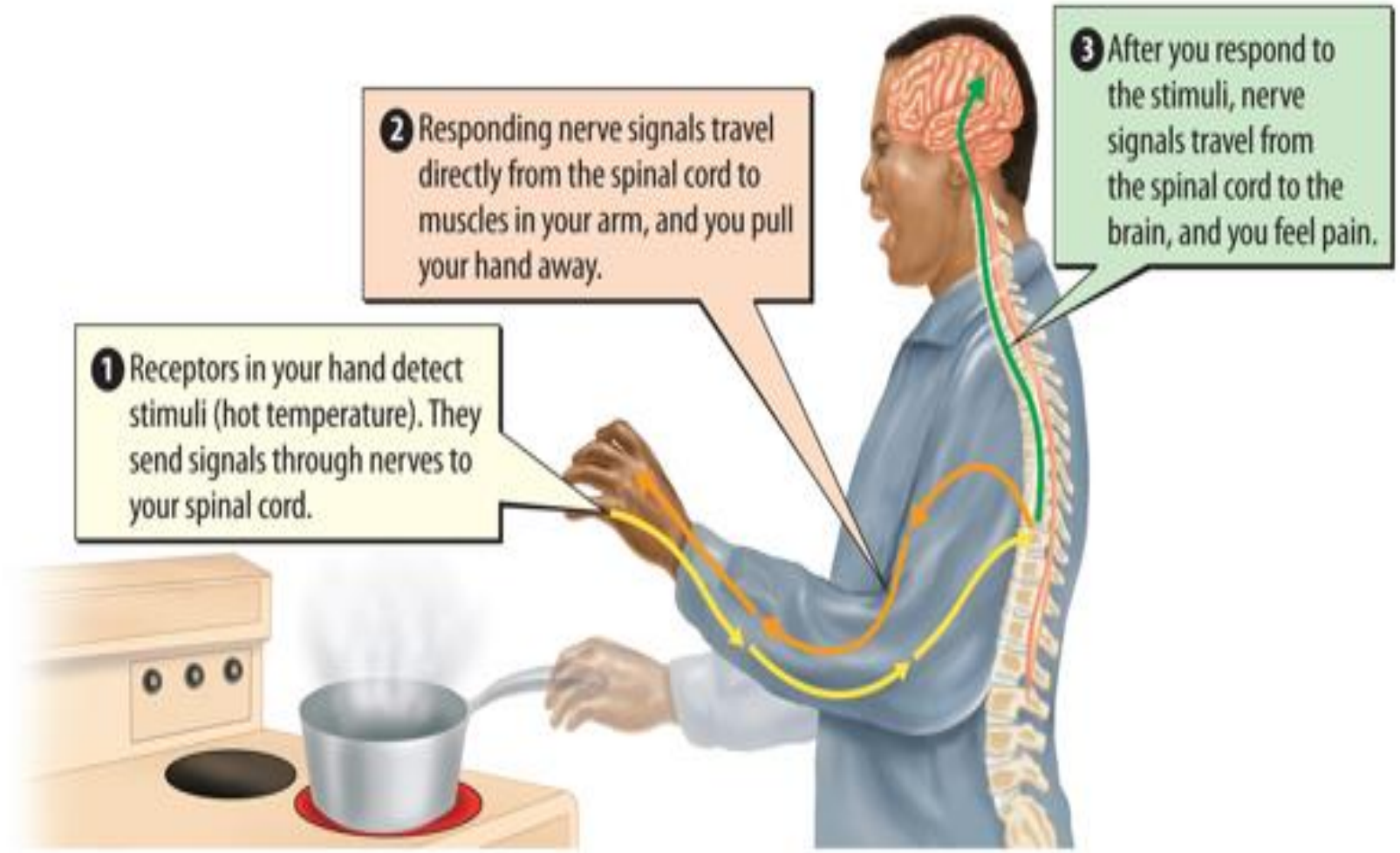
REFLEXS

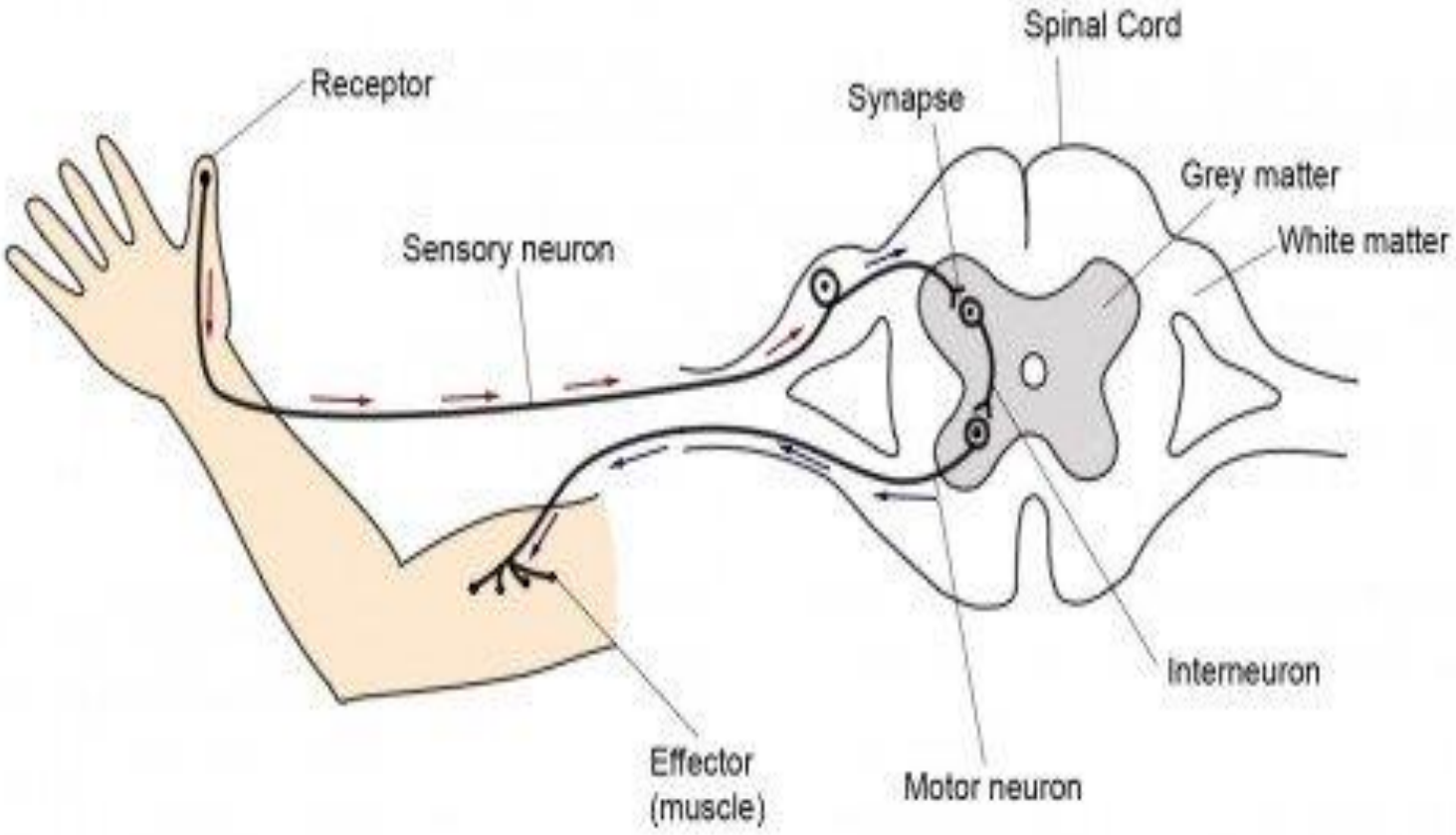
2.86 describe the structure and functioning of a simple reflex arc illustrated by the withdrawal of a finger from a hot object

Some sense organs are not connected directly to the brain.

This is a defense mechanism allowing almost instant responses to threatening or dangerous stimuli (e.g. pain/hot object).

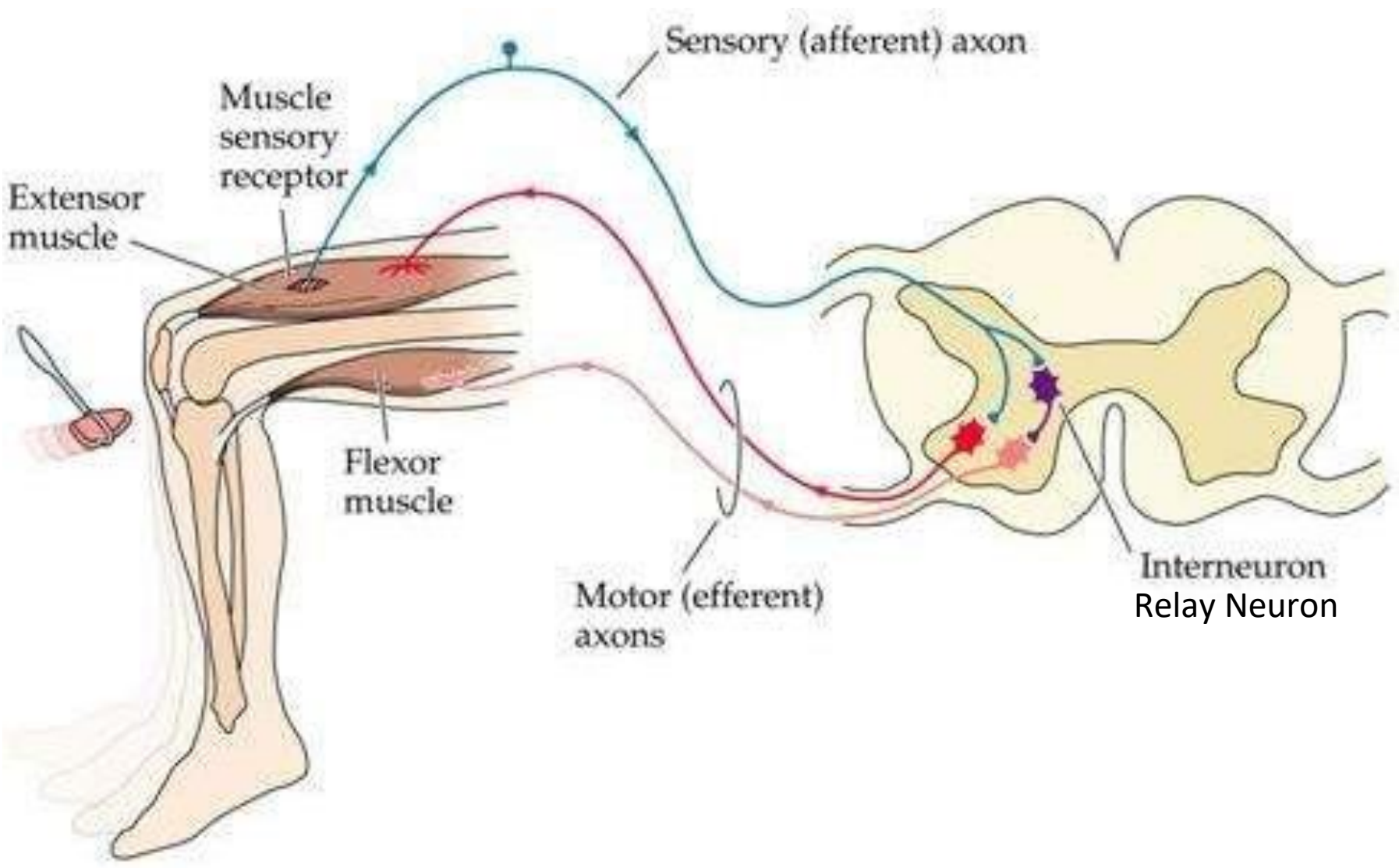
These instant responses are controlled by nerves in the spine, rather than the brain and are called **reflexes**


1 Receptors in your hand detect stimuli (hot temperature). They send signals through nerves to your spinal cord.
2 Responding nerve signals travel directly from the spinal cord to muscles in your arm, and you pull your hand away.
3 After you respond to the stimuli, nerve signals travel from the spinal cord to the brain, and you feel pain.


Spinal Cord
Receptor
Synapse
Grey matter
White matter
Sensory neuron
Interneuron
Effector
(muscle)
Motor neuron

REFLEX ARC

2.86 describe the structure and functioning of a simple reflex arc illustrated by the withdrawal of a finger from a hot object



STEP BY STEP REFLEX ARC

2.86 describe the structure and functioning of a simple reflex arc illustrated by the withdrawal of a finger from a hot object

1) A **stimulus** is detected by a **receptor**
2) The receptor initiates a nerve impulse in the **sensory nerve**
3) The sensory nerve (which runs from the receptor to the spine) passes the message/impulse onto an **interneuron/Relay Neuron** in the spine
4) The interneuron/relay neuron passes the message to a **motor nerve**
5) The motor nerve (which runs from the spine to a muscle in the same limb as the receptor) passes the message onto the **effector** muscle
6) The effector muscle carries out the **response** (muscle contraction).

Reflex Arc Timing

2.86 describe the structure and functioning of a simple reflex arc illustrated by the withdrawal of a finger from a hot object

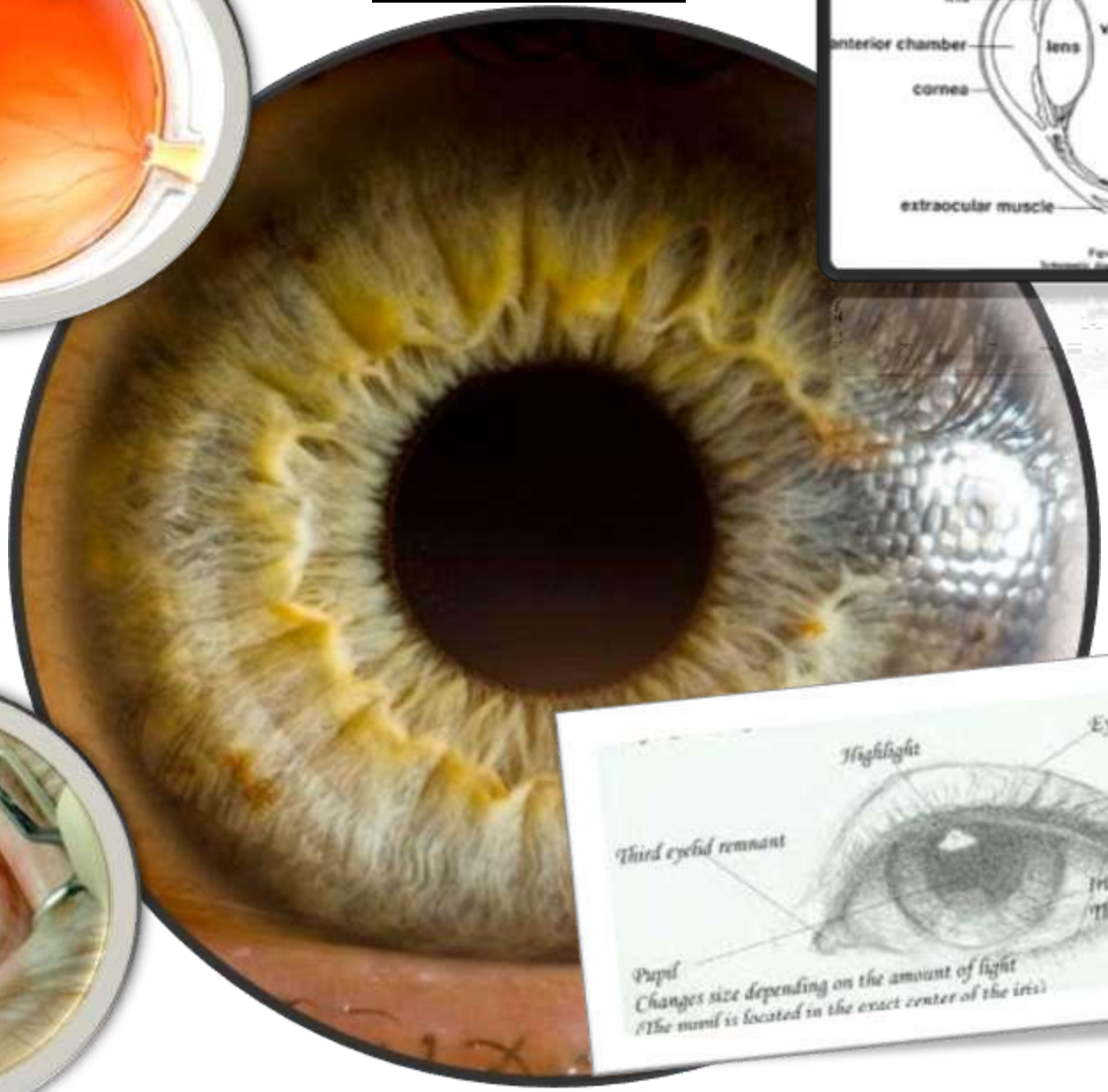
The entire process (stimulus to response) happens in less than a second and does not involve the brain.

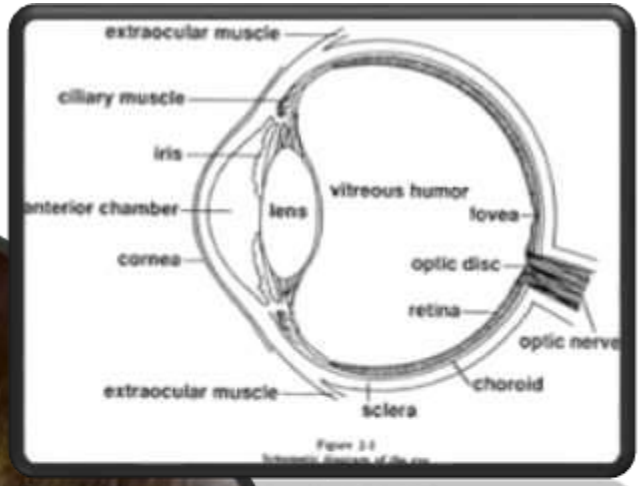
The purpose of the interneuron is also to inform the brain of what has happened.

Reflex Summary

1) Immediate response to stimulus
2) Automatic reactions
3) Limits damage to organism

THE EYE




extraocular muscle
ciliary muscle
iris
anterior chamber
cornea
lens
vitreous humor
fovea
optic disc
retina
optic nerve
choroid
sclera
extraocular muscle

Eye Lid
Highlight
Eye Lashes
Lower and upper
Third eyelid remnant
Iris
The colored part of the
Pupil
Changes size depending on the amount of light

EyE WebSites

2.87 describe the structure and function of the eye as a receptor

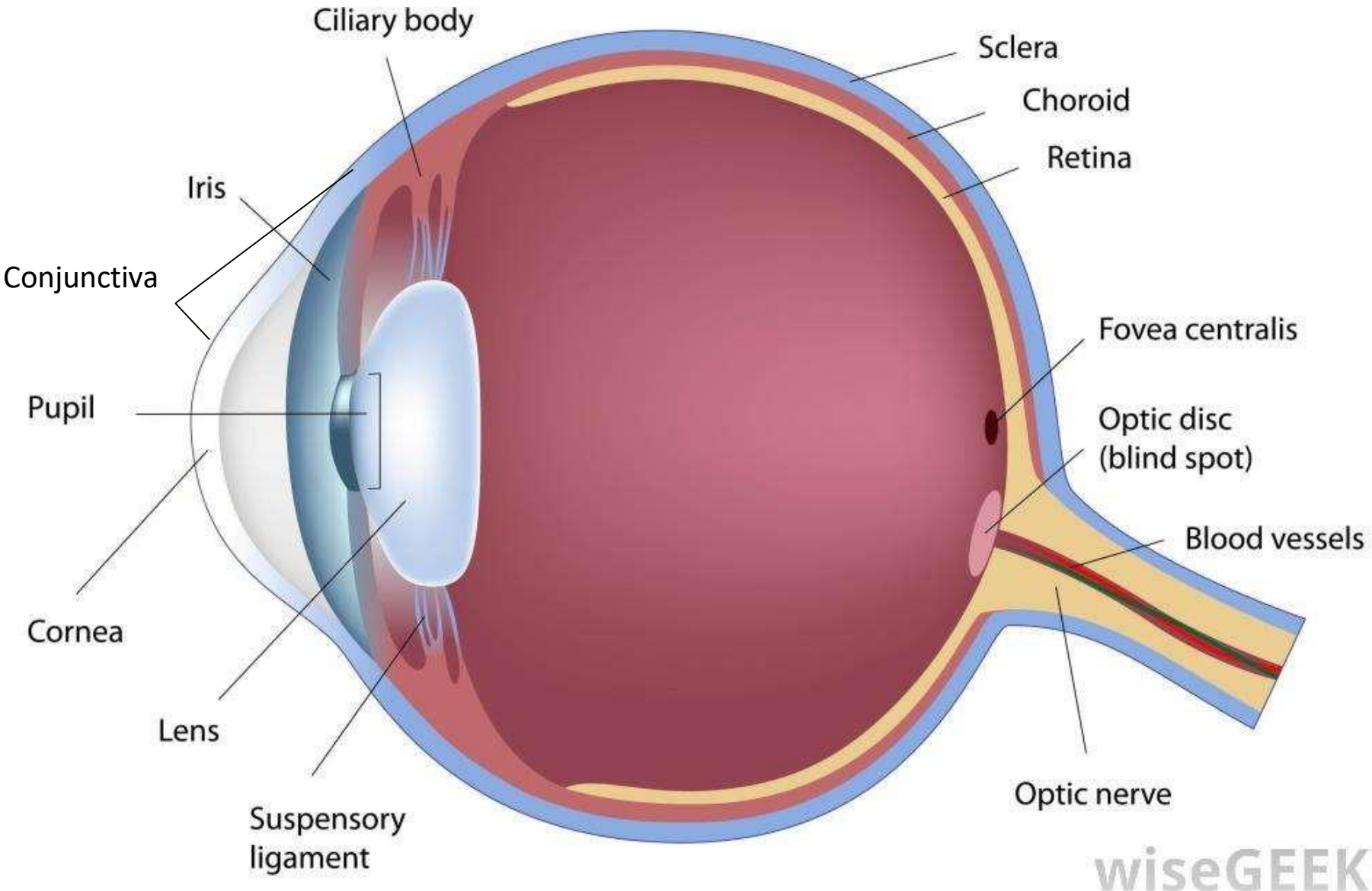
- a) Label the eye
  http://www.kscience.co.uk/animations/eye_drag.htm

- b) Light and the eye
  http://www.kscience.co.uk/animations/eye.htm

- c) Fun with your blind spot
  http://www.med.yale.edu/neurobio/mccormick/fill_in_seminar/figure1.htm

EYE DIAGRAM

2.87 describe the structure and function of the eye as a receptor



Define these Terms

2.87 describe the structure and function of the eye as a receptor

- Ciliary Body (muscle) — Contracts or Relaxes to change shape of lens
- Iris — Coloured muscular part of eye that controls pupils size
- Pupil — Opening in the iris that lets light through to the retina
- Cornea — Transparent front part of the eye that refracts light
- Lens — Transparent part of the eye that bends light (refracts)
- Suspensory Ligament — Ligament that controls the shape of the lens
- Sclera — Dense white covering of the eye
- Choroid — Vascular membrane of the eyeball between the sclera and the retina & stops light reflecting around in the eye
- Retina — Light sensitive membrane that converts light to electrical signals to the brain
- Fovea — Part of the retina with a high density of cones for very sharp vision
- Optic Disk (blind spot) — Area of retina that is insensitive to light
- Optic Nerve — Where electrical impulses from retina travel to brain
- Conjunctiva — helps lubricate the eye by producing mucus and tears

RODS & CONES

2.87 describe the structure and function of the eye as a receptor

Light is detected by **photoreceptors** in the eye. These receptors form the **retina** (the inner lining of the eye).

There are two types of photoreceptor

Rods, which see only in black & white

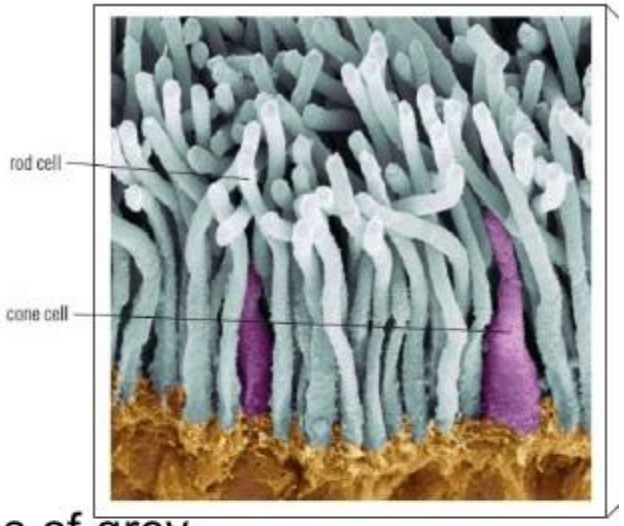
&

Cones, which see in either **red**, **blue** or **green**

(3 types of cones)

Hint: Cone and Colour both start with 'C'

Rods and Cones



- **rod** cells: **light** sensors
  - 120 million
  - Functions in less intense light
  - Used in peripheral vision
  - Responsible for night vision
  - Detects black, white and shades of grey
- **cone** cells: detects **colour**
  - 7 million
  - Highest concentration at fovea centralis
  - Functions best in bright light
  - Perceives fine details
  - 3 types of cone cells, each sensitive to one of the three primary additive colours: red, green, and blue

Automatic Reflexs

2.88 understand the function of the eye in focusing near and distant objects, and in responding to changes in light intensity (TA)

There are **two** types of reflex you need to know about in the eye

1) Responding to different light levels

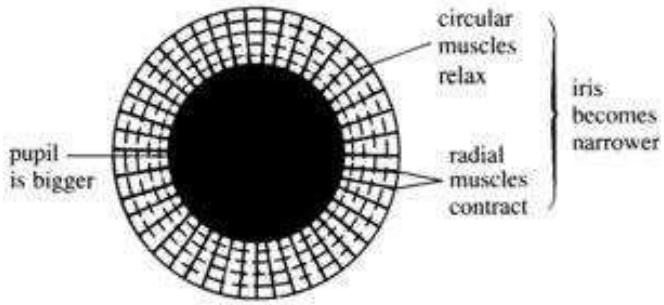
2) Focusing the eye

Responding to Light Levels

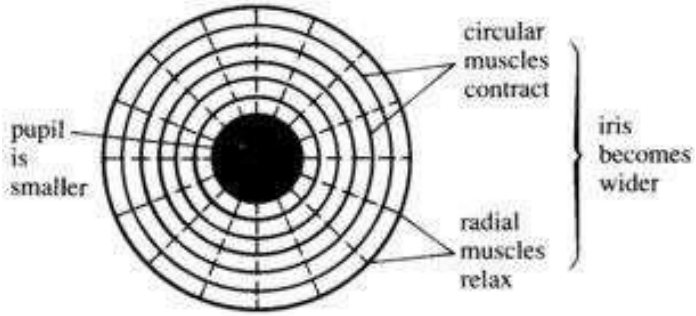
(Antagonistic Muscle Pairs at Work)

2.88 understand the function of the eye in focusing near and distant objects, and in responding to changes in light intensity (TA)

Condition (Stimulus)	Bright light	Dim light
Receptors	More photoreceptors stimulated	Less photoreceptors stimulated
Impulses	More impulses sent to the brain via optic nerve	Fewer impulses sent to the brain via optic nerve
Effectors	Radial muscles of the iris relax Circular muscles of the iris contract	Radial muscles of the iris contract Circular muscles of the iris relax
Gross Effect	Pupil constricts (becomes smaller) Less light enters the eye	Pupil dilates (becomes larger) More light enters the eye



(b) The eye in dim light

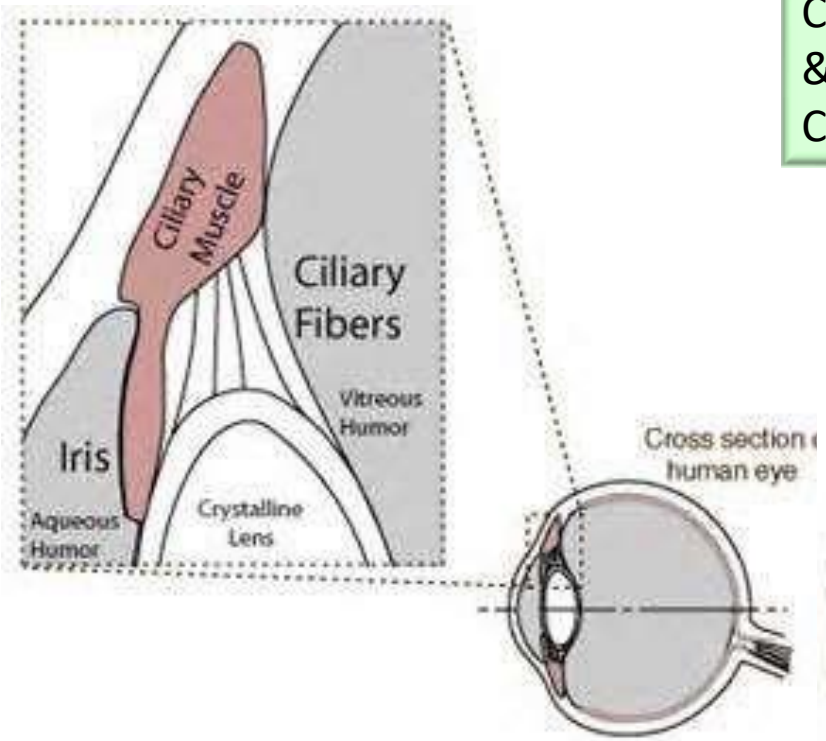


(a) The eye in bright light

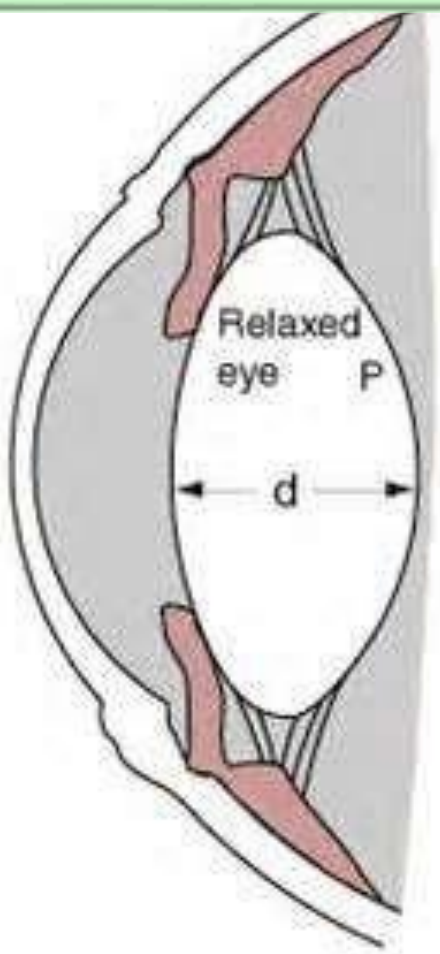
FOCUSING THE EYE

2.88 understand the function of the eye in focusing near and distant objects, and in responding to changes in light intensity (TA)

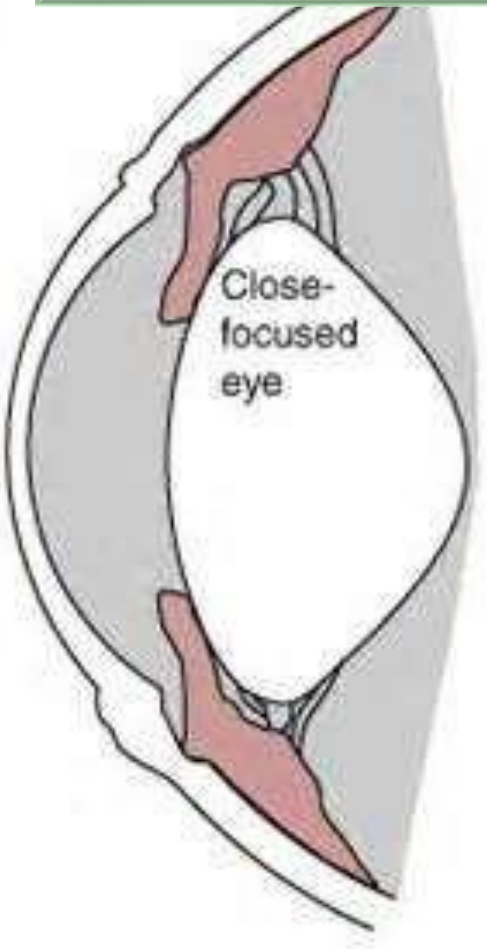
Cilary Muscle & Suspensory Ligaments



Ciliary Muscle Relaxed & Suspensory Ligament Contracted



Ciliary Muscle Contracted & Suspensory Ligament Relaxed



Ciliary fibers are also known as **Suspensory ligaments**

ACCOMODATION

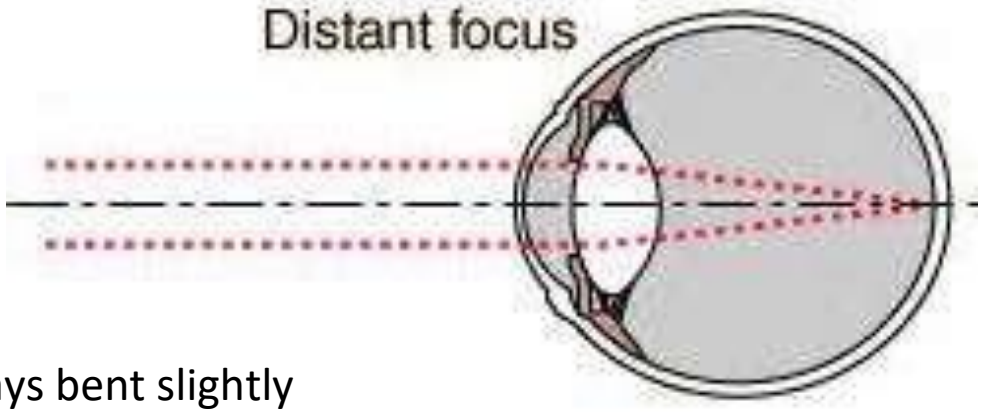
2.88 understand the function of the eye in focusing near and distant objects, and in responding to changes in light intensity (TA)

(Focusing)

Distant Focus

Ciliary Muscles relax

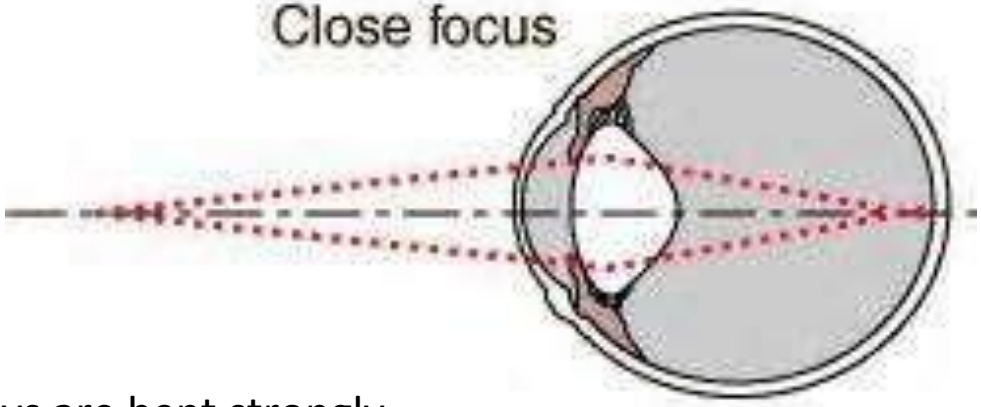
- Suspensory Ligaments contract
  - Lens is pulled
    - Lens is thin
      - Light rays bent slightly
        - Light rays focus on retina

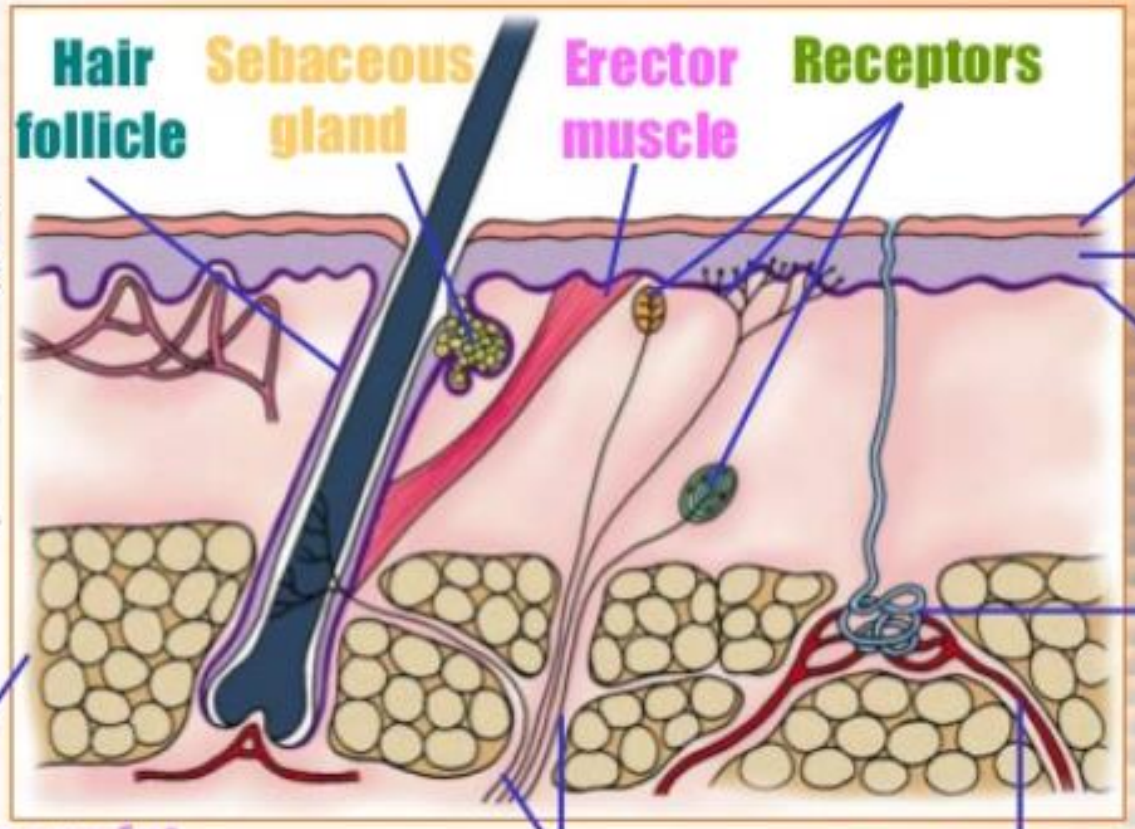


Close Focus

Ciliary Muscle contract

- Suspensory Ligaments relax
  - Lens is not pulled
    - Lens is fat
      - Light rays are bent strongly
        - Light rays focus on retina





Structure of Mammalian Skin

Structure and Function of Skin Component

Structure	Function
Epidermis	Consist of three layer
• Cornified layer	• Contains keratin an effective waterproof layer • Protected body from microbial infection, mechanical and thermal damage
• Granular layer	• Replaces dead cells from the cornified layer
• Malphigian layer	• Cells undergo cell division • Contains melanin to protect genetic material from UV radiation
Dermis	
• Blood vessel	In temperature regulation
• Sebaceous gland	Secretes sebum which act as a lubricant
• Sweat gland	Produces sweat which is an excretory product as well as cooling agent
• Hair	Involves in heat control
• Erector muscle	Contract and relaxes to control position of hair
• Receptors	Detect changes such as heat temperature and pressure
• Elastic fibre	Has collagen which affects elasticity of skin

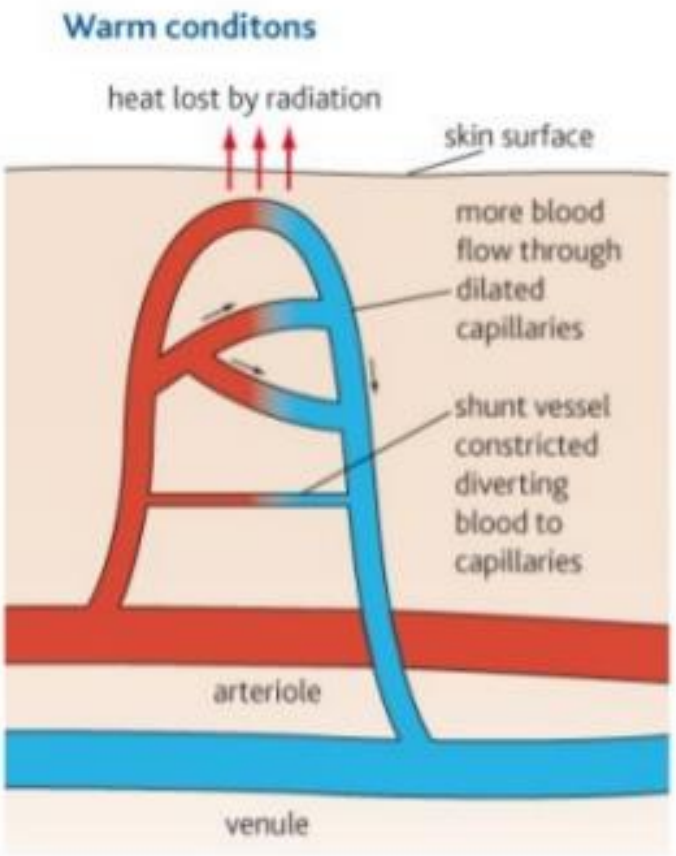
Response of skin to heat and cold

Response to heat	Response to cold
• Hair is lowered as erector muscles relax • Does not trap air, reducing insulation	• Hair is raised as erector muscles contracts • Air around hair forms a thick layer of insulation
• More blood is transported to the skin as blood vessels dilated	• Shunt vessels are dilated, blood bypasses skin surface
• Sweat is secreted by sweat glands • Evaporation of sweat causes cooling	• Absence of sweating
• Reduction of metabolic rate reduces heat generated	• Increases in metabolic rate • Shivering

LO: State the function of arterioles, venules and shunt vessels

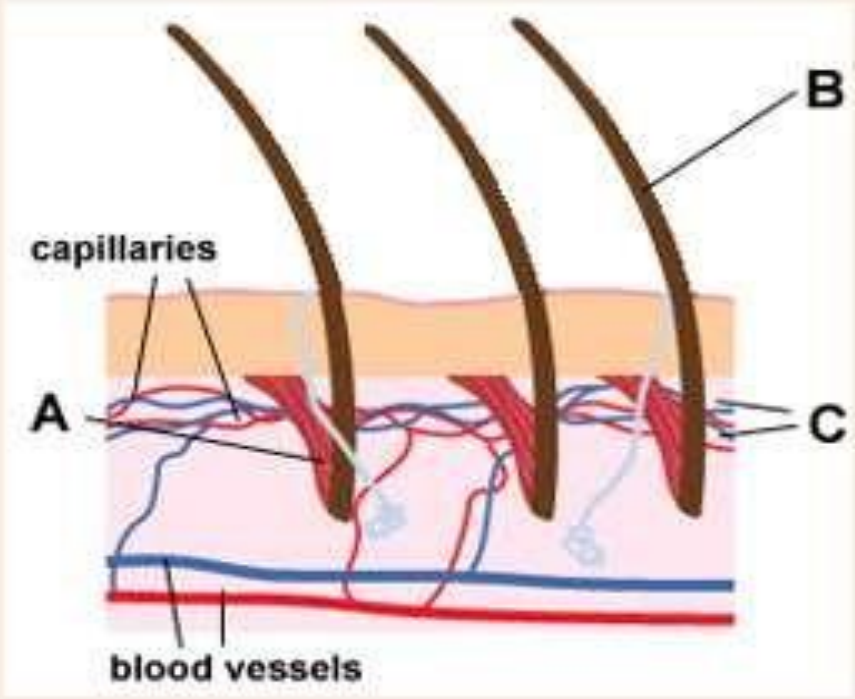
ARTERIOLES, VENULES AND SHUNT VESSELS

- **Shunt vessel**
  - A blood vessel that links ar artery directly to a vein, allowing the blood to bypass the capillaries in certain areas.
  - Shunt vessels can control blood flow by constriction and dilation



Controlling Skin Temperature

Too cold

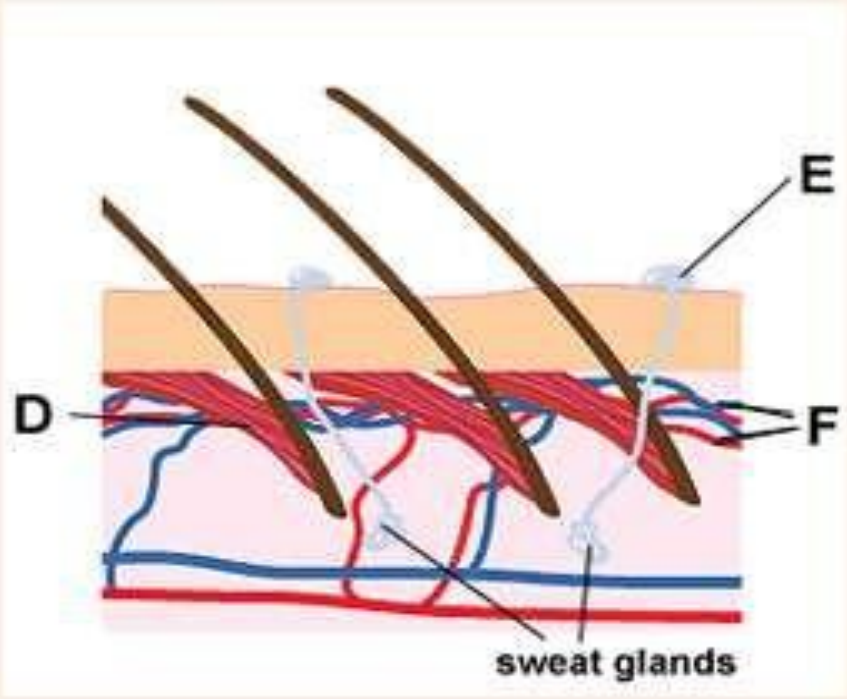


A - Hair muscles pull hairs on end.

B - Erect hairs trap air.

C - Blood flow in capillaries decreases.

Too hot



D - Hair muscles relax. Hairs lie flat so heat can escape.

E - Sweat secreted by sweat glands. Cools skin by evaporation.

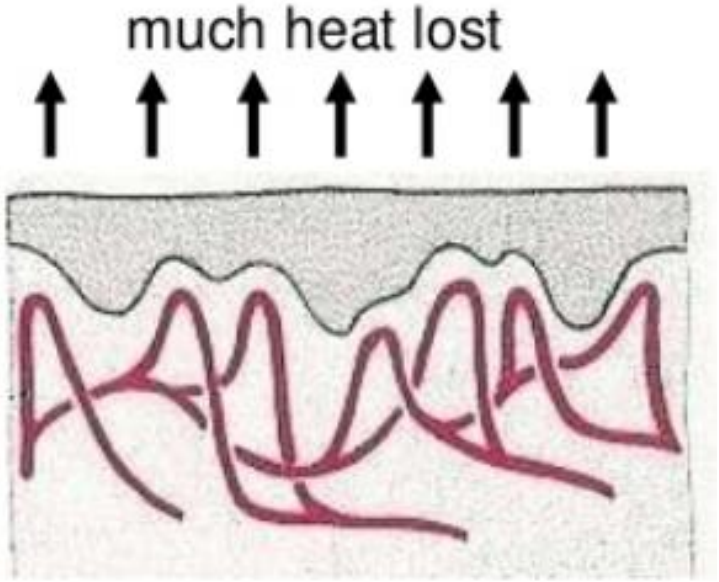
F - Blood flow in capillaries increases.

Blood is diverted

2.89 describe the role of the skin in temperature regulation, with reference to sweating, vasoconstriction and vasodilation (TA)

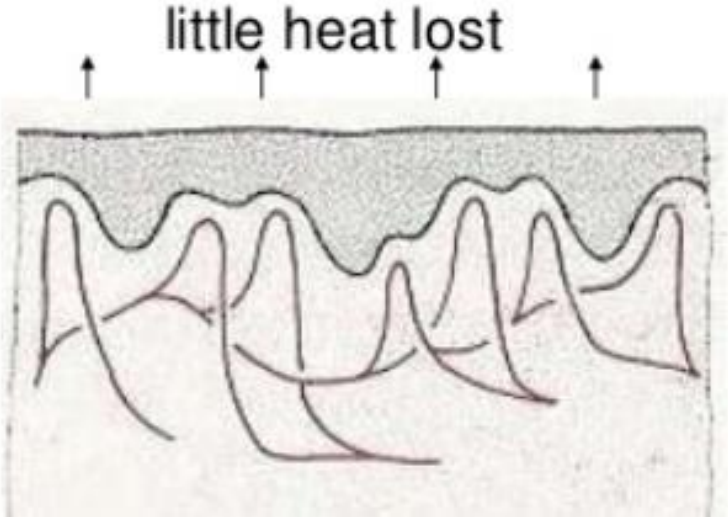
Vasodilation

If the body temperature rises, the blood vessels in the skin dilate (become wider) and allow more blood to flow near the surface. The heat loss from the blood through the skin helps cool the circulating blood



Vasoconstriction

If the body temperature falls. The blood vessels in the skin constrict. Less warm blood flows near the surface so less heat is lost



Hormones involved in Coordination

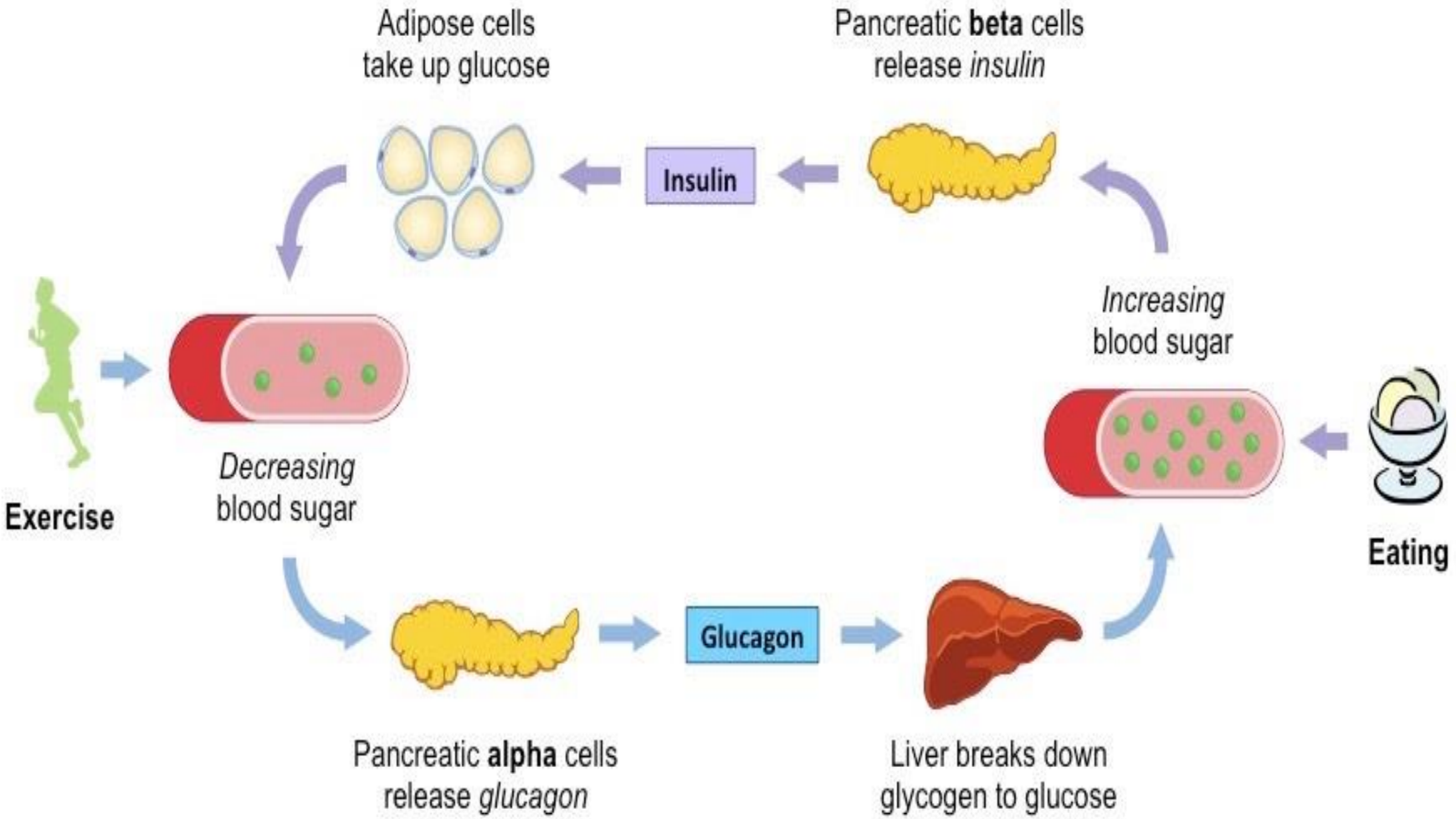
2.90 understand the sources, roles and effects of the following hormones: ADH, adrenaline, insulin, testosterone, progesterone and oestrogen.

Hormone	Source	Effect
ADH	Pituitary	Regulated blood osmoregulation
Adrenaline	Adrenal glands	Increases heart rate and breathing rate during exercise (more O_2 for respiration)
Insulin	Pancreas	Decreases blood glucose level after a meal. Glucose converted to Glycogen and stored in liver.
Testosterone	Testes	Triggers puberty in boys (secondary sexual characteristics)
Progesterone	Ovaries	Maintains uterus lining and (indirectly) causes **menstruation**

Oestrogen	Ovaries	Triggers puberty in girls. Stimulates growth of uterus lining each month and (indirectly) causes **ovulation**

Effects of adrenaline

- Skin becomes pale as blood is diverted away
- Deeper, more rapid breathing and airways become wider
- Heart beats more rapidly
- Blood is diverted away from digestive system to muscles by using sphincters
- Adrenal glands release the hormone adrenaline
- Glycogen in muscles is converted to glucose, and released into the blood
- Widened pupils
- Adrenaline


Adipose cells
take up glucose
Pancreatic **beta** cells
release *insulin*
Insulin
Increasing
blood sugar
Exercise
Decreasing
blood sugar
Eating
Glucagon
Pancreatic **alpha** cells
release *glucagon*
Liver breaks down
glycogen to glucose