Organisation and Coordination

- Describe the gross structure of the human brain and outline the functions of the: *cerebrum*; *cerebellum*; *medulla oblongata*; and *hypothalamus*.
- Describe the role of the brain and nervous system in coordinated muscular movement.
- Discuss why animals need to respond to their environment.
- Outline the organisation of the nervous system in terms of *central* and *peripheral systems* in humans.
- Outline the organisation and roles of the autonomic nervous system.
- State that responses to environmental stimuli in mammals are coordinated by nervous and endocrine systems.
- Explain how in mammals the *fight or flight* response to environmental stimuli is coordinated by the nervous and endocrine systems.

Types of Neurone – A Reminder

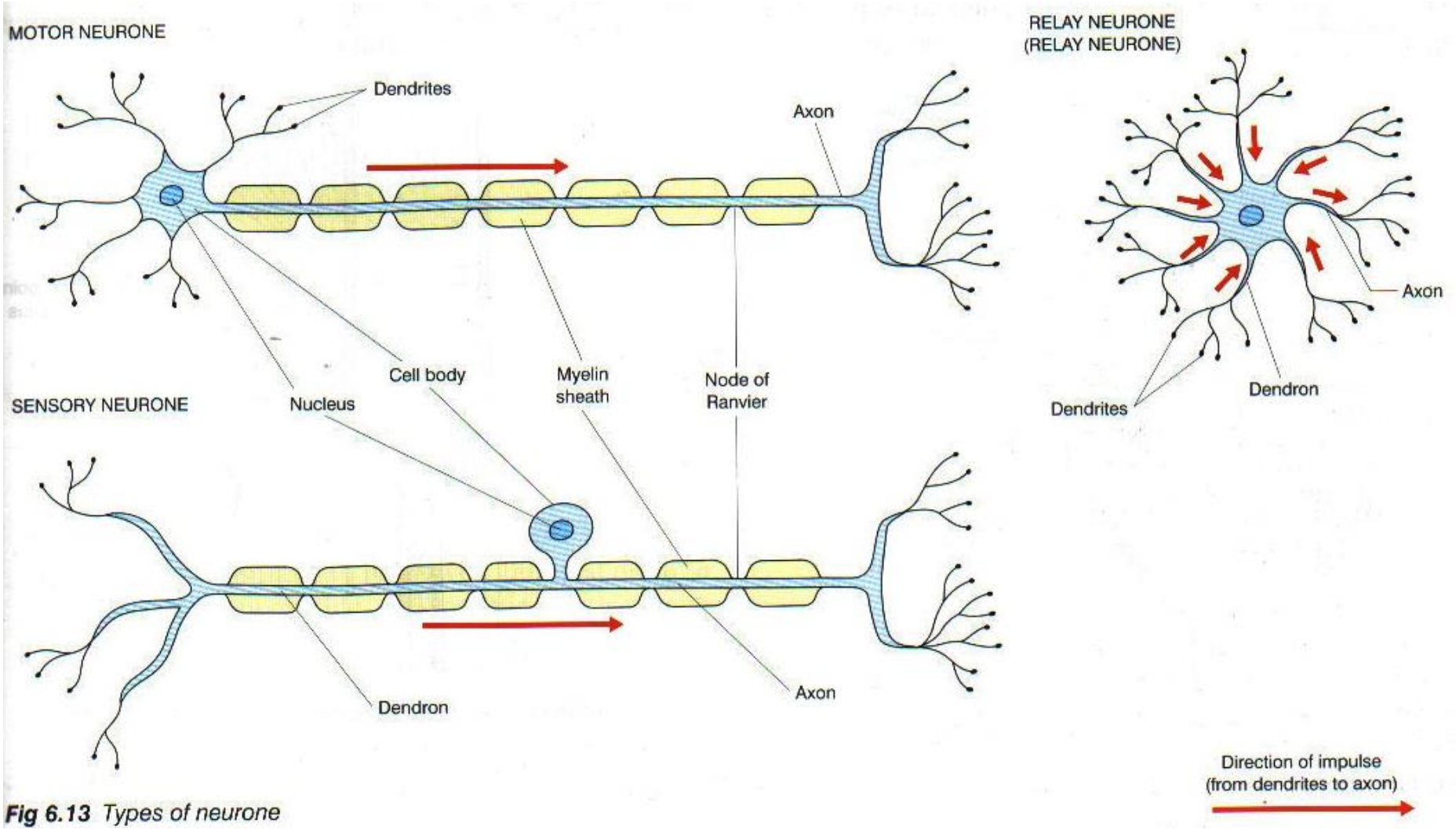
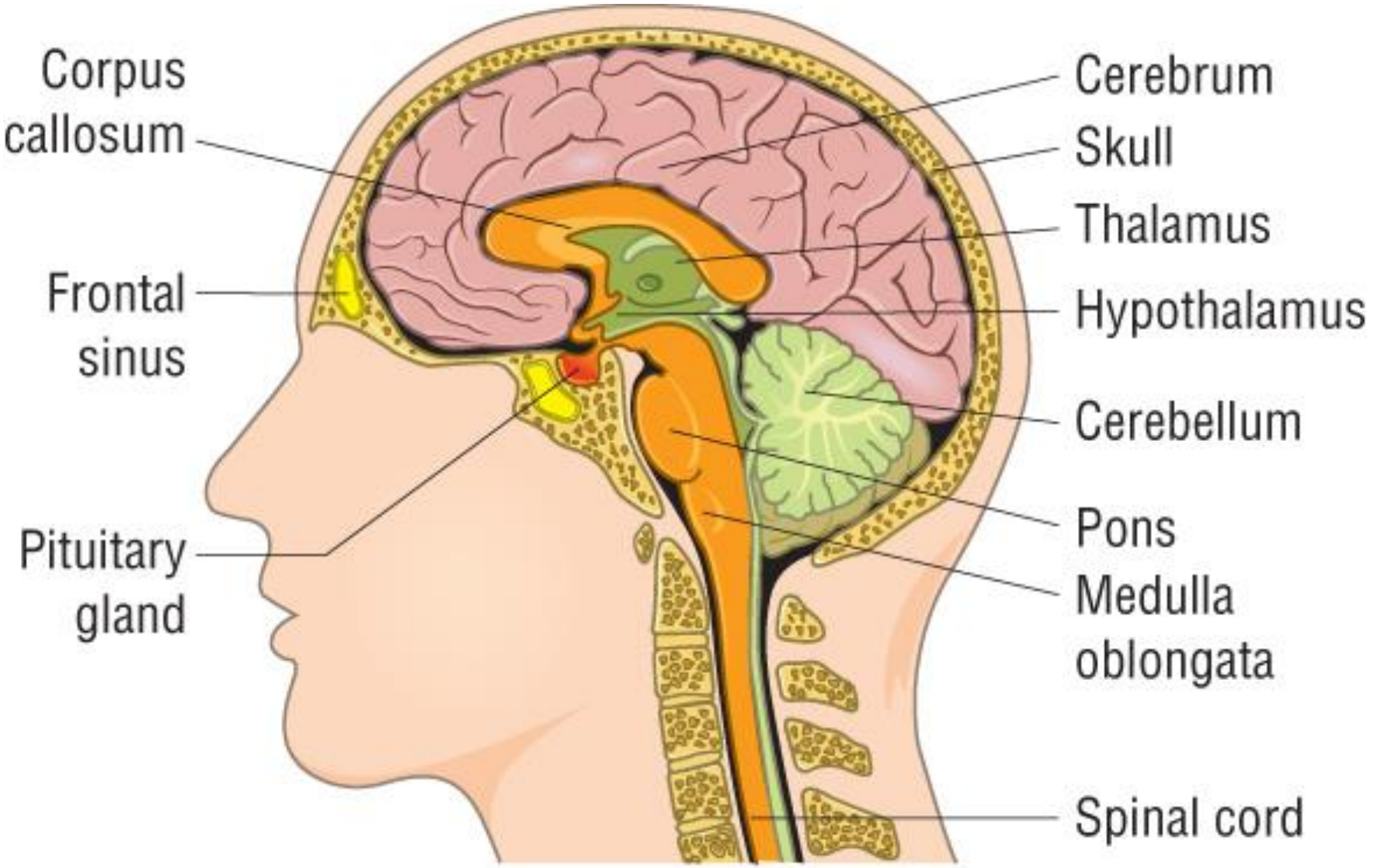
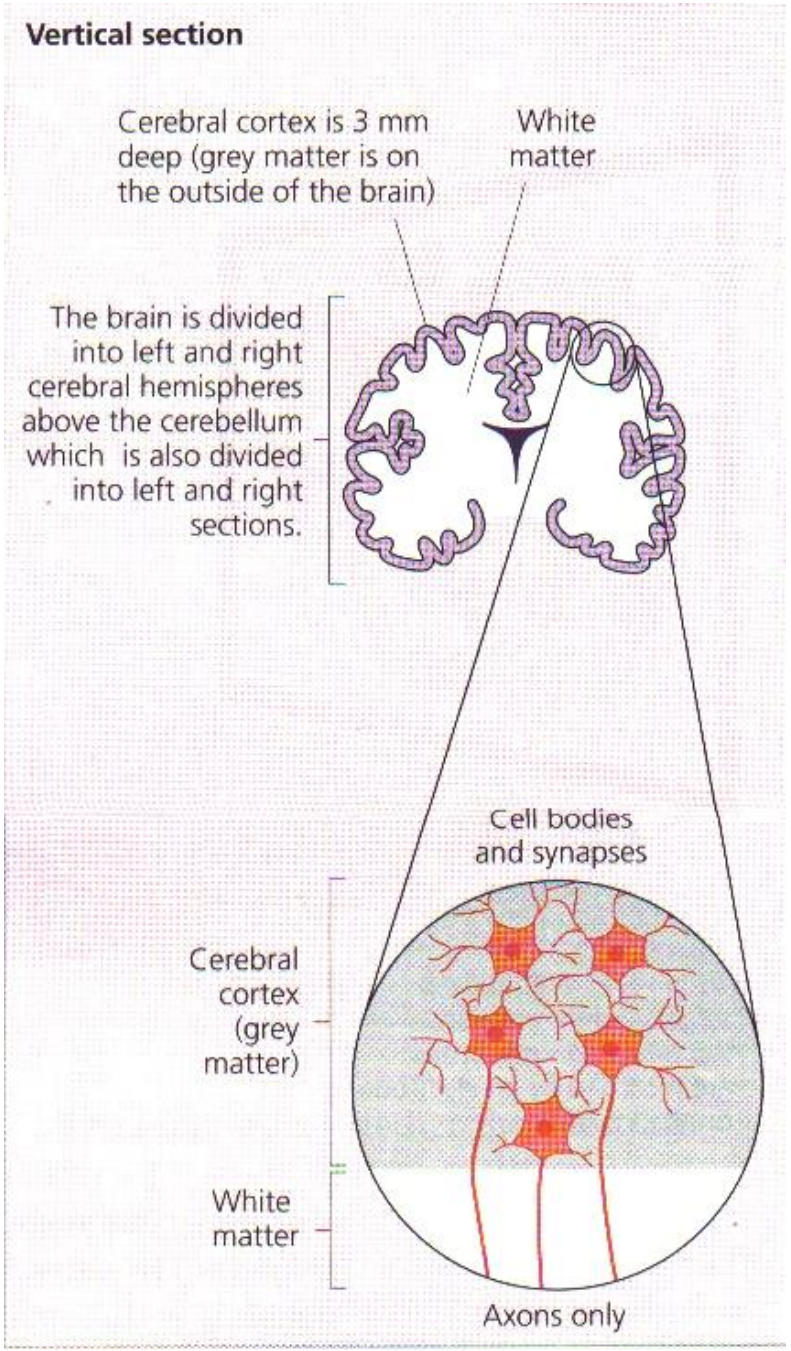


Fig 6.13 Types of neurone

The Brain

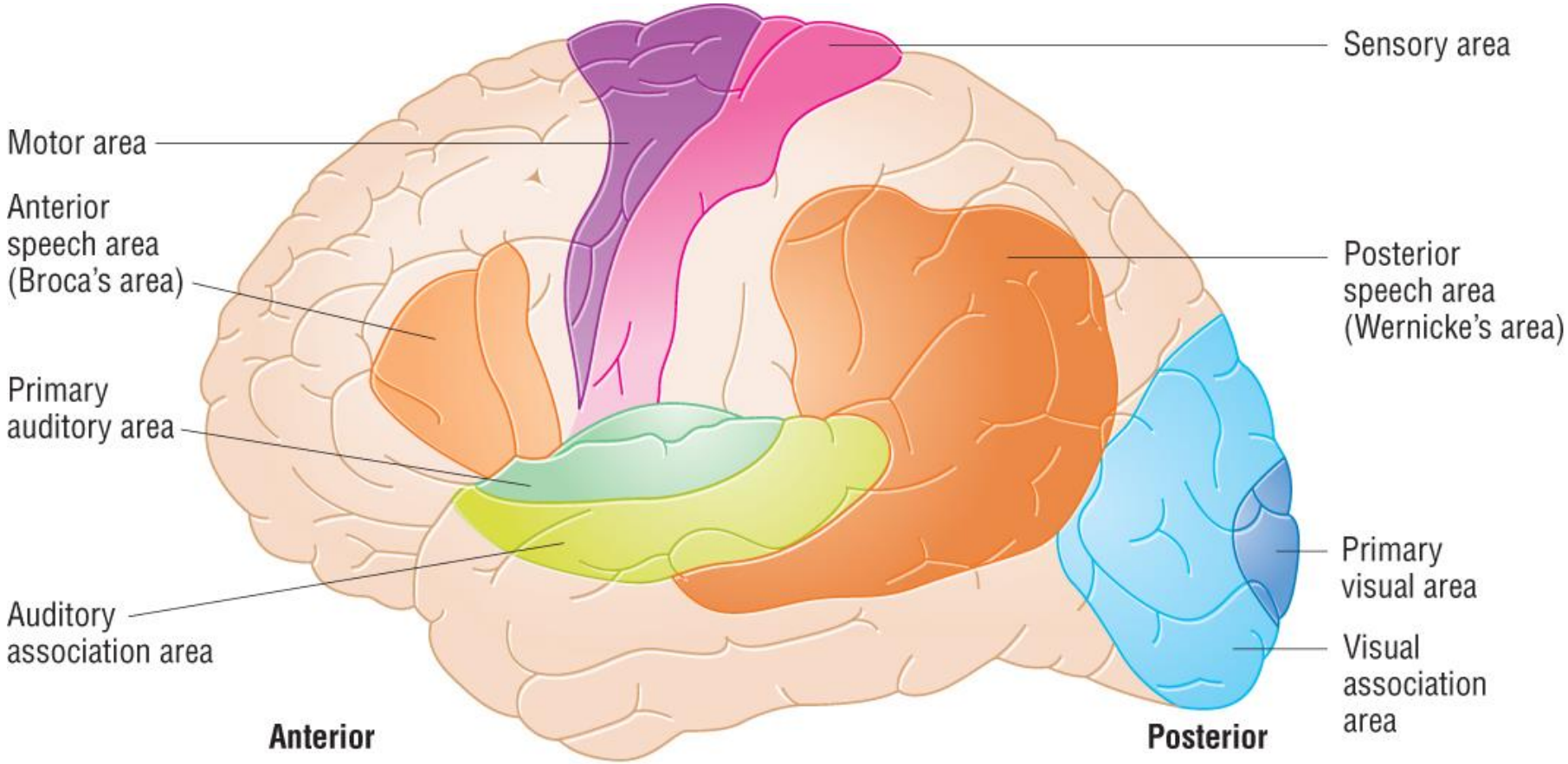

Corpus callosum
Frontal sinus
Pituitary gland
Cerebrum
Skull
Thalamus
Hypothalamus
Cerebellum
Pons
Medulla oblongata
Spinal cord

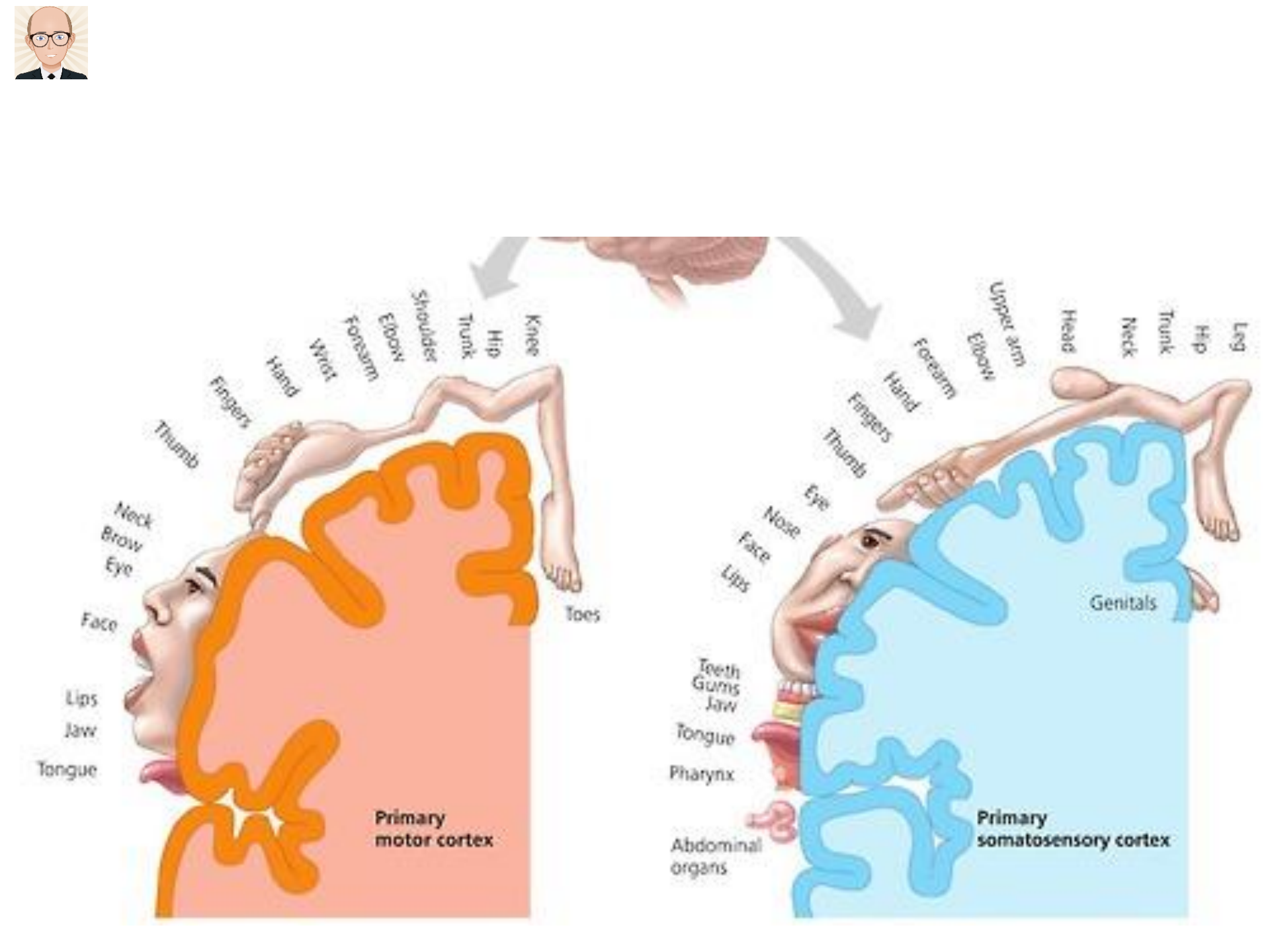
- The cerebral cortex contains synapses & cell bodies.
  - Thought to be the root of:
    - Consciousness
    - Emotional responses
    - Intelligence
    - Judgement
    - Reasoning
    - Ability to override reflexes



Cerebral Cortex

- Divided into areas responsible for specific activities and/or body regions.




Knee
Hip
Trunk
Shoulder
Elbow
Forearm
Wrist
Hand
Fingers
Thumb
Toes
Neck
Brow
Eye
Face
Lips
Jaw
Tongue
Primary motor cortex
Leg
Hip
Trunk
Neck
Head
Upper arm
Elbow
Forearm
Hand
Fingers
Thumb
Eye
Nose
Face
Lips
Genitals
Teeth
Gums
Jaw
Tongue
Pharynx
Abdominal organs
Primary somatosensory cortex

Cerebellum

- After the decision to move voluntary muscles is initiated by the cerebral cortex, many movements involve a large level of non-conscious control.
  - This control is provided by the cerebellum.
    - Eg. Walking, driving, playing music or sport.
- Cerebellum is also involved with fine-tuning sensory information
    - Eg. Judging distances & speeds of objects.

Examples of Cerebellum Activities

- Motor
  - Fine muscle movements in order to remain balanced & upright.
  - Manipulation of tools/instruments.
  - Operation of antagonistic muscles.
- Sensory
  - Judgement of positions of objects.
  - Feedback from muscles during movement.

Medulla Oblongata

- Controls non-skeletal muscles.
  - ie Controls the Autonomic Nervous System.

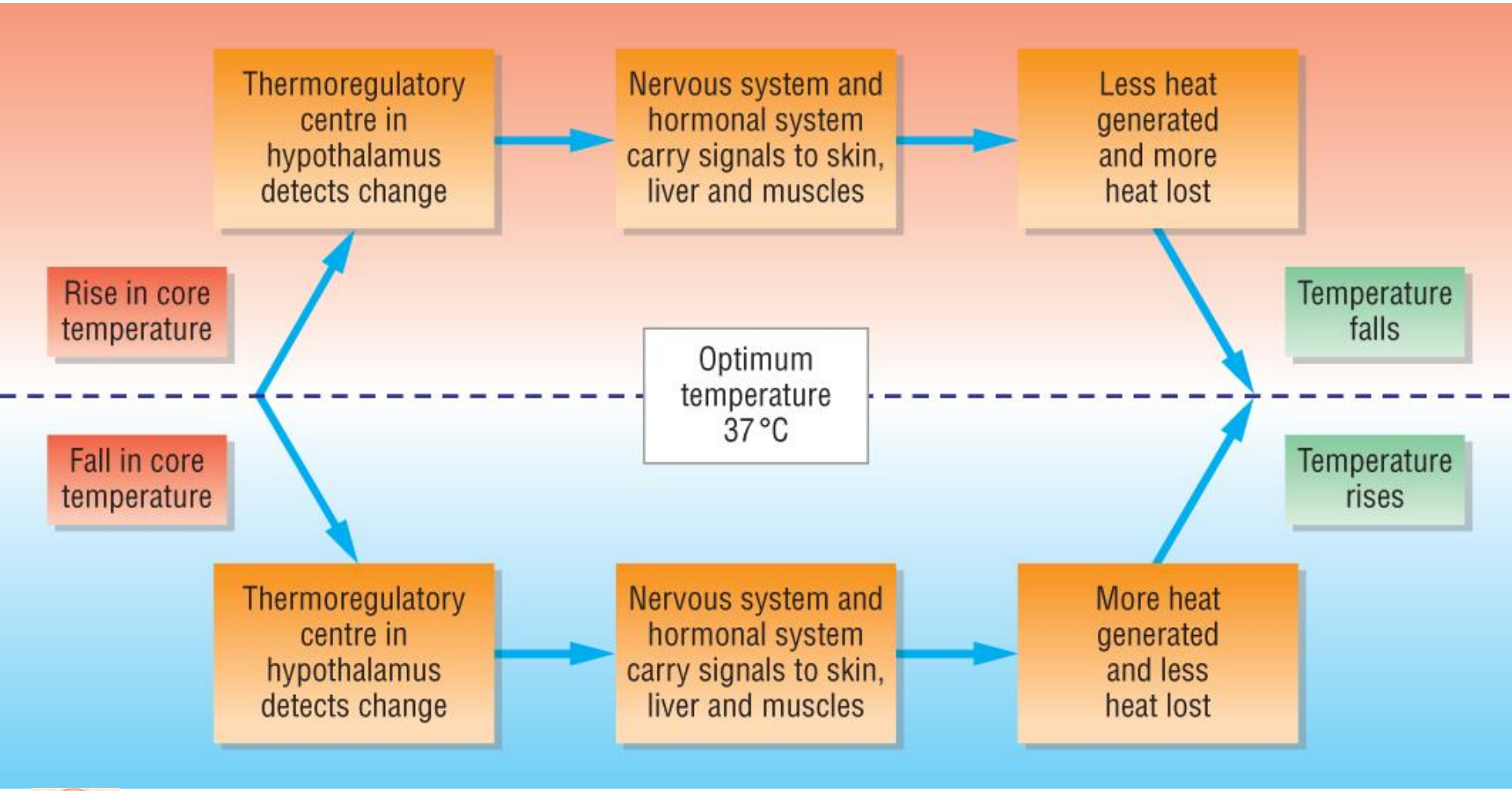
- Contains the regulatory centres for many vital processes.
  - Cardiac Centre
    - Regulates heart rate
  - Respiratory Centre
    - Regulates breathing rate & depth.

Hypothalamus

- Controls many homeostatic mechanisms.
  - Temperature regulation
  - Osmotic regulation

- Regulates the pituitary gland.
  - So controls much of the body's endocrine system.

Control of temperature regulation – a reminder



Walls of DCT & CD become MORE permeable to water

Pituitary gland releases MORE ADH

Detected by osmoreceptors in hypothalamus

Conserving water

Stimulate thirst centre of brain

Less water leaves the body. Urine is concentrated

More water consumed

Gaining water

Decreased water potential of blood

Normal blood water potential

More water leaves the body. Urine is Dilute

Increased water potential of blood

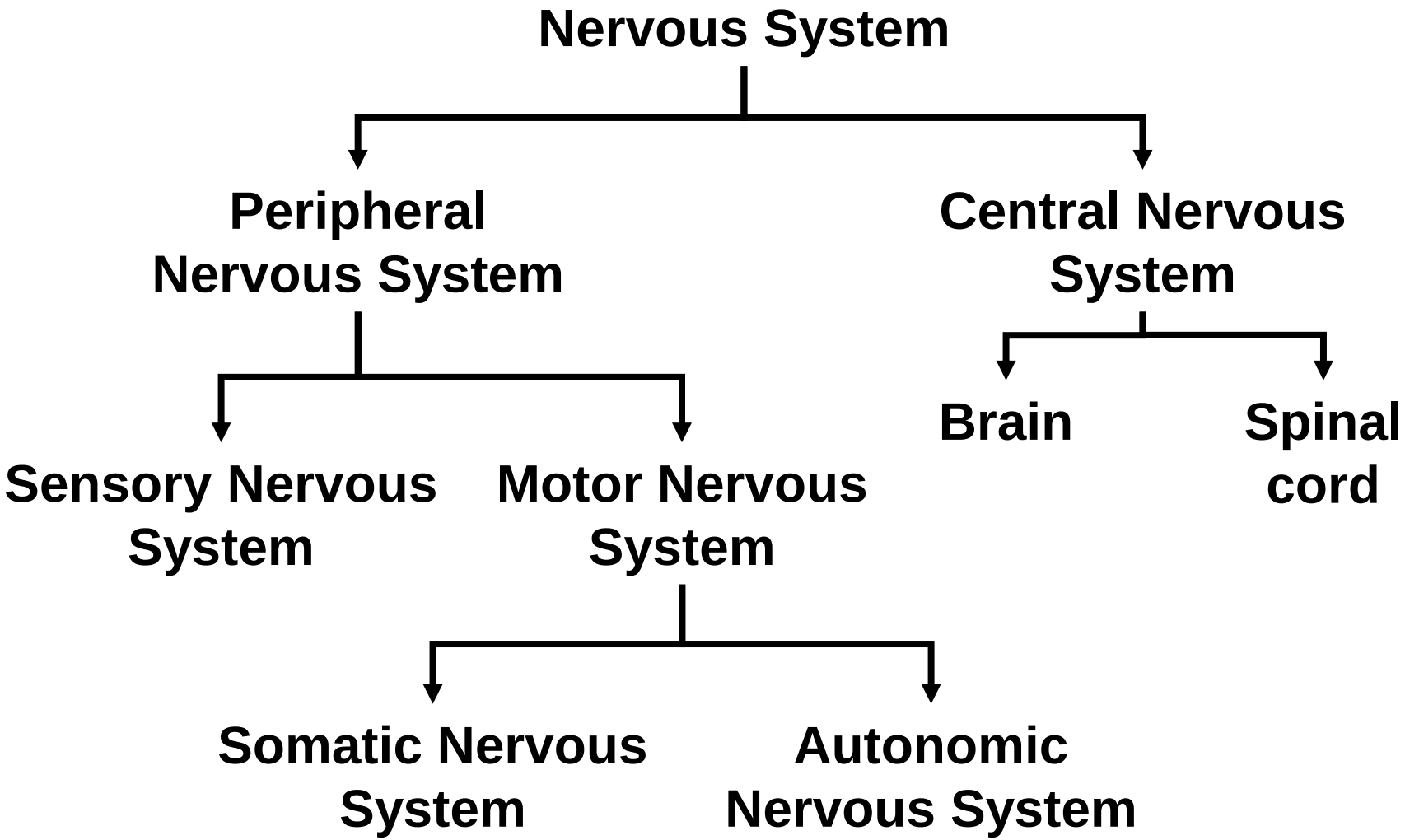
Removing water

Walls of DCT & CD become LESS permeable to water

Pituitary gland releases LESS ADH

Detected by osmoreceptors in hypothalamus

Nerve Organisation – A Reminder



Resting Potential – A Reminder

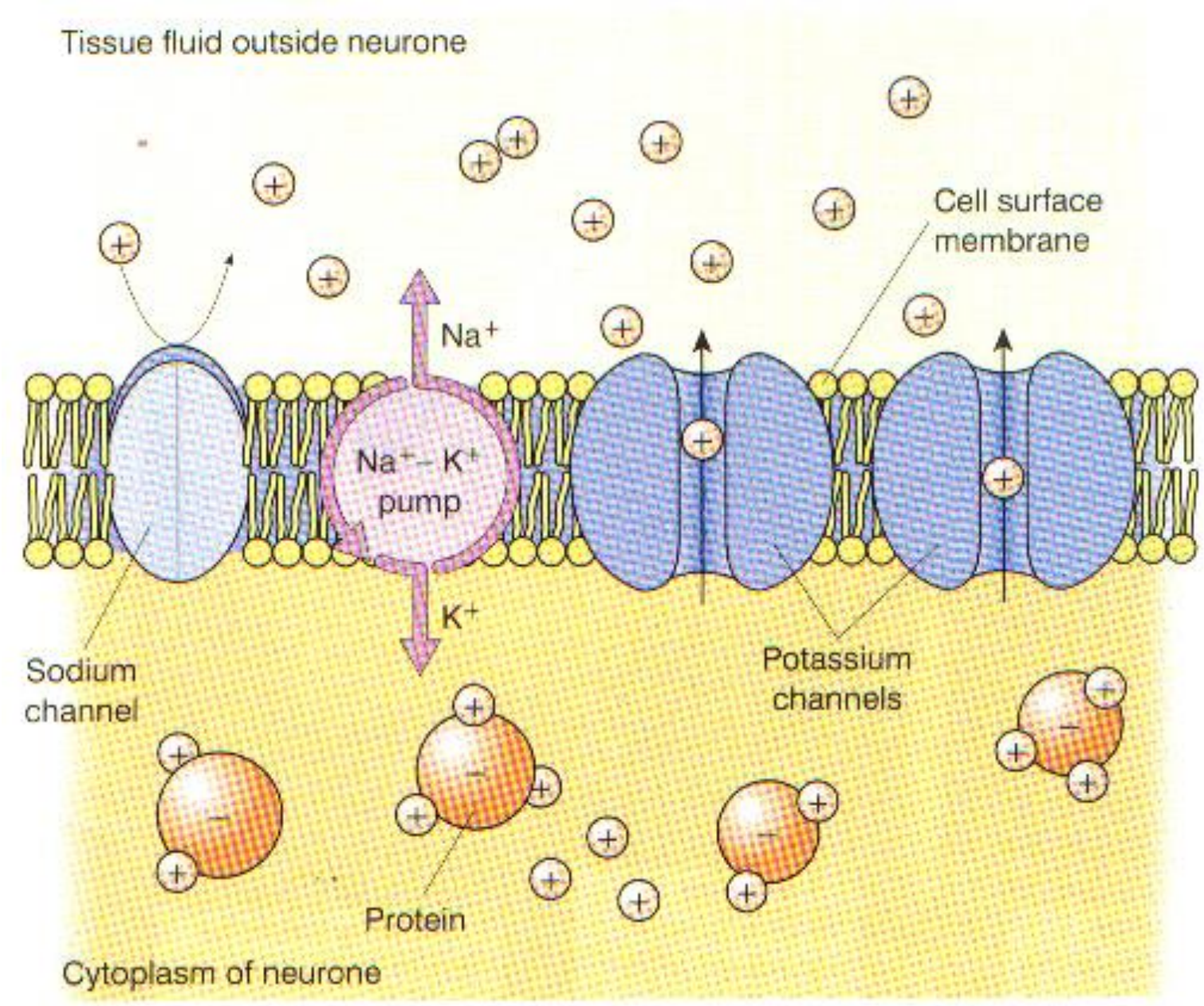


Fig 6.21 *Distribution of ions at resting potential*

Action Potential – A reminder

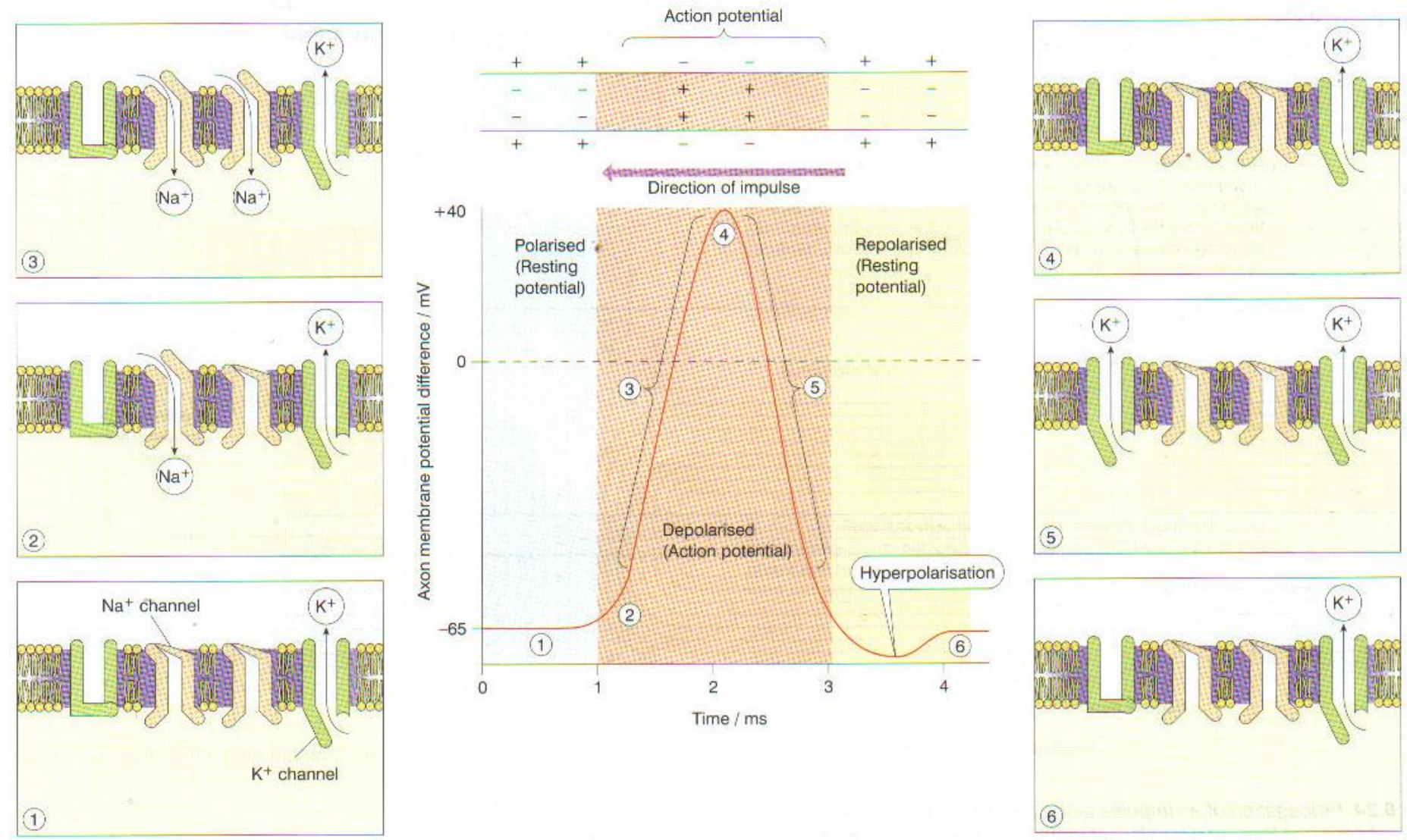


Fig 6.22 *The action potential*

Autonomic Nervous System

- Mostly outside conscious control.
  - Homeostatic mechanisms via Hypothalamus.
  - Regulatory centres via Medulla Oblongata.
  - Heightened emotional responses (eg. Stress).

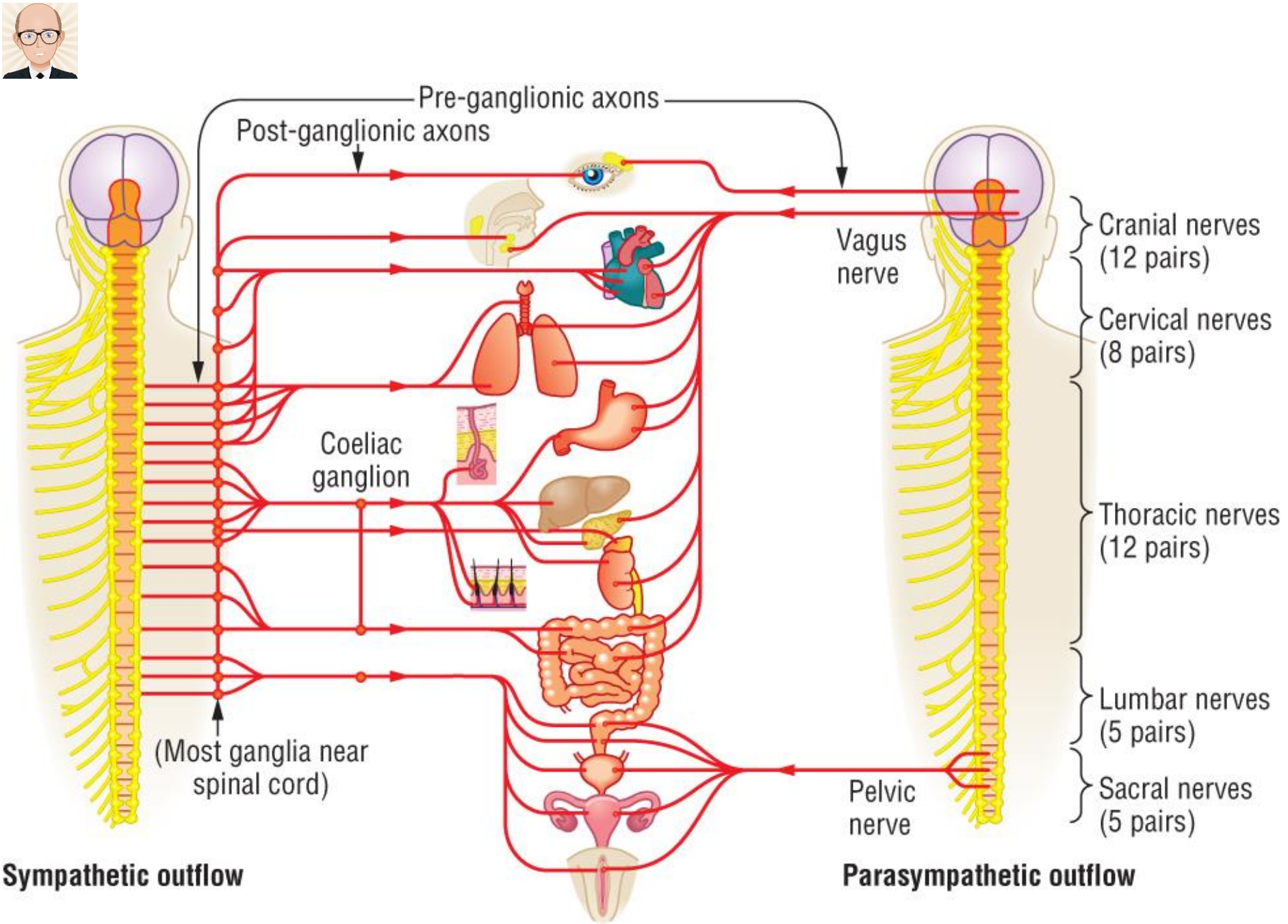
Differences between ANS & CNS

Autonomic Nervous System	Central Nervous System
Most neurones are non-myelinated	Most neurones are myelinated
Connections to effector organs always involve at least two neurones	Connections to effector organs involve only one
Two types of motor neurone: Sympathetic & Parasympathetic.	Motor, sensory & relay neurones

Sympathetic v Parasympathetic

- Often referred to as antagonistic.
- Changes to internal conditions alters the balance between the two systems

Sympathetic	Parasympathetic
Most active in times of stress	Most active in times of relaxation or sleep
Neurones synapse at a ganglion just outside the spinal cord. Pre-ganglionic neurones are short.	Neurones synapse at a ganglion within the target tissue. Pre-ganglionic neurones vary in length.
Post ganglionic neurones secrete noradrenaline at the synapse to the effector	Post ganglionic neurones secrete acetyl choline at the synapse to the effector
Effects include: Increased heart & ventilation rate, pupil dilation & orgasm	Effects include: Decreased heart & ventilation rate, pupil constriction & sexual arousal


Pre-ganglionic axons
Post-ganglionic axons
Vagus nerve
Cranial nerves (12 pairs)
Cervical nerves (8 pairs)
Coeliac ganglion
Thoracic nerves (12 pairs)
Lumbar nerves (5 pairs)
(Most ganglia near spinal cord)
Pelvic nerve
Sacral nerves (5 pairs)
Sympathetic outflow
Parasympathetic outflow

Comparing Nervous & Endocrine Systems

Endocrine System	Nervous System

Comparing Nervous & Endocrine Systems

Endocrine System	Nervous System
Uses chemicals (hormones).	**Uses nerve impulses.**
Transmission by the blood system.	**Transmission by nerve fibres.**
Strength of stimulus affects concentration of hormone.	**Strength of stimulus affects frequency of impulse.**
Transmission is slow.	**Transmission is rapid.**
Hormones travel to all parts of the body. Only target organs respond.	**Impulses travel to specific parts of the body.**
Effects are widespread.	**Effects are localised.**
Response is slow.	**Response is rapid.**
Response is often long-lasting.	**Response is short-lived.**
Effects may be permanent & irreversible.	**Effects are temporary & reversible.**

Responding to Stimuli

- Our responses to sensory stimuli (internal & external) are finely coordinated to ensure our survival.
  - They often involve a combination of nervous and endocrine systems.
  - Eg. Temperature regulation
    - Behavioural changes (removing a jumper) rely on nervous control.
    - Physiological changes (sweating) often rely on endocrine control.
  - Eg. Fight/Flight response.

The Fight/Flight Response

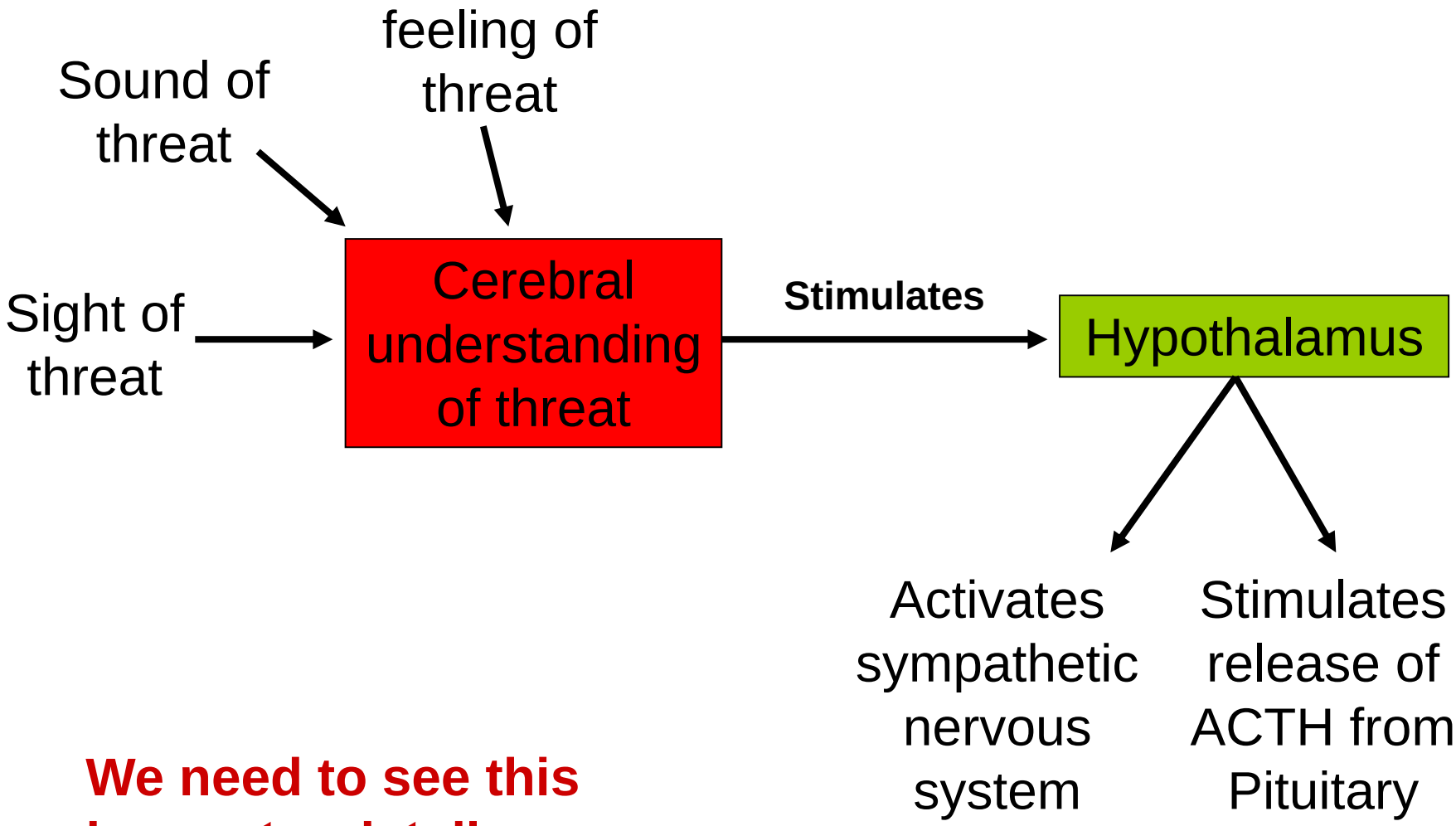
- The physiological changes that prepare a body to deal with a threat.
  - Either by challenging the threat (fight)
  - Or by running away (flight)

- A range of coordinated nervous & hormonal responses

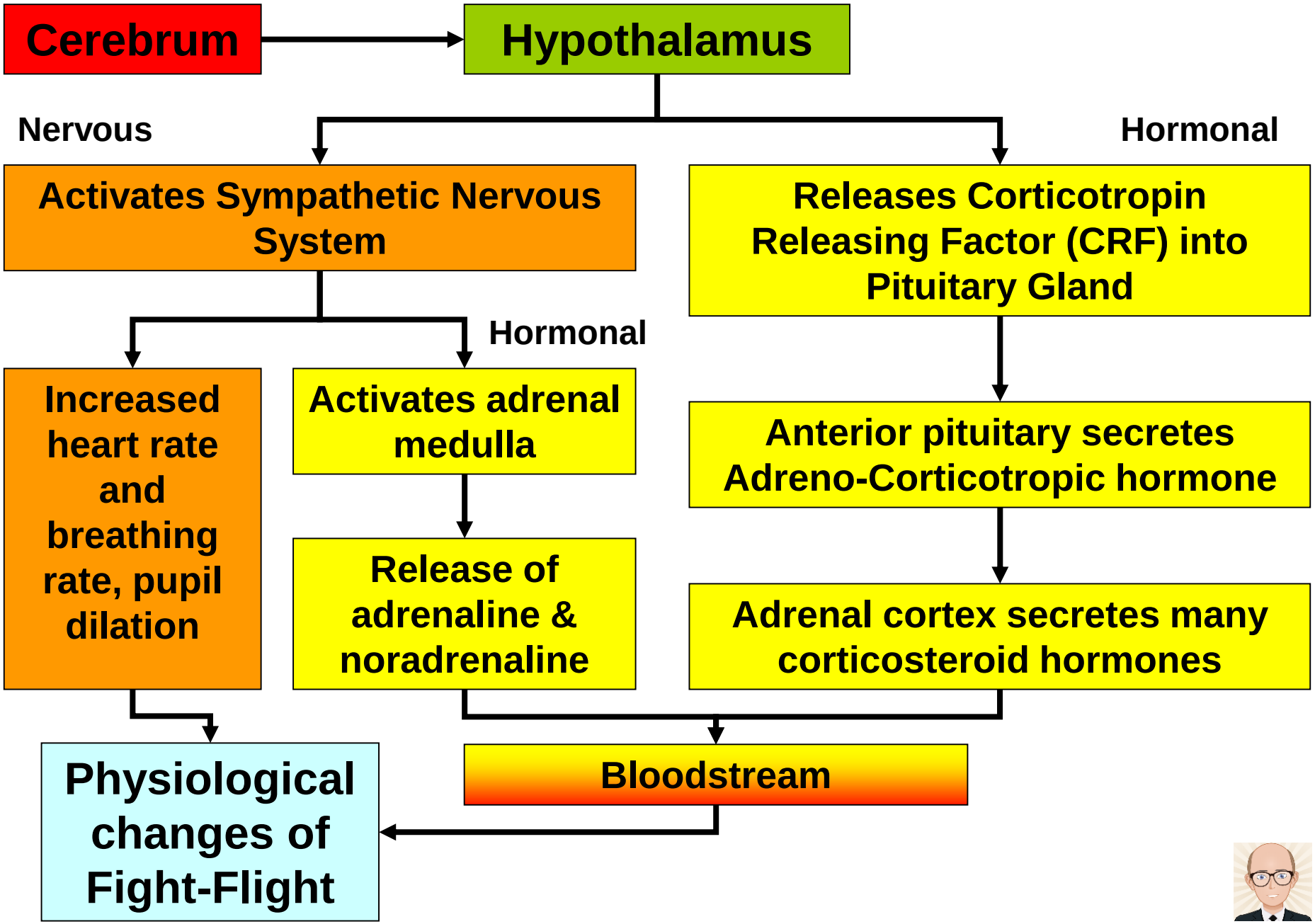
The Physiological Changes

- Pupils dilate
- Heart rate & blood pressure increase
- Arterioles to digestive system & skin constrict.
- Arterioles to liver & muscles dilate
- Blood glucose levels increase
- Erector pili muscles in skin contract
- Ventilation rate & depth increase
- Endorphins released by the brain
- Sweat production increases

Coordination of these Changes



We need to see this in greater detail…


Cerebrum
Hypothalamus
Nervous
Hormonal
Activates Sympathetic Nervous System
Releases Corticotropin Releasing Factor (CRF) into Pituitary Gland
Hormonal
Increased heart rate and breathing rate, pupil dilation
Activates adrenal medulla
Anterior pituitary secretes Adreno-Corticotropic hormone
Release of adrenaline & noradrenaline
Adrenal cortex secretes many corticosteroid hormones
Physiological changes of Fight-Flight
Bloodstream

Fight/Flight Theory

- The Fight/Flight response was first described in 1915.
- Since been updated:
  - Animals may fight in some situations but flee in others.
  - Not all animals fight or flee
    - Some freeze (play dead).
    - Some change colour (camouflage)