RECEPTION,RESPONSE AND CO-ORDINATION IN PLANTS & ANIMALS

by

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STIMULUS

- Any change in the internal or external environment of an organism.

Irritability

- The ability an organism to detect, interpret and respond to changes in the environment.

Response

- A physiological , muscular or behavioral activity that is initiated

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Response cont..

- Multicellular animals have sense organs (receptors) that detect stimuli which create impulses that are relayed to the co-ordinating system.
- Co-ordinating Centre interprets impulses before a response is made.
- Co-ordination in animals include Receptors,co-ordinating Centre and Effectors.

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Plants

- Plant responses are grouped according to the type of stimulus.
- If the stimulus causes movement towards it then it causes positive response but away then it is negative response.

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Stimuli and example of response.

Stimulus	Example of response
• Light	• Phototropism
• Heat	• Thermo taxis
• Water	• Hydrotropism
• Gravity	• Geotaxis
• Chemicals	• Chemotaxis
• Touch	Thigmotropism/ haptotropism
• Air	Aerotaxis

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Types of responses.

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Taxis

A locomotory response of a motile cell e.g. gamete or whole organism in response to an external stimulus.

May be positive or negative

These responses are grouped according to stimuli they cause.e.g

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i)Photo taxis

- A response to variation in light intensity and direction.
- E.g. Euglena, spirogyra and fruit fly move towards light.
- Wood lice, maggots and termites usually move away from light.

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ii) Aero taxis.

- A response to variation in oxygen concentration.
- E.g. Amoeba moving from an area of low oxygen concentration to high oxygen concentration.

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iii) Osmotaxis.

- Response to variation in osmotic pressure.
- E.g. Marine crabs burrowing in the sand to avoid dilution of body fluids.

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iv) Rheotaxis

Response to variation in direction of water or air currents

- Fishes and Planarians move against currents in water.
- Butterflies and Moths fly into wind currents to detect the scent of flowers.

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v) Chemotaxis.

Response to variation in chemical substances.

- Movement of male gamete towards the female gamete
- E.g sperms (antherozoids) of mosses and ferns move towards the ovum in archegonia.
- Mosquitoes fly away from insecticide repellants.

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vi)Thermotaxis.

- Locomotory response to temperature changes.
- E.g. Paramecium moves from a lower temperature 150c to moderate warmth of a bout 250c.

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Survival values of tactic responses.

- Enable organisms escape from harmful stimuli/move away from unfavorable environment.
- Organisms are able to move to favourable habitats and acquire resources e.g. nutrients, mates.
- Chemotaxis enables fertilization to take place.

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Tropism

- Growth movement in plants/parts of a plant in response to a unidirectional stimulus.
- Tropic movement may be positive or negative.
- It is named after the stimulus that evokes it.

Types of tropism.

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a) Phototropism.

- Growth curvature in response to unidirectional light/intensity of light.
- Shoots are positively phototropic while roots show negative phototropism.

b) Chemotropism.

Growth curvature in response to unidirectional gradient of chemical concentration.e.g pollen tube that grows towards chemicals secreted by

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c) Rheotropism.

- Growth curvature in response to unidirectional water currents.

d) Geotropism

- Growth curvature in response to unidirectional force of gravity.
- Roots are positively geotropic while shoots are negatively geotropic.

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e) Thermotropism

- Growth curvature in response to variation in temperature.
- Example Sunflower orientation to sun involves both thermotropism and phototropism.

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f) Haptotropism/Thigmotropism.

- Growth curvature due to touch of a part of a plant with a solid object.
- It is shown by climbing plants or tendrils when they come in contact with a supporting surface.
- Roots show negative thigmotropism when they grow to avoid solid obstacles such as rocks.

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Survival values /importance of tropic responses to plants.

- Phototropism exposes leaves/shoots in position for maximum absorption of sunlight for photosynthesis.
- Hydrotropism enables roots of plants to seek water/search water.
- Haptotropism /thigmotropism enables plants to obtain mechanical support especially those that lack woody stems.

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Importance cont…

- Geotropism enables roots to grow deep in the soil for anchorage
- Chemotropism enables pollen tube to grow towards the embryo sac to facilitate fertilization

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Similarities between tropism and taxis

- Both are adaptive responses
- Both respond to unidirectional stimuli
- They respond to similar environmental stimuli
- They are both ways of obtaining limited a mount of nutrients.

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Differences between tropism& taxis.

Tropism

- Are growth responses
- Are slow
- Are caused by growth hormones
- Are permanent

Taxis

- Are locomotory responses
- Are fast
- Not influenced by growth hormones
- Are temporary

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Co-ordination in plants.

- Plants are co-ordinated by plant hormones e.g. Auxins & Gibberellins (cell differentiation and elongation),Abscisic acid ,Cytokinins, Ethylene, florigens.
- Cytokinins affect cell elongation.

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Auxins and plant hormones.

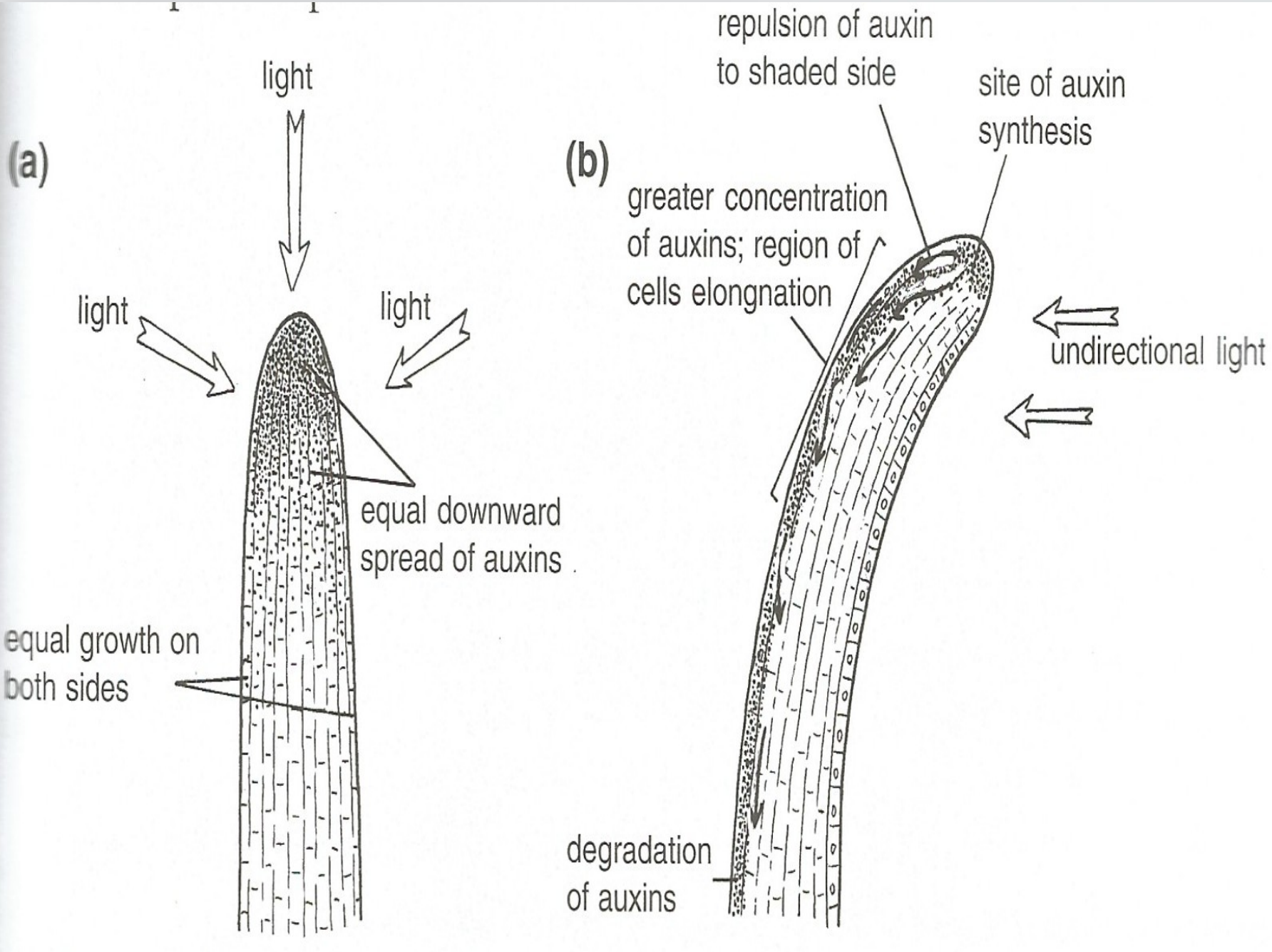
- Auxins e.g. I.A.A stimulates growth in both shoots and roots.
- Shoots require high concentration of I.A.A than roots since high concentration in roots inhibit growth.

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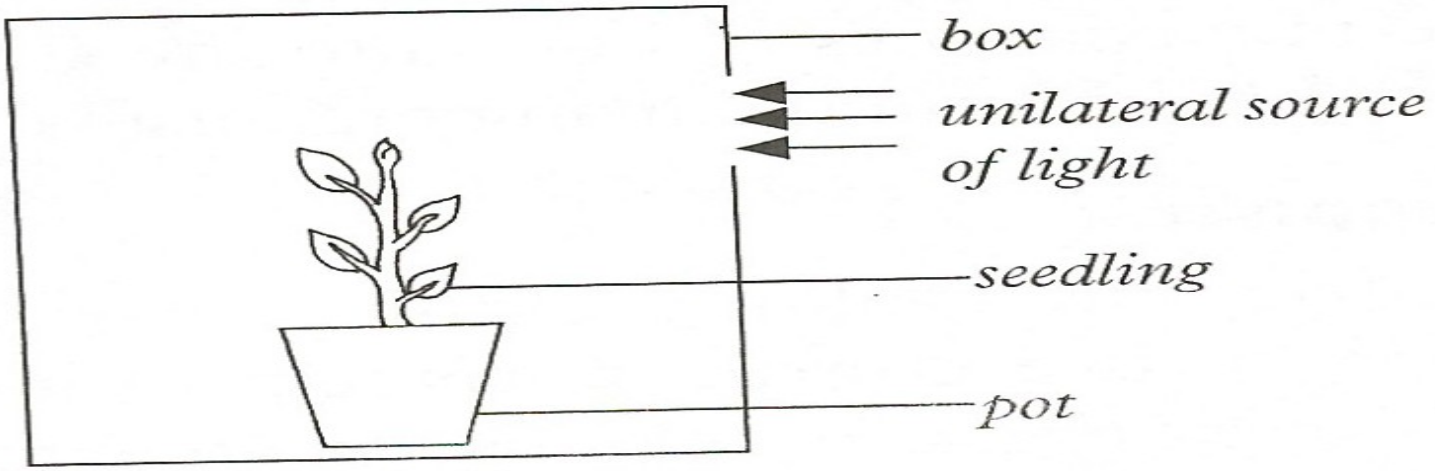
Auxins and phototropism.

- When seedlings are exposed to unidirectional light, the shoot bends towards the source of light.
- Light causes lateral migration of auxins from the light side to dark place.
- This causes more growth on dark side hence seedling bends towards source of light.

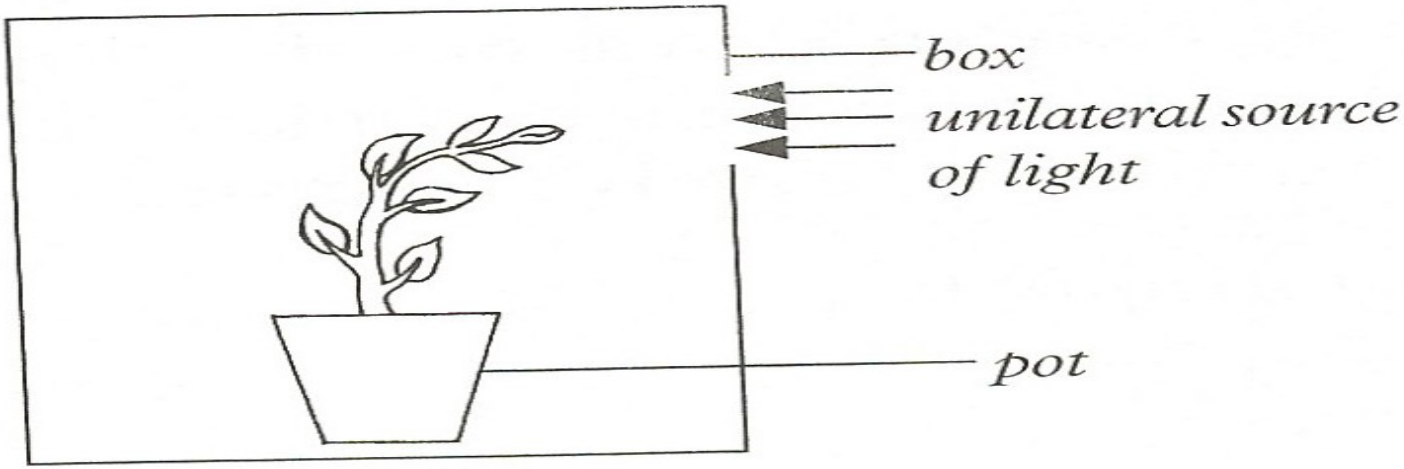
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(a) set-up



(b) results

g. 3.1 Phototropism in a plant

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Auxins and Geotropism.

- Roots are positively geotropic while shoots are negatively geotropic.
- Clinostat is used to illustrate that the stimulus is responsible for growth of shoots and roots.
- When a seedling is put on a clinostat and the chamber is rotated, all parts of the seedling will receive equal stimulation from gravity.

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Cont...

- The seedling will grow straight roots & shoots
- A non rotating control shows a normal response of gravity i.e. roots downwards while shoots upwards.
- Due to gravity, auxins accumulate on the lower side of the seedling.
- The upper part of the seedling has less auxin concentration than the lower part.

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Cont…

- The higher auxin concentration causes more elongation on the lower side than upper side of the shoot hence the shoot bends upwards away from force of gravity.
- Higher auxin concentration in roots causes less elongation on the lower side hence the root bends down wards towards the force of gravity.

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able to absorb water and minerals.

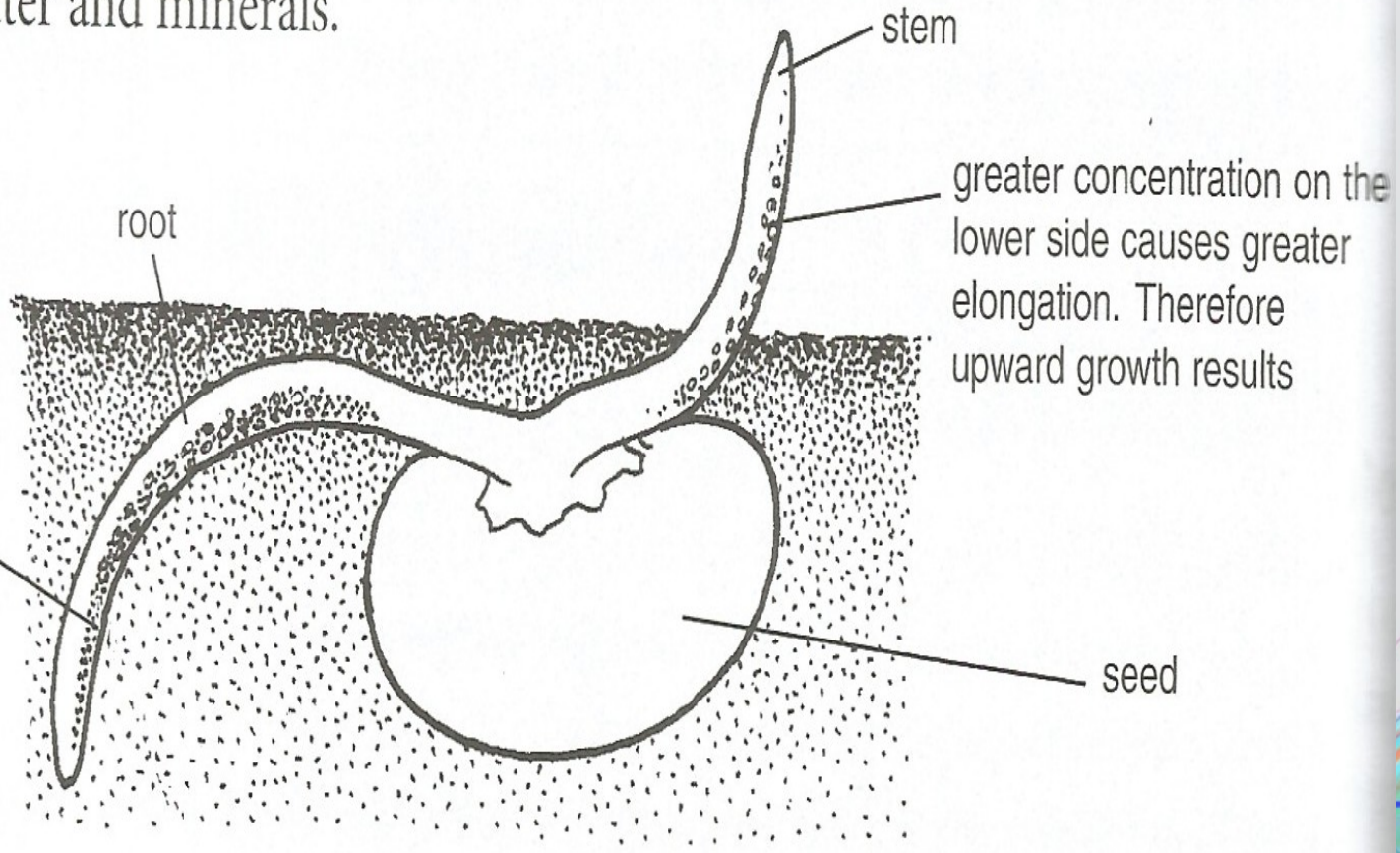
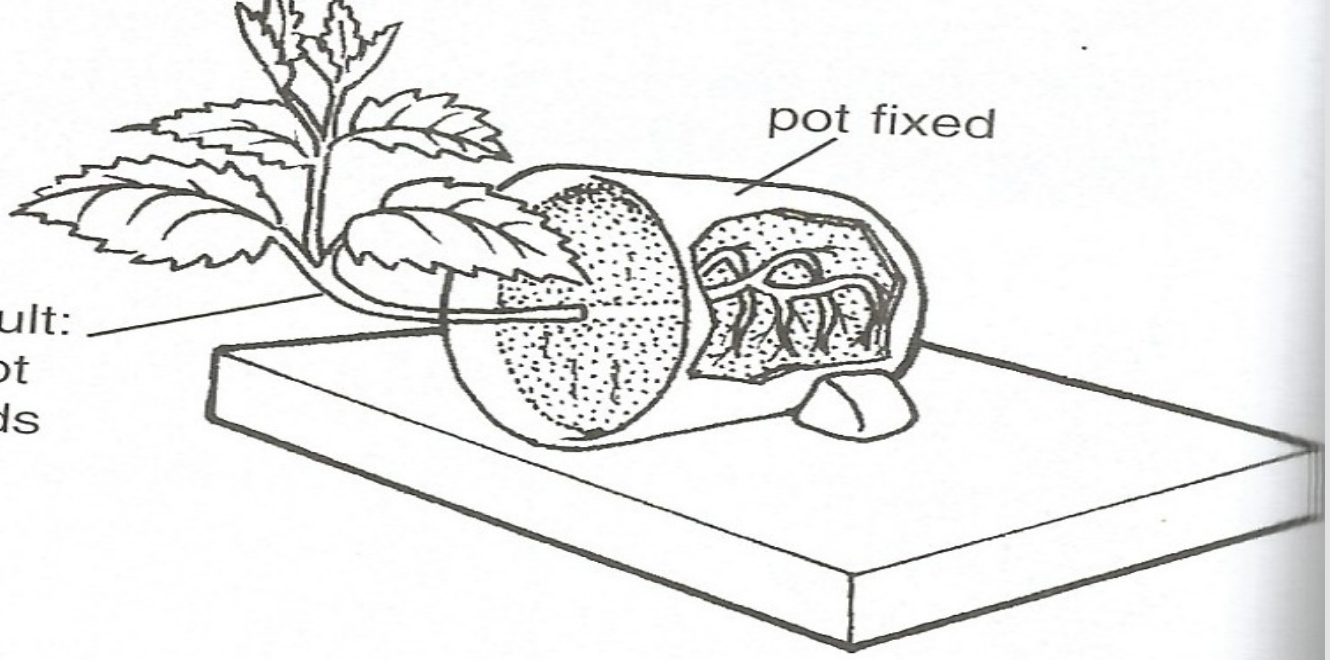
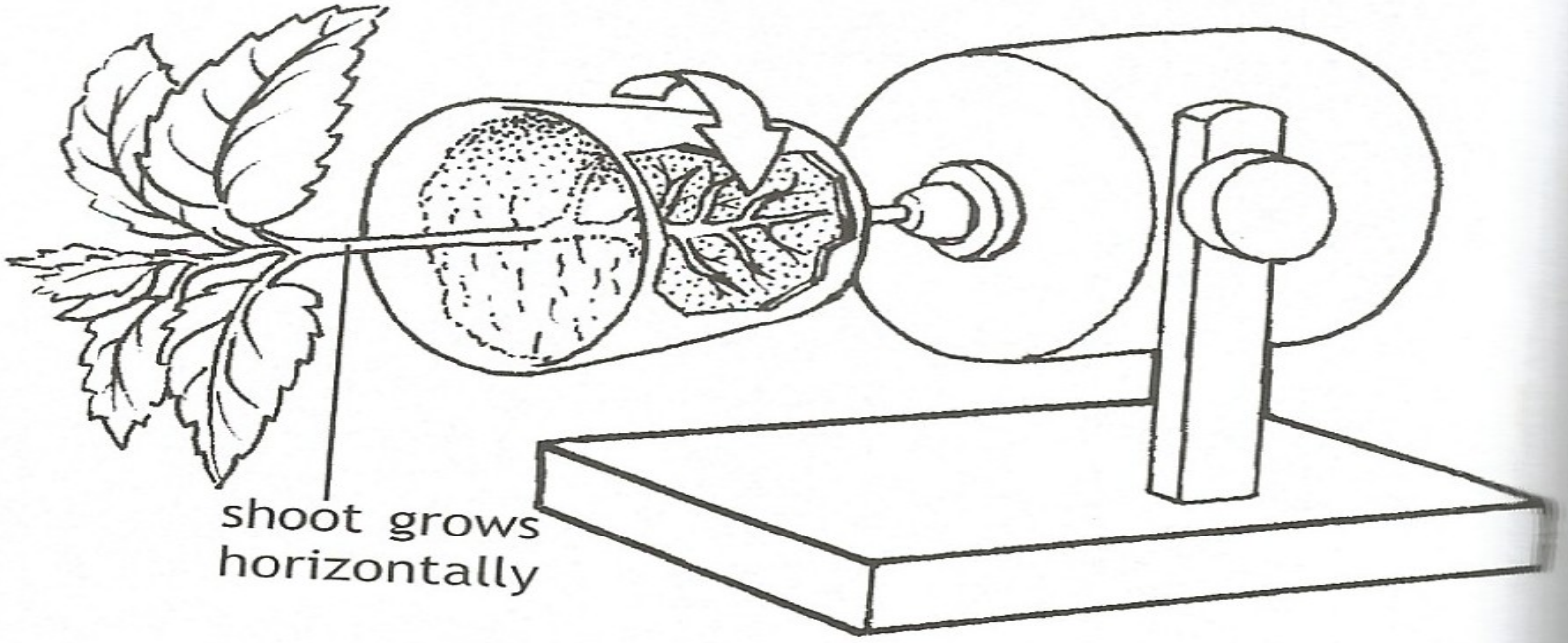


Fig. 3.11. Distribution of auxins in a seedling and the resulting response

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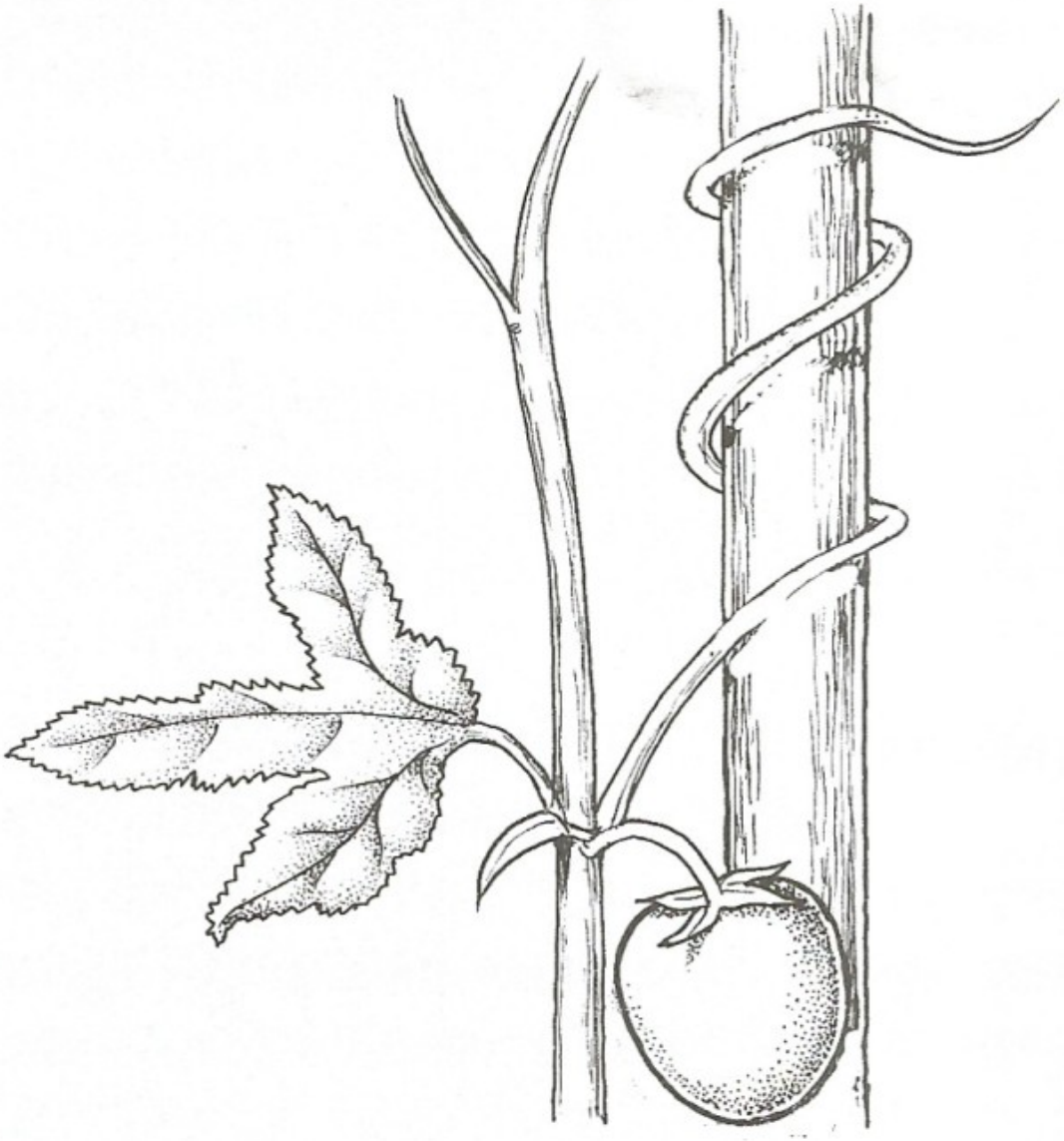
ii) **Control**: (gravity cancelled out)



Auxins and Thigmotropism.

- When climbing stems or tendrils come into contact with a suitable hard object, contact causes them to curve and coil around hard objects.
- Contact with support causes migration of auxins to out side causing more growth on the side away from contact surface.
- This causes tendrils to curl round the support.

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Auxins and Hydrotropism.

- Growth of a part of a plant in response to water.
- Roots of plants grow towards water and are said to be positively hydrotropic
- Roots grow adjacent to moist soil along the slope of the wire gauze.

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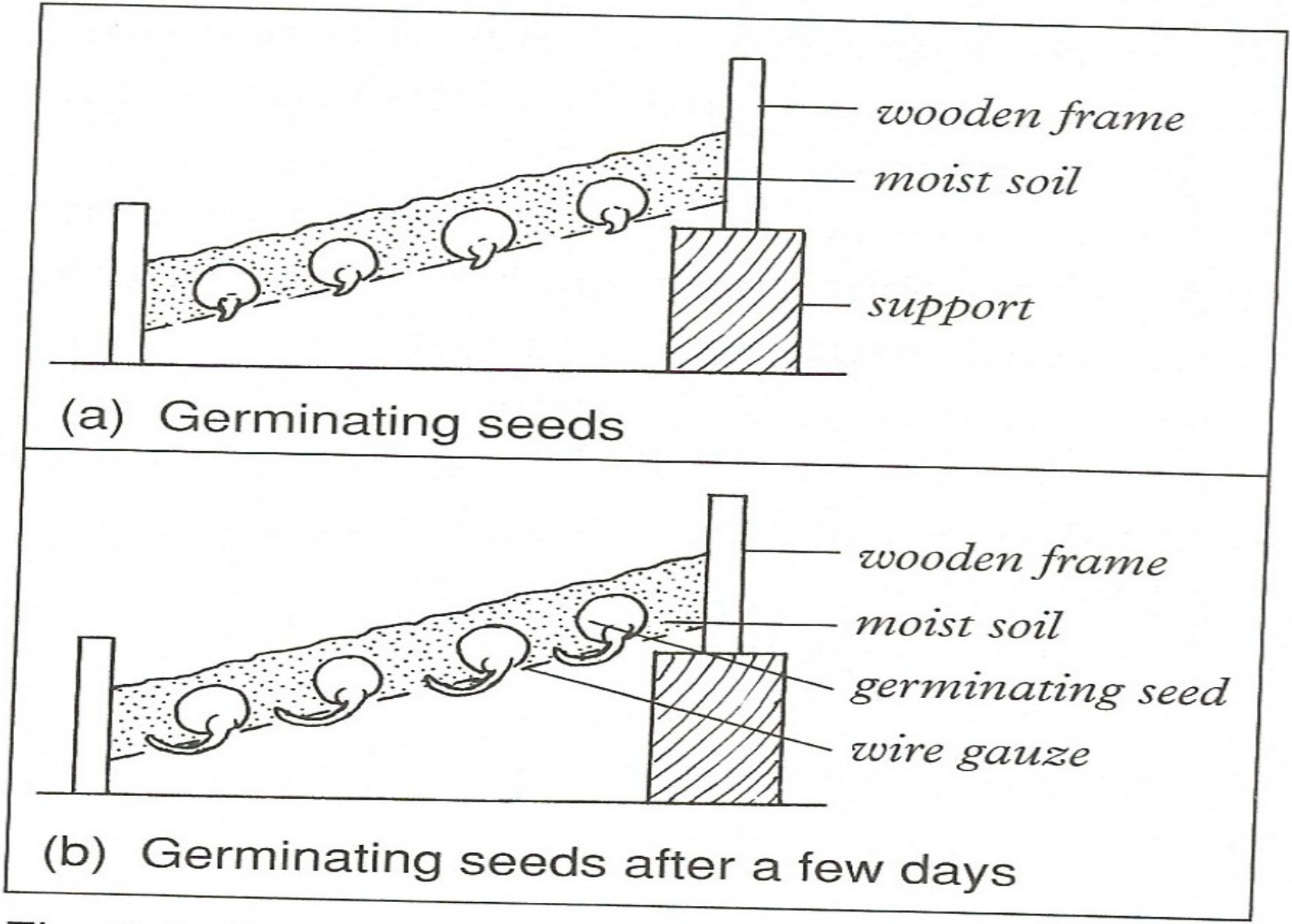


Fig. 3.4 Demonstrating hydrotropism

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Assignment

- Describe the role of hormones in growth and development of plants.
- State the application of plant hormones in Agriculture
- What is apical dominance?

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Reception, Response and Coordination in Animals.

- Irritability is a characteristic of all organisms & involves the ability to respond to a stimulus.
- Single celled organisms e.g. amoeba have an elaborate receptor-effector apparatus hence the whole protoplasm is sensitive & responds to stimuli.
- Amoeba responds to stimuli by forming pseudopodia either towards

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Larger animals.

- The larger the animal the more difficult it becomes to communicate changes between different parts.
- In animals there are two different but related systems of co-ordination.

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a) Nervous system

- It is fast acting and its effects are localized.
- It involves electrical and chemical transmission.

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Endocrine system

- It is slower in acting and its effects are diffuse.
- It relies on chemical transmission through the circulatory system.

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The nervous system.

- Comprises of highly differentiated cells whose function is to detect sensory coordination code.
- This is inform of electrical impulse and transmits them to other differentiated cells that are capable of producing a response.
- It comprises of the following:

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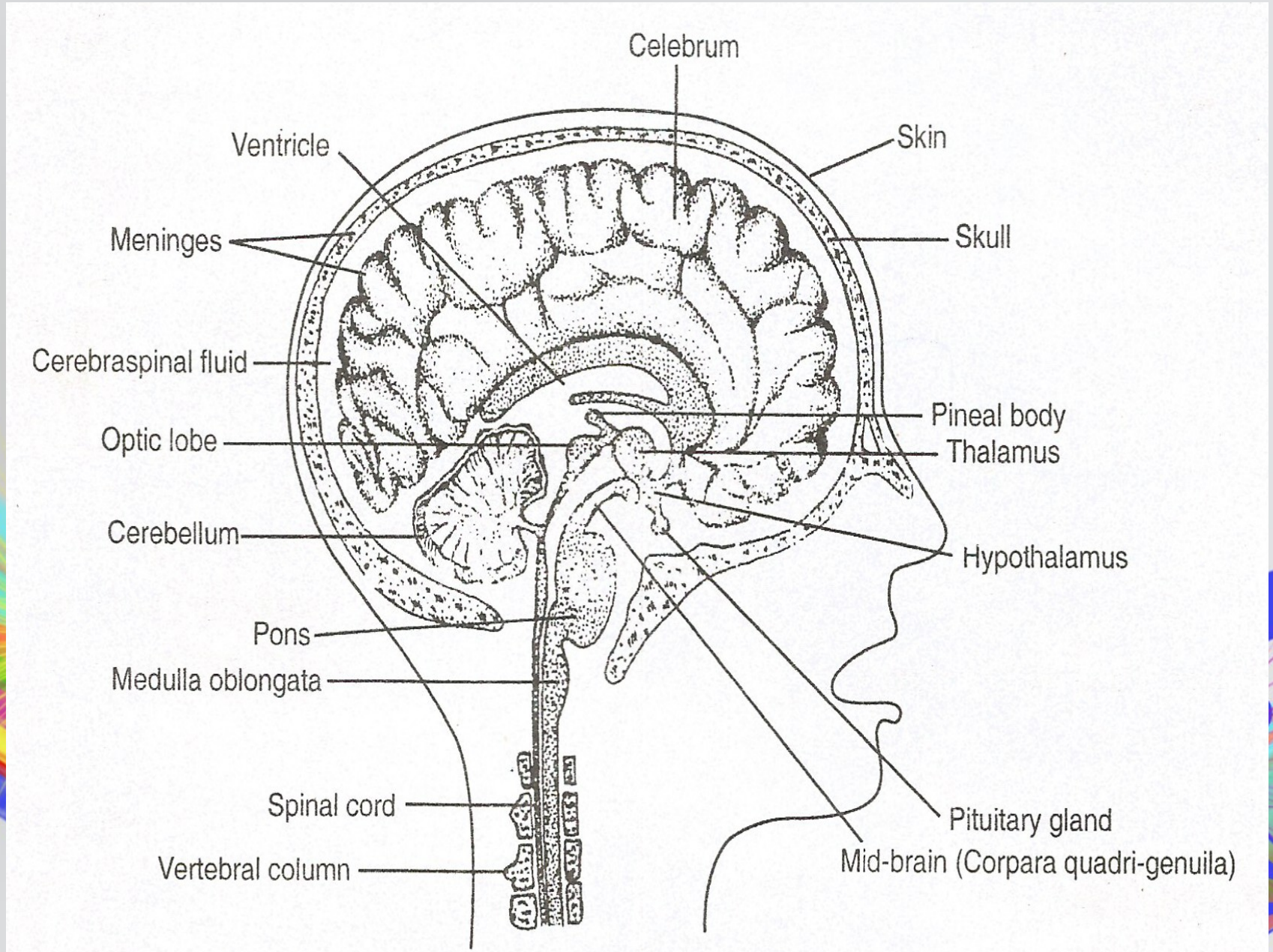
a) Central nervous system

- Consists of the Brain and Spinal cord.

Function

- To co-ordinate the sensory impulse.

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b) Peripheral nervous system.

Consists of

- Sensory nerves
- Motor nerves

Sensory nerves transmit impulses from the receptors to central nervous system.

Motor nerves transmit impulses from central nervous system to the effectors which are muscles and glands.

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c) Sense organs.

- Have specialized cells for detecting light,smell,sound and other stimuli.
- They include eyes,tongue,ear,skin and nose.

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Structure of a nerve cell.

- Nerve cell (neurone) is the basic functional unit of the nervous system.
- They ramify throughout the organism forming an elaborate communication system.
- Neurones consist of
  - A cell body
  - Arm like extension called Dendron

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- The Dendron terminate inform of dendrites
- Dendrites may elongate to form an axon that may be bounded by a specialized cytoplasm Axoplasm
- The impulse moves through the axoplasm.
- The axon is insulated by the myelin sheath which is surrounded by neurolemma and schwann cell.

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Function of schwann cell

Secretes myelin sheath.

- Myelin sheath has nodes of Ranvier that helps to propagate and speed up the impulses. Neurones can be
  - Unipolar
  - Bipolar
  - Multipolar
- Depending on number of dendrites projecting from cell body.

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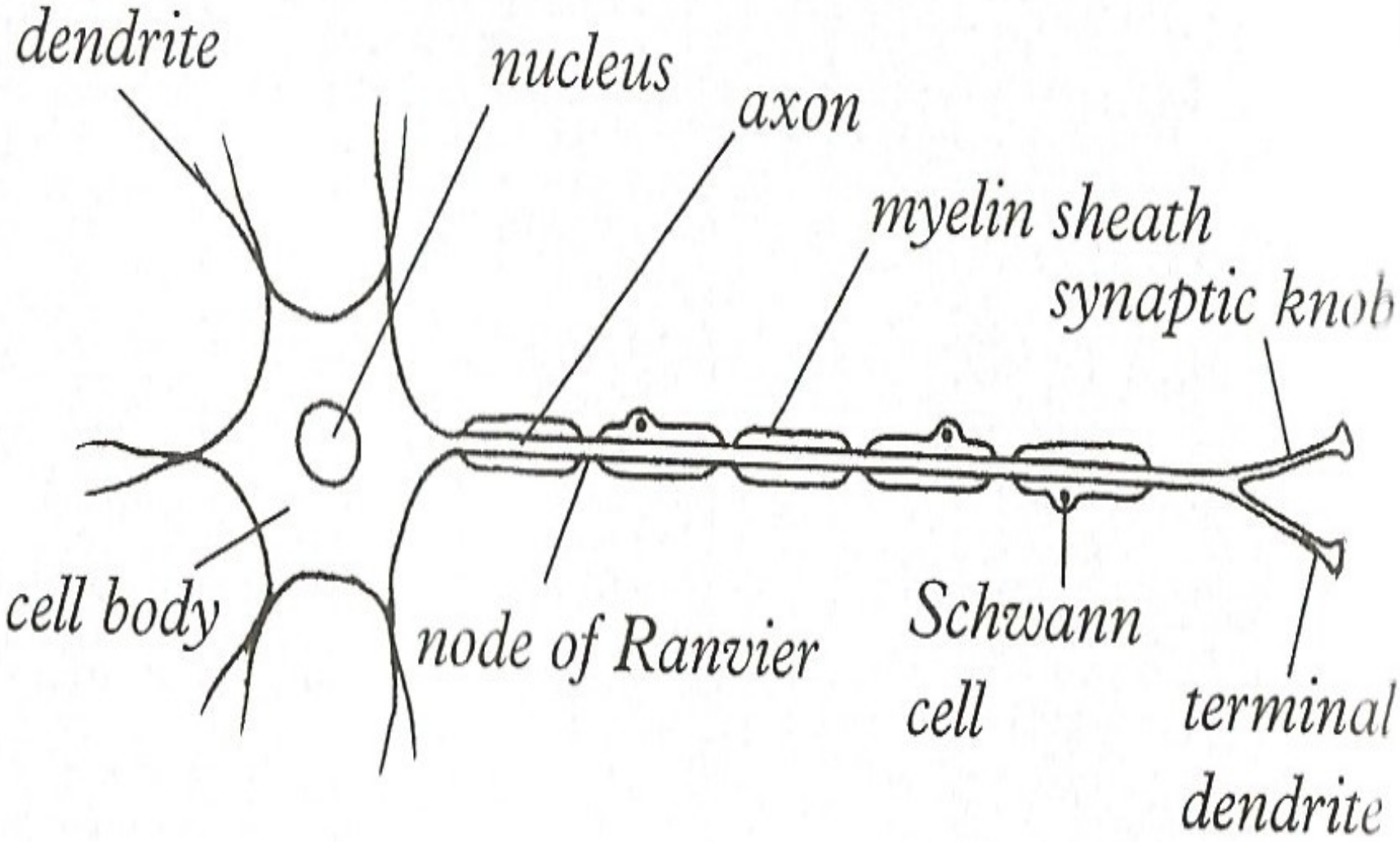


Fig. 3.7 Structure of a neurone

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Types of Neurones.

1. Sensory Neurones
2. Motor Neurones
3. Relay Neurones

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Sensory neurone

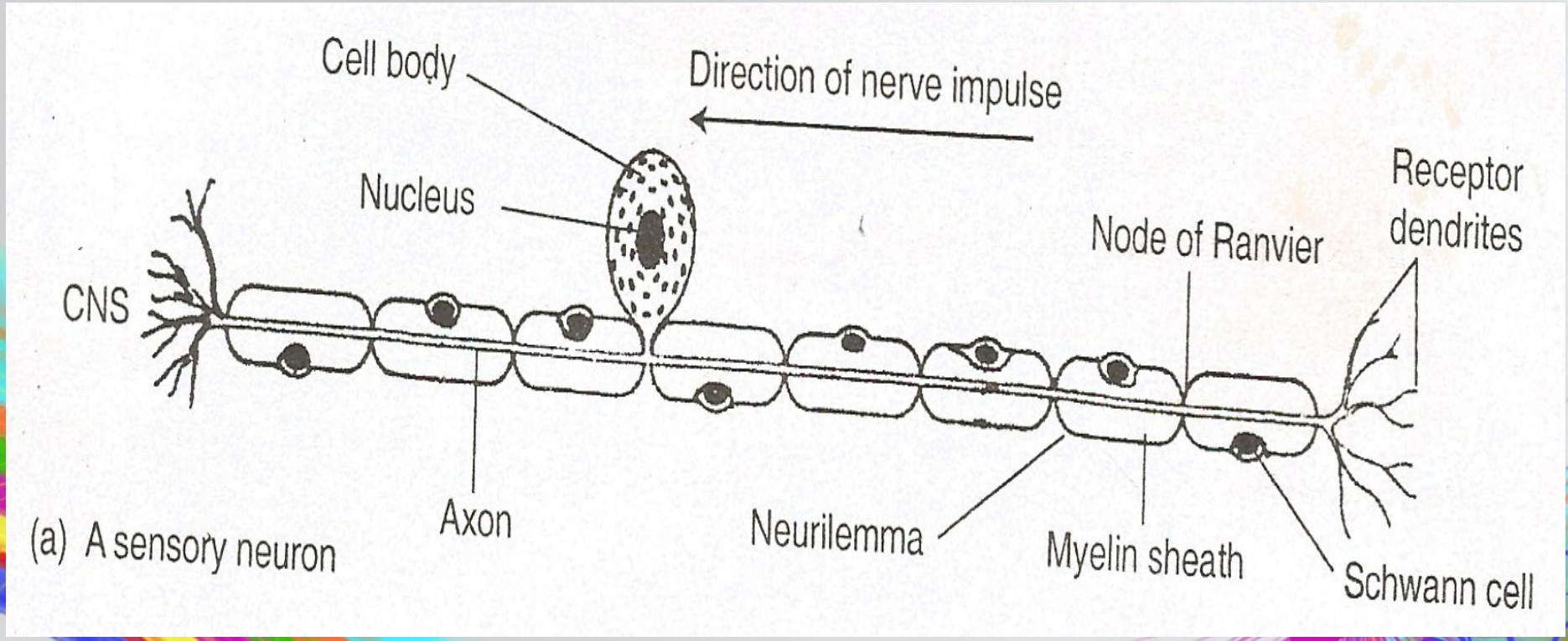
- They link sense organs through receptor dendrites to central nervous system through terminal dendrites.
- The cell body is located off the axon & outside the central nervous system.
- Cell body is unipolar
- Both axon and Dendron are long.

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Function

- They transmit impulses from the sense organs to central nervous system.

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(a) A sensory neuron

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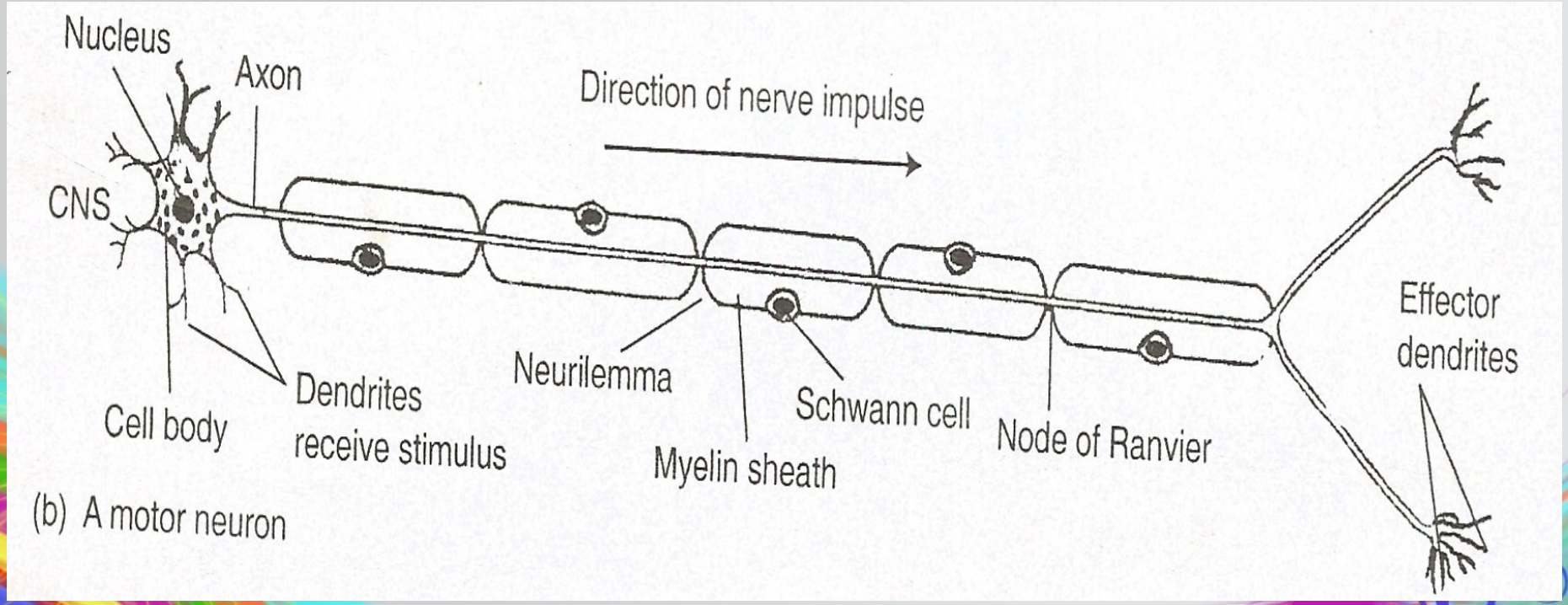
Motor Neurones

- They link the central nervous system through receptor dendrites to effectors e.g. muscles through effector dendrites.

Function

- They transmit impulses from central nervous system to effectors (Glands and muscles)

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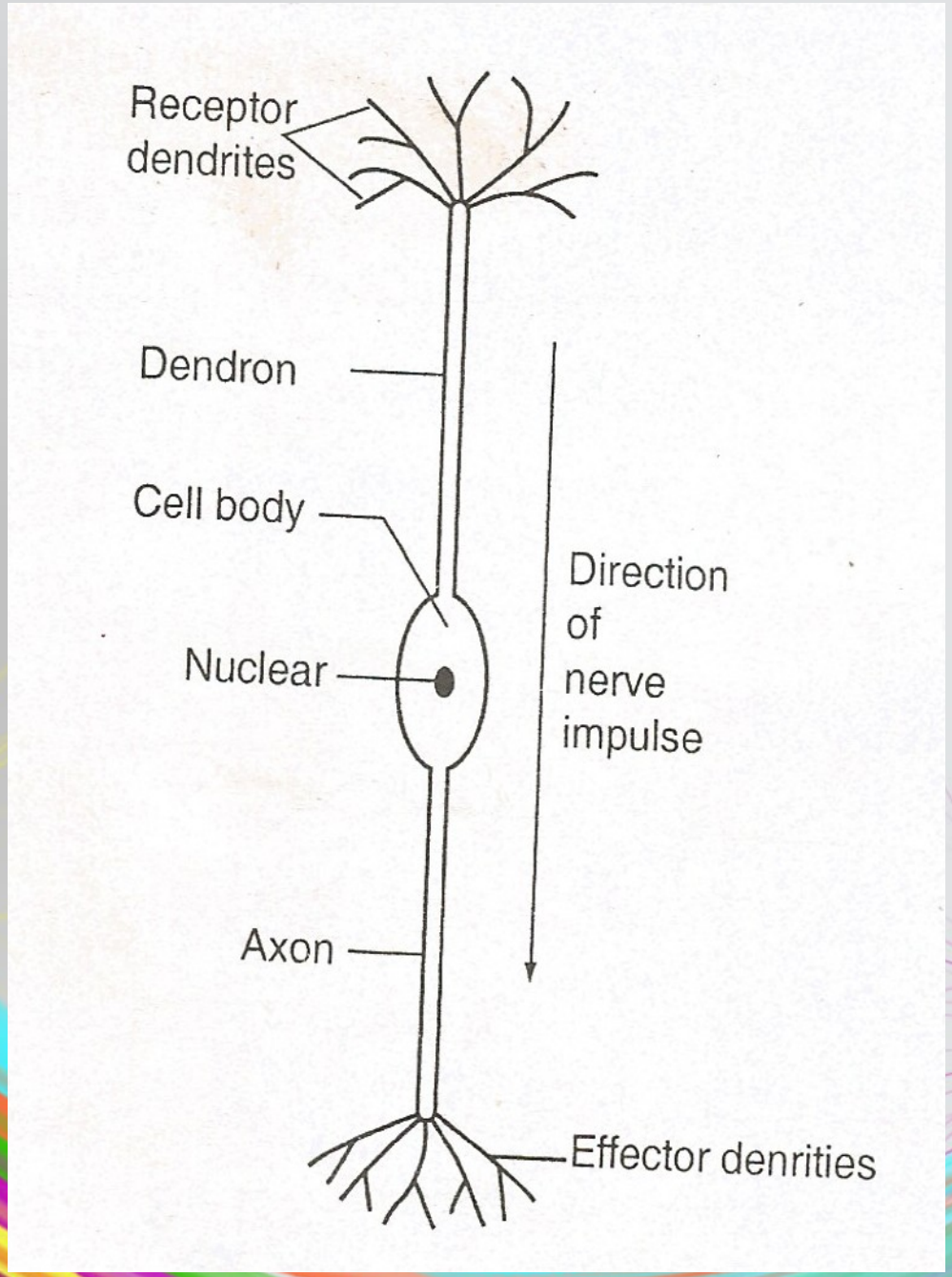
Relay neurone

- Are either Bipolar or multipolar cells
- They link sensory Neurones to motor Neurones
- They are non-myelinated and are found within the central nervous system.

Function

- Transmit impulses between sensory and motor Neurones.

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Central nervous system.

- It is composed of
  - Brain
  - Spinal cord
- It is covered protective membranes called meninges.
- Meninges consists of Dura,pia and arachnoid
- The tough outer membrane is Dura matter covering the brain and spinal cord.

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- It is composed of connective tissues rich in capillary network
- The innermost membrane is the pia matter.
- It has many blood capillaries and lymph vessels
- The two membranes are separated by a space arachnoid layer filled with cerebrospinal fluid.

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- The brain cells obtain oxygen and nutrients from this fluids.
- The layer cushions and protects the central nervous system
- The CNS and its meninges are enclosed within the axial skeleton.
- Cranium protects the brain while vertebral column protects the spinal cord.

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- The skeleton structures have foramina (holes) for passage of peripheral nerves and blood vessels.

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The Brain

- It is a delicate organ which is the main Centre for integrating and co-ordinating the impulse.
- Three main components
  - Fore brain
  - Mid brain
  - Hind brain

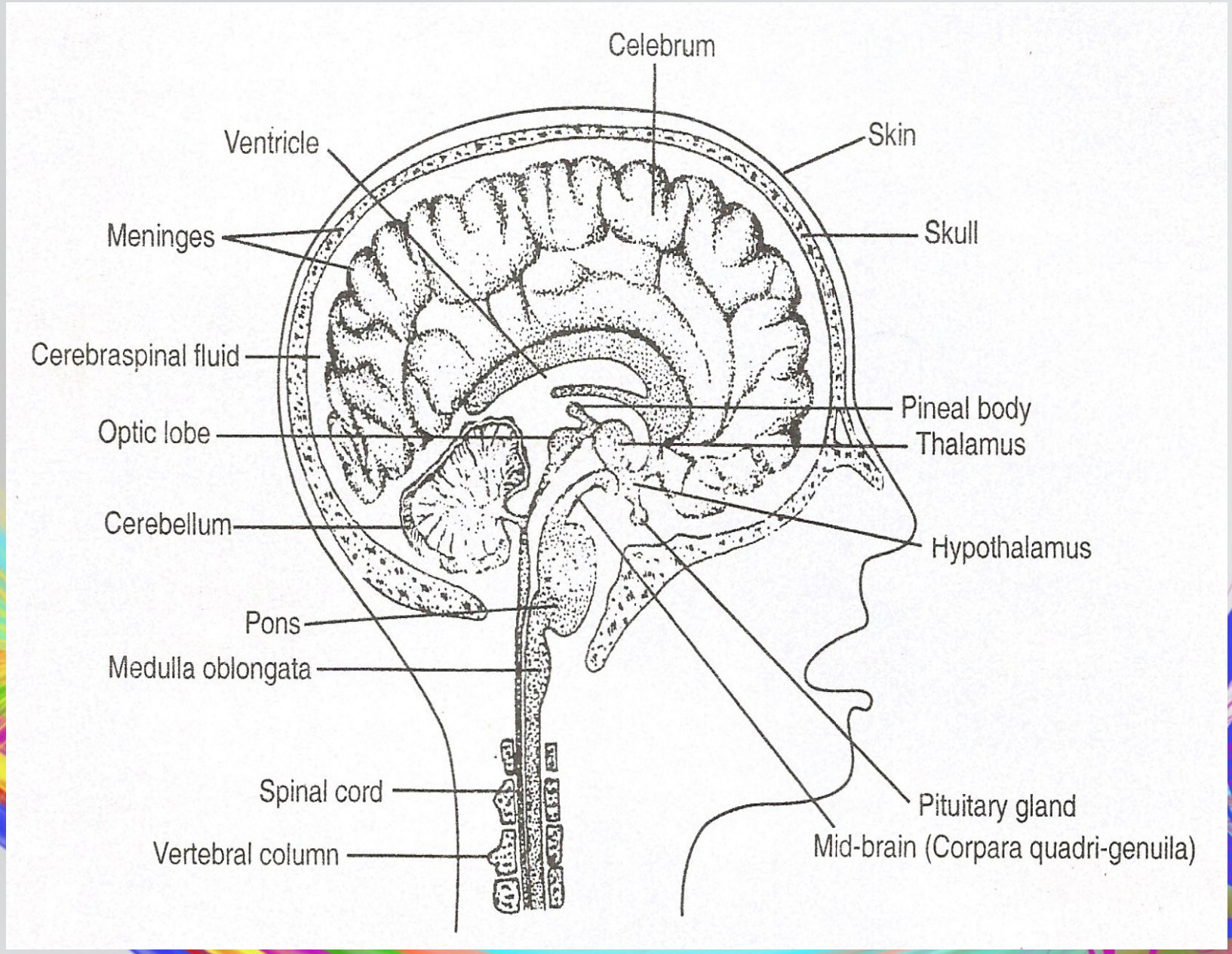
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Fore brain.

Consists of:

i. Cerebrum
ii. Thalamus
iii. Hypothalamus
iv. Pituitary gland

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Cerebrum

- It is a highly developed part consisting of right and left cerebral hemispheres.
- It integrates/interprets sensory nerve impulses concerned with hearing, vision and taste
- It controls voluntary body movements of limbs and neck,learning,memory, character & imagination.

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Thalamus

- It integrates sensory impulses from the eyes, ears & skin and sends them to the cerebrum
- Hypothalamus
- Controls impulses concerned with osmoregulation,thermoregulation,sleep, wakefulness,breathing,appetite,sexual feelings,emotions,anger and fear.

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Pituitary glands.

- Secretes hormones such as antidiuretic hormone.

Mid Brain(corpora quadrigemia)

- Relays impulses from spinal cord and fore brain

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Hind Brain.

- Consists of Cerebellum and Medulla oblongata.
- Cerebellum controls body posture, movement by controlling and co-ordinating muscular movements
- Medulla oblongata controls involuntary activities such as breathing, swallowing, salivation, vomiting, blood pressure (dilation & constriction of blood vessels.

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Spinal cord.

- It is a posterior extension of the brain running to the tail.
- It is enclosed by meninges and protected by the vertebral column.
- It consists of

i. White matter

ii. Grey matter.

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a) White matter.

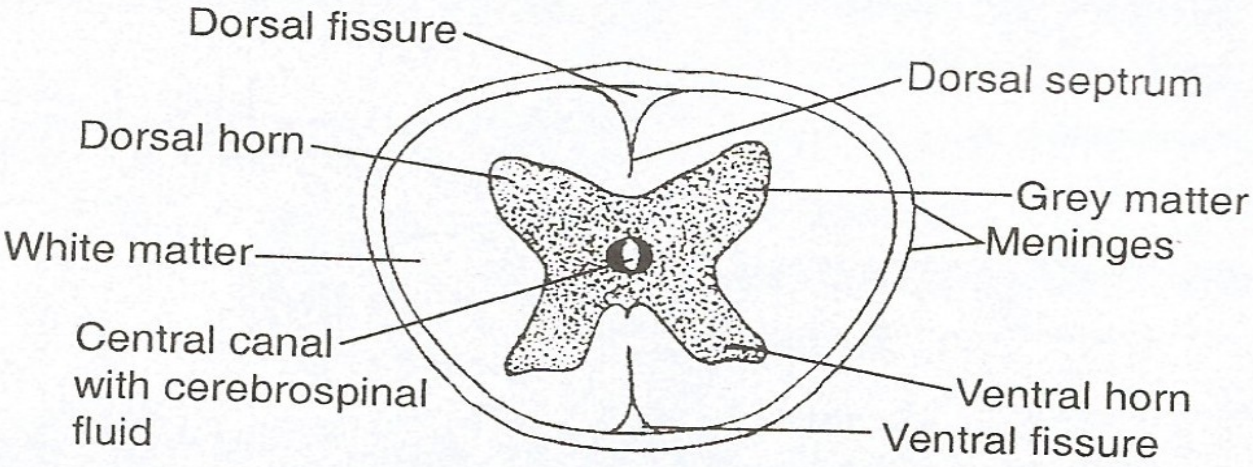
- Outer part of spinal cord surrounding the Grey matter.
- Consists of nerve fibres, axons of sensory and motor neurons
- Myelin sheaths of these Neurones give this part its shiny white appearance.

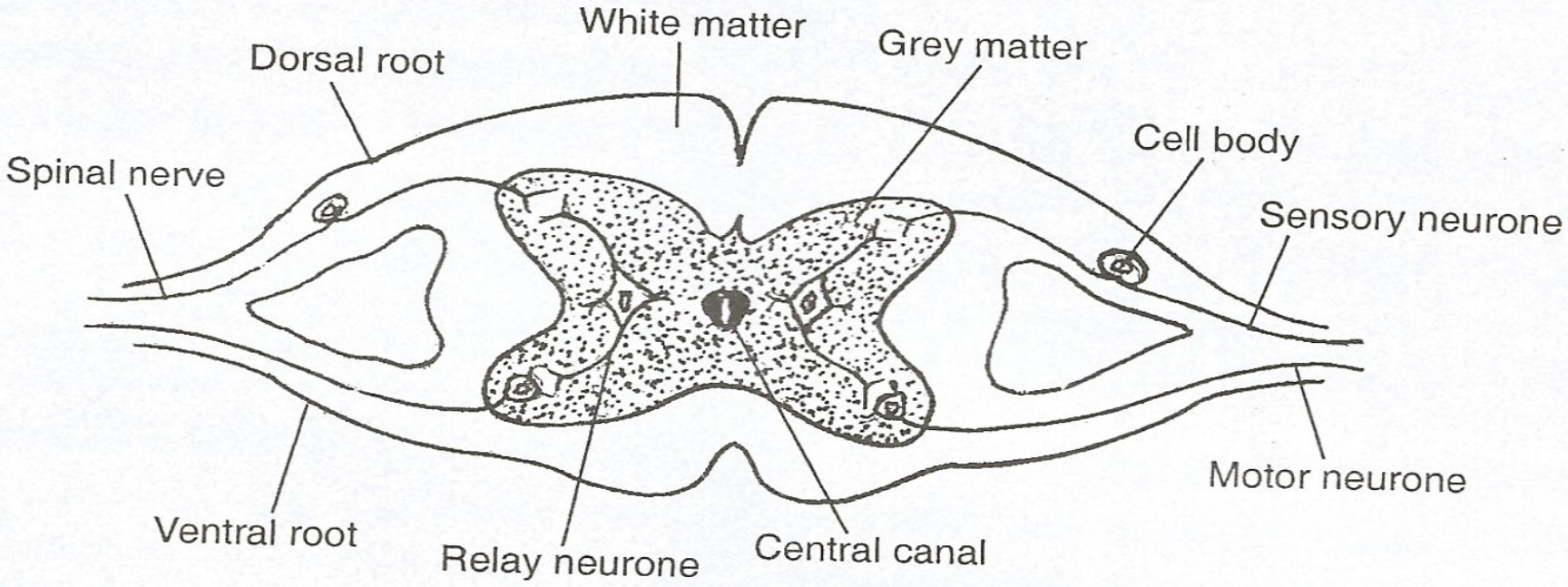
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b) Grey matter.

- Forms the central part of spinal cord.
- Consists of cell bodies and dendrites of relay Neurones
- It is H-shaped surrounding a canal filled with cerebrospinal fluid.
- Function
- It relays impulses from sensory to motor Neurones.

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Peripheral nervous system.

- Made up of cranial and spinal nerves.
- They emerge from the brain and spinal cord respectively
- In man there are 31 pairs of spinal nerves that transmit impulses to and from organs below the head to spinal cord and eventually to the brain.

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Cranial nerves.

- There are 12 pairs of cranial nerves in man

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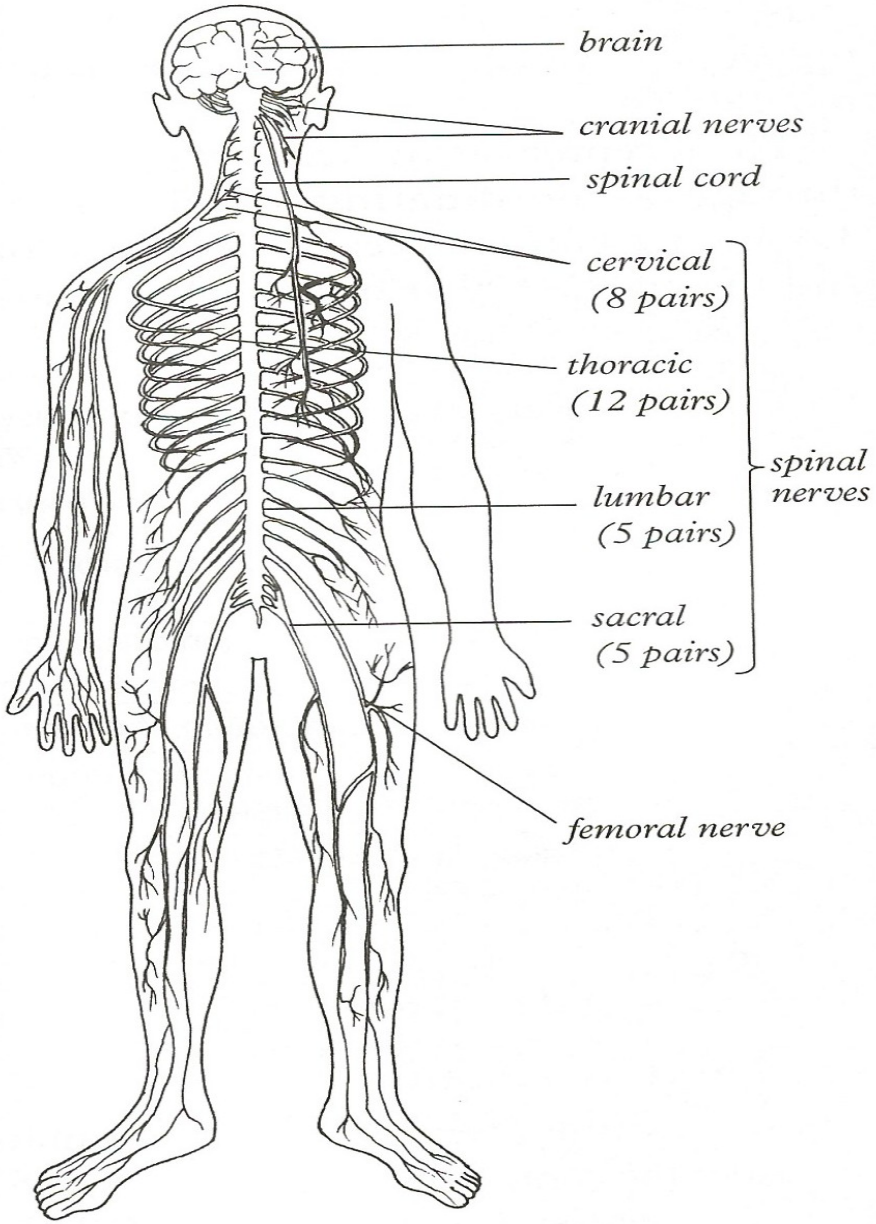


Fig. 3.6 Nervous system of a human being

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Reflex action.

It is a rapid automatic response to a certain stimulus by an organ or group of organs on receiving the impulse.

Types of reflex action

a) Simple reflex action

b) Conditioned reflex action

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Simple reflex action.

- It is a specific single and automatic response for a particular stimulus.
- It is the simplest form and doesn’t depend on learning.
- Examples
- Blinking of the eye when an object passes close to it.
- Withdrawal of a finger from a hot object

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Cont..

- Coughing and sneezing
- Secretion of tears when onions are cut.
- The path taken by a reflex action from the receptor to the effector is Reflex arc.
- A reflex arc consists of

a) Sensory neurone that transmits impulses from receptors in sense organs to grey matter of the spinal

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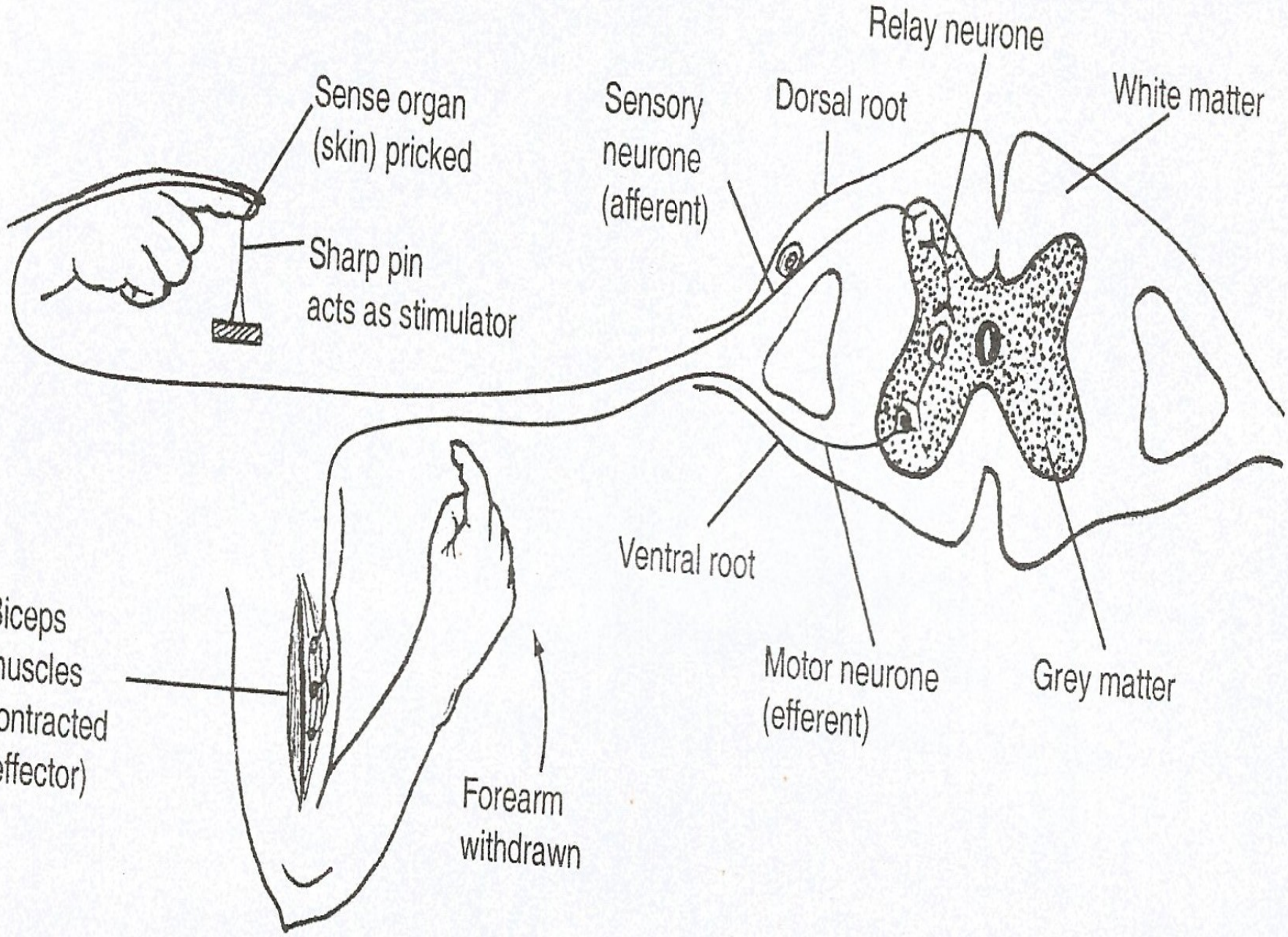
Reflex arc cont..

b) Relay neurone that is found in the grey matter of spinal cord where impulses are integrated and co-ordinated.

c) Motor neurone that transmit impulses from the spinal cord to the effectors which respond to the stimulus.

When a persons hand accidentally touches a hot object, it is quickly

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Conditioned reflex action.

- It is an automatic response evoked from an animal by unrelated stimulus substituted for the one that causes the response.
- It is formed from the last experience and involves modification of behavior through learning.
- A dog salivates when food is presented to it.

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- If a bell is rung just before the food is presented & procedure repeated several times, the dog learns to associate bell ringing with food.
- The dog will salivate as soon as it hears the sound of the bell whether food is present or not.
- It weakens with time hence requires some reinforcement.

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Examples of conditioned reflex action.

I. Walking
II. Playing
III. Cycling
IV. Writing etc.

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Differences between conditioned & simple reflex action

Simple reflex action

- Single stimulus brings about a response.
- Simplest form of behavior independent of behavior
- Sensory and Motor components are same at all times.
- Response has survival value to the stimulus.

Conditioned reflex action

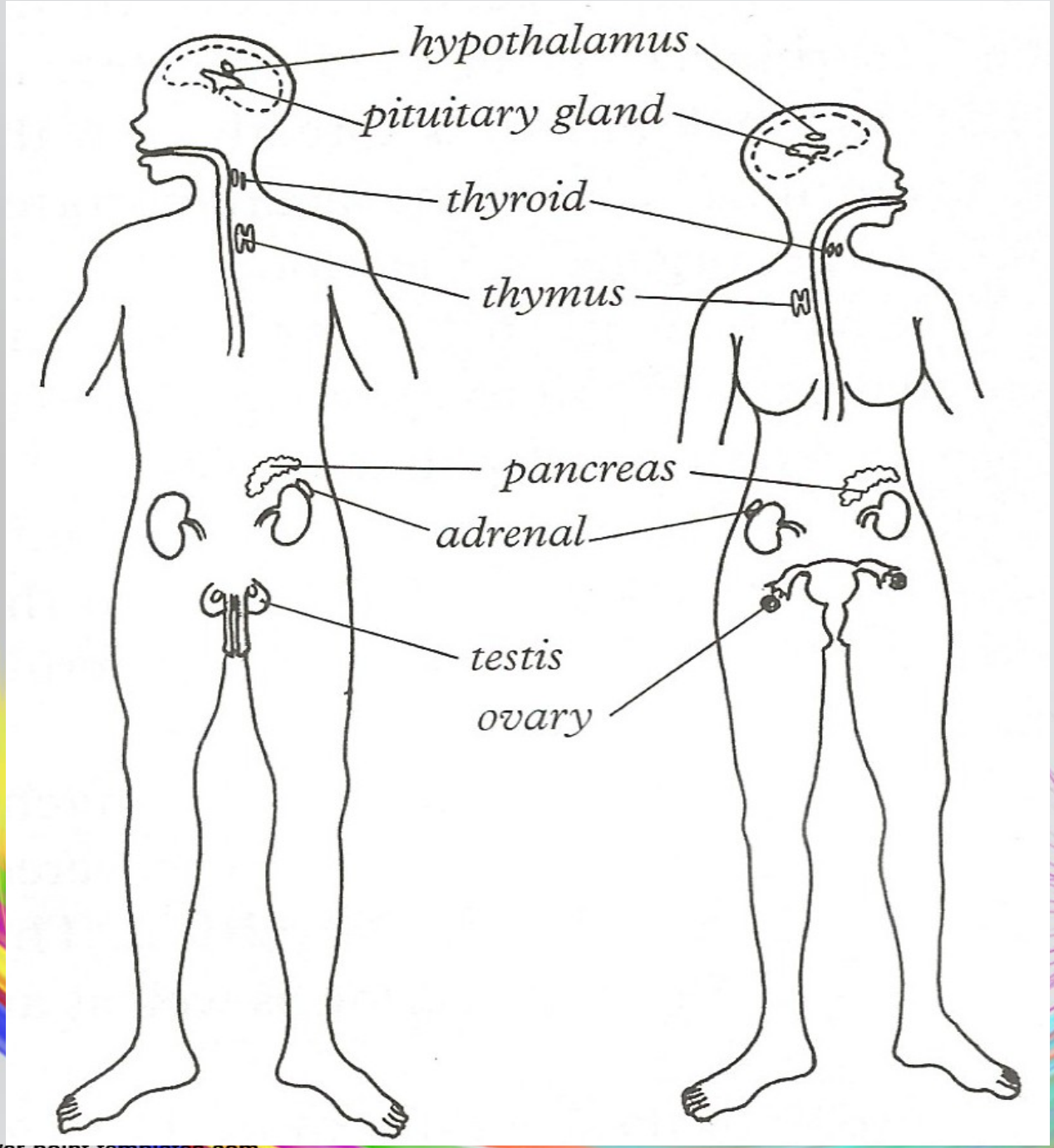
- Repeated stimulus bring about a response
- Involves modification of behavior and is dependent on experience
- Primary sensory component is replaced by secondary component but motor remain unchanged

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Endocrine system.

- It is made up of ductless glands which secrete hormones
- Hormones are organic compounds protein in nature produced in small quantities in one part of the body & transported by blood to another part where it produces a response.

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Hormones operate on a feed back mechanism.

An impulse from the nervous system e.g. during an emergency there is a reflex action which involves production of adrenaline hormone from Adrenal glands

- Luteinizing hormone stimulates corpusluteum to secrete Progesterone hormone.

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Thyroxine hormone.

- Produced by Thyroid gland found in the neck region.
- Functions

a. Increase glucose oxidation

b. Enhances the effect of Somatotrophin (growth hormone)

c. Works with adrenaline to enhance involuntary activities e.g. increased circulation rate.

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Effects of under secretion. (Hypothyroidism)

- Leads to insufficient iodine in the diet
- Leads to cretinism in children and myxoedema in adults
- Low metabolic rate due to reduced heartbeat, breathing rate, low body temperature
- Mentally and physically sluggish
- Weight gain(obesity) and retention of excess fluids(oedema) hence swollen feet and puffy face.

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n/b

- Cretin-Deformed legs, dry leathery skin and large tongue
- Myxoedema-Swelling of thyroid gland (Goitre)

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Control

- ✓Balanced diet
- ✓Use of iodised table salt
- ✓Administration of iodine tablets.

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Effects of overproduction . (Hyperthyroidism)

- It occurs when there is presence of plasma proteins that stimulate thyroid activity.
- It leads to increased metabolic rate hence increased heartbeat, breathing rate and high temperatures
- Individuals show nervousness, restlessness &easily irritable
- It can lead to heart failure(Thyrotoxicosis)

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Control

- Treatment with radioactive iodine
- Surgical removal of the part of thyroid gland.

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Adrenaline hormone.

- Produced by adrenal glands.
- It prepares the body for emergency fight or flight.
- Effects
- Heartbeat increases increasing the rate of circulation.
- Increase metabolic rate
- Arterioles to the skin and digestive system constrict

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Cont..

- Glycogen is converted to glucose in the liver.
- Skeletal muscles contract and relax to allow movement
- Breathing rate becomes faster and deeper
- Fats are converted to fatty acids available in blood for muscle contraction.

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Over secretion of Adrenaline

- Brought by growth of a tumor in medulla of adrenal glands
- High blood pressure
- Severe headache
- Racing heart
- Sweating and faintness.

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Similarities between Endocrine and nervous system.

- Both provide means of communication within the body of an organism.
- Both involve transmission of impulses triggered by a stimulus and a response.
- Target organs of hormones are like the effector organs
- Both involve chemical transmission
- Both bring about survival responses

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Differences between endocrine and nervous system.

Endocrine system

- Chemical substance evoke a response
- Chemical transmitted through blood
- Response slow and affect several parts of the body
- Effects are long lasting
- Response takes place involuntarily

Nervous system

- Nerve impulse evoke the impulse
- Impulse only through a nerve fibre.
- Response quick,specific and localised
- Effects rapid and short lived
- Takes place voluntarily and involuntarily.

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Effects of drug abuse.

- A drug is any chemical substance that has psychological and physiological effects.
- Drug abuse is the indiscriminate use of drugs with no regard to their side effects.

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Effects

- Depressed appetite and poor feeding leading to emaciation
- Interference with absorption of vitamins such as K &E that may lead to sterility and blindness.
- Lowers nervous coordination leading to loss of posture and balance
- Irritation of lungs and respiratory tract leading to frequent coughs and infections.

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Effects cont....

- May lead to cancer of lungs, throat and urinary bladder.
- May cause stomach ulcers
- Damage to tissues of heart and liver leading to heart attack and cirrhosis
- Interferes with temperature regulation hence excessive heat loss.

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Cont…

- Damage to brain leading to sleeplessness (insomnia),loss of memory (amnesia), hallucinations, mental illness(madness)
- Poor foetal development and pregnancy complications in women
- Irreversible damage to vital tissues and organs leading to death
- Impaired judgment in addicted persons predisposing them to accidents and infections such as

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SENSE ORGANS

- Have specialized cells for detecting light,smell,sound and other stimuli.
- They include Eyes,tongue,ear,skin and Nose.

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EYE.

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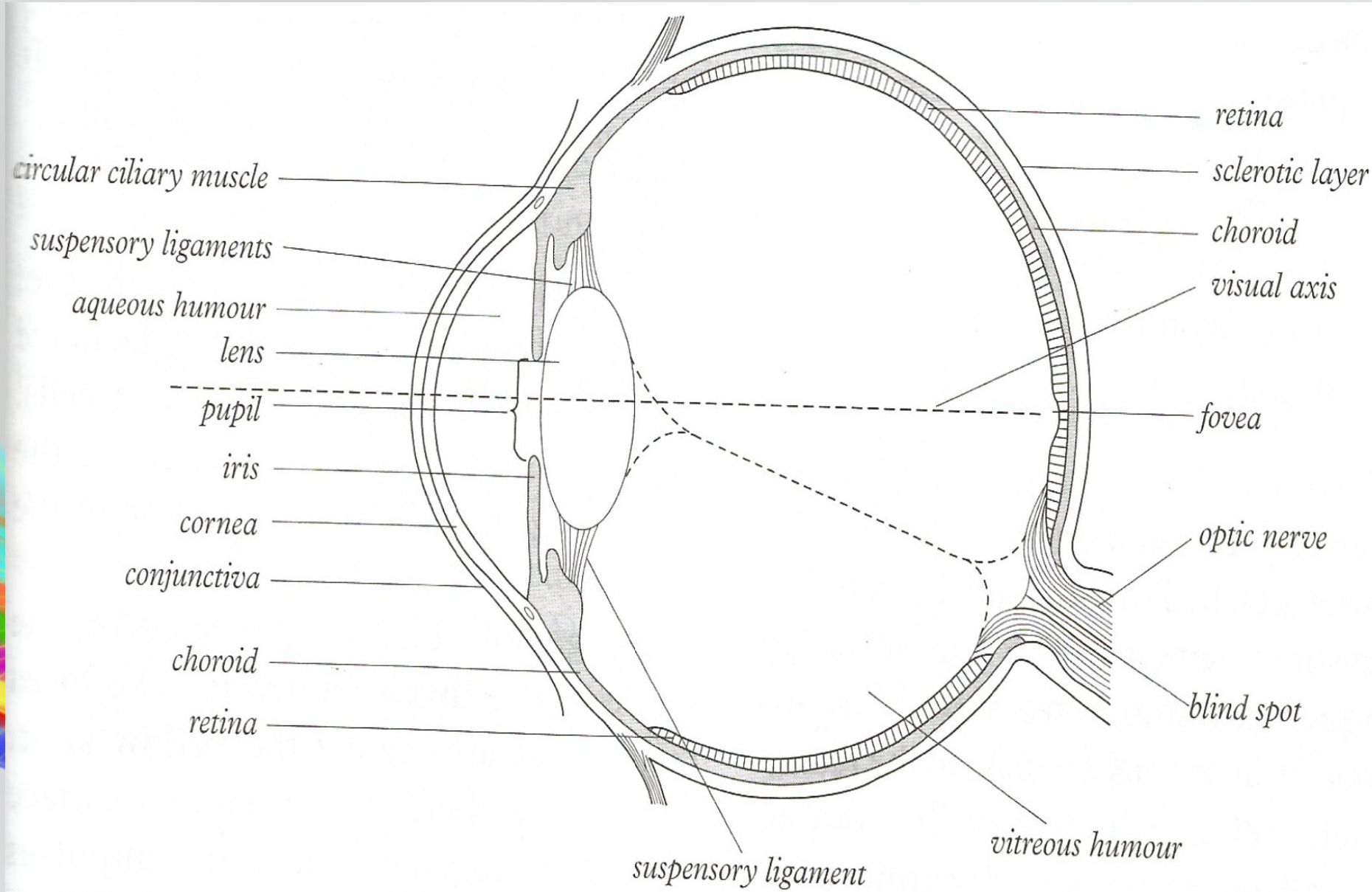


Fig. 2.09 Th

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- It is a photoreceptor located in a socket in the skull called Orbit.
- Orbit offers the eye protection from physical damage
- It is suspended in a socket by three muscles.
  - Inferior and superior oblique.
  - Superior and inferior rectus.
  - External and internal rectus.

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Parts of the eye cont..

Inferior and superior oblique muscles

- Moves the eye left and right

Superior and inferior rectus muscles

- Moves the eye up and down

External and internal rectus muscles

- Steady the eye in its up and down movement.

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- In front of the eyeball is Eyelids with eye lashes
- They protect the eye from foreign particles
- They also protect the retina from bright light by reflex action
- Eyebrows prevent sweat from entering the eye.

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- The gland vertebrae has lachrymal(tea) gland that produce tears which wash foreign particles from the eye.
- The vitreous humour fills posterior chamber of the eye.
- It is a fluid which maintains the shape of the eye
- It also refracts light rays

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Aqueous humour.

- Fills the anterior chamber.
- It is a fluid through which oxygen/nutrients pass to Cornea or lens
- It maintain the shape of the eyeball
- It refracts light rays
- The wall of the eye consists of three layers namely Sclera(Sclerotic layer/outer layer, Choroid layer(middle)& Retina(inner layer)

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Sclera

- It is made up of collagen fibres
- It maintains the shape of the eyeball
- It protects the eye
- It forms a thick transparent cornea
- The cornea is curved thus refracts light rays towards the retina
- It is transparent hence allows light to pass through

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Conjunctiva

- It is thin and transparent hence allows light to pass through
- It is tough hence protects the eye

Choroid

- Is a layer of tissue with black/dark pigments
- It contains blood vessels that supply oxygen and nutrients to the eye
- It removes metabolic wastes from the eye.

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Yellow spot/fovea centralis

- Has high concentration of cones for accurate vision(visual acquity)
- Blind spot
- Has neither cones nor rods
- This is the place where the optic nerve enters the eye/leaves the eye.
- Optic nerve
- Has sensory nerve fibres for transmission of impulses to the brain for interpretation

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Lens

- It is biconcave for refraction of light rays
- It is made up of elastic muscles that adjust to focus on far or near objects (accommodation)
- It is transparent to allow light rays to pass through

Suspensory ligaments

- Are inelastic hence hold the lens in position
- They attach the lens to ciliary body

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Ciliary body.

- Made up of muscle fibres which contract and relax to change the shape/curvature of lens
- It is glandular hence produces aqueous humour.

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Iris

- Is the coloured part of the eye
- It has radial and circular muscles which control the size of the pupil.

Pupil

- Is the small hole at the Centre of the iris.
- Light passes through it into the eye.

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Accommodation

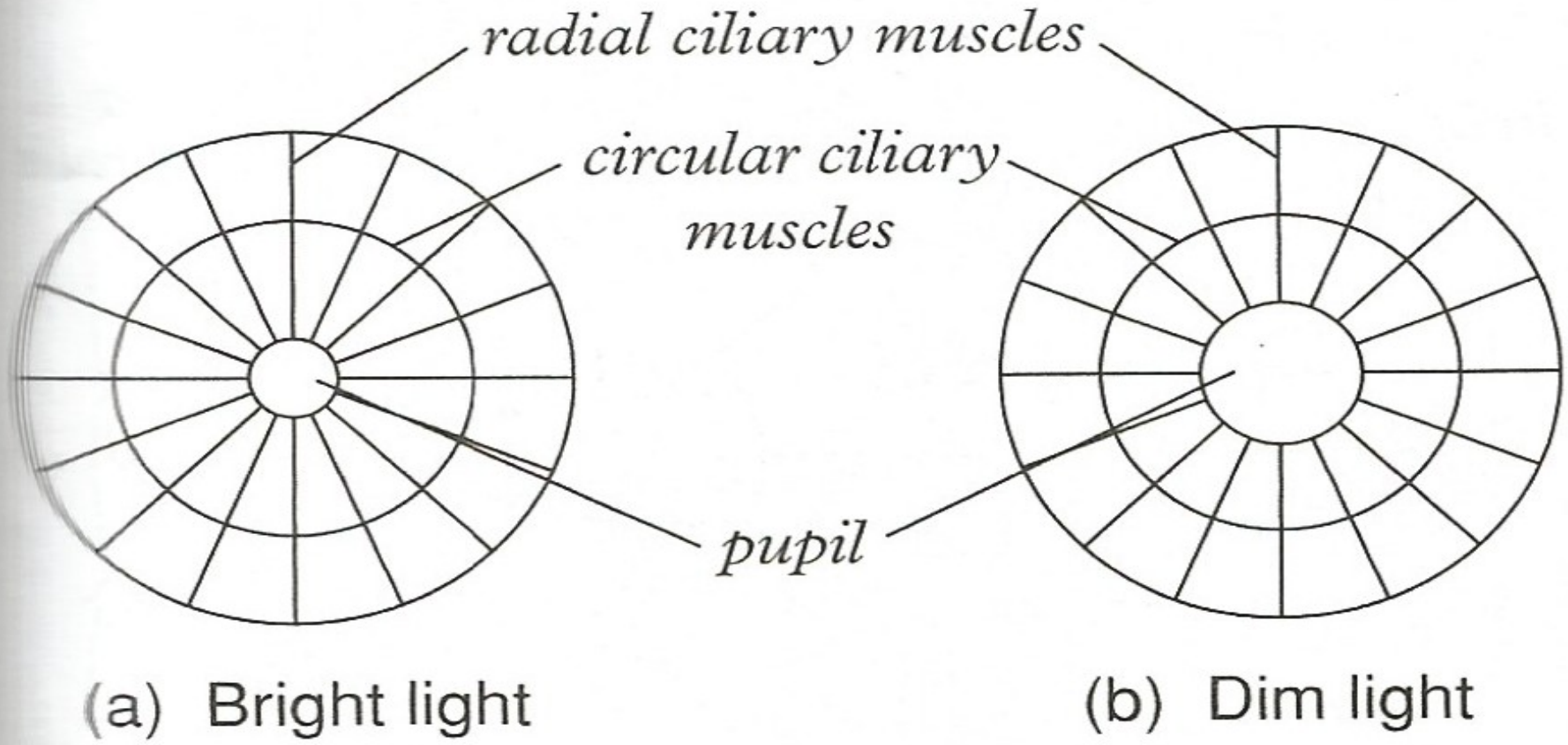
- Is the alteration of the shape of lens so that it can focus on near or far objects.
- Alteration of lens is done by ciliary muscles
- When ciliary muscles relax, the perimeter of lens is pulled outwards giving it a flattened shape.
- When they contract, tension on lens is released hence moves to spherical shape.

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Accommodation cont..

- The lens become flatter on distant objects and rounder for near objects
- In bright light, circular muscles of iris contract, iris expand and the pupil becomes smaller.
- In dim light, radial muscles of iris contract, the iris contracts becoming smaller and the pupil enlarges.

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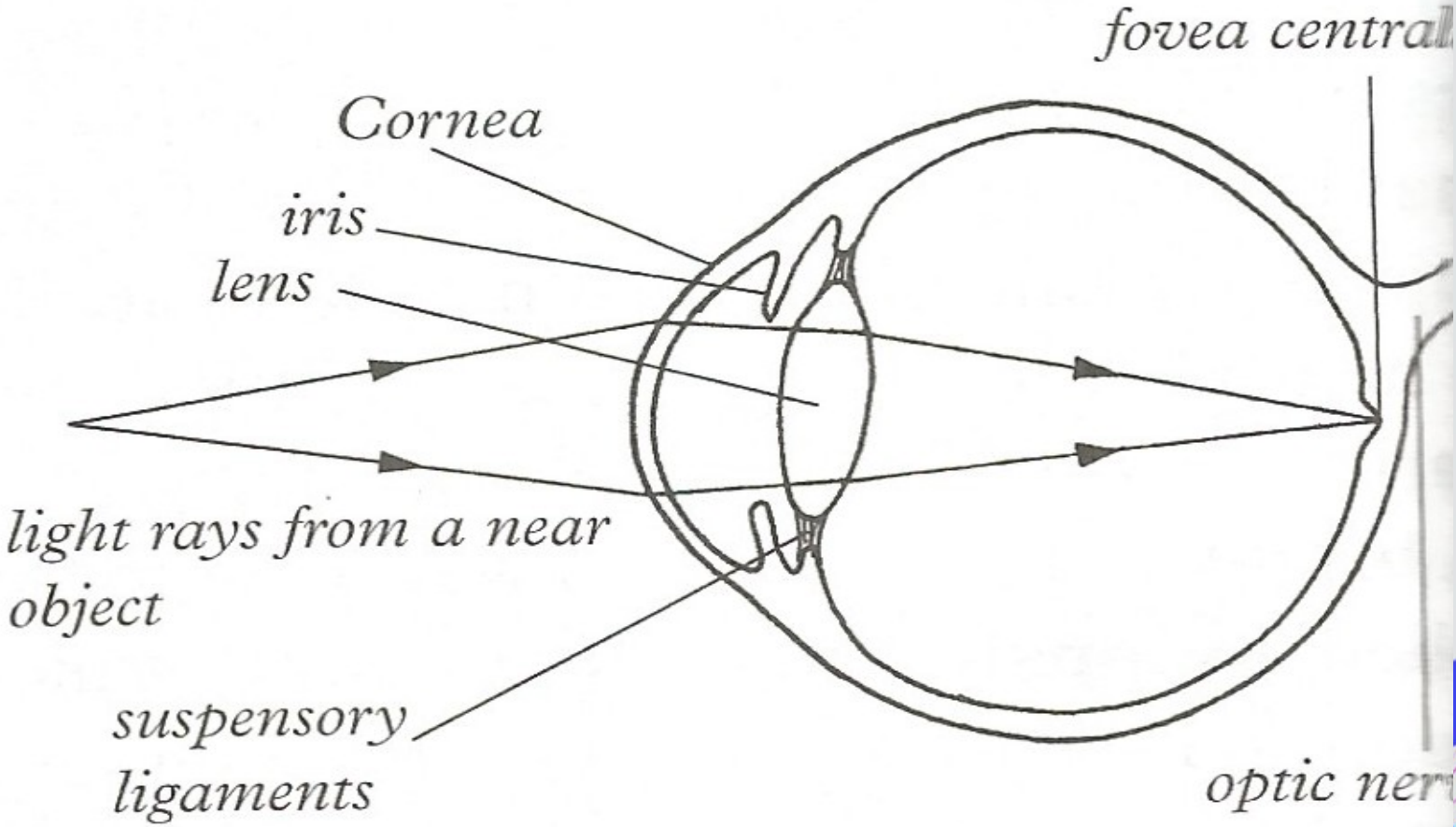
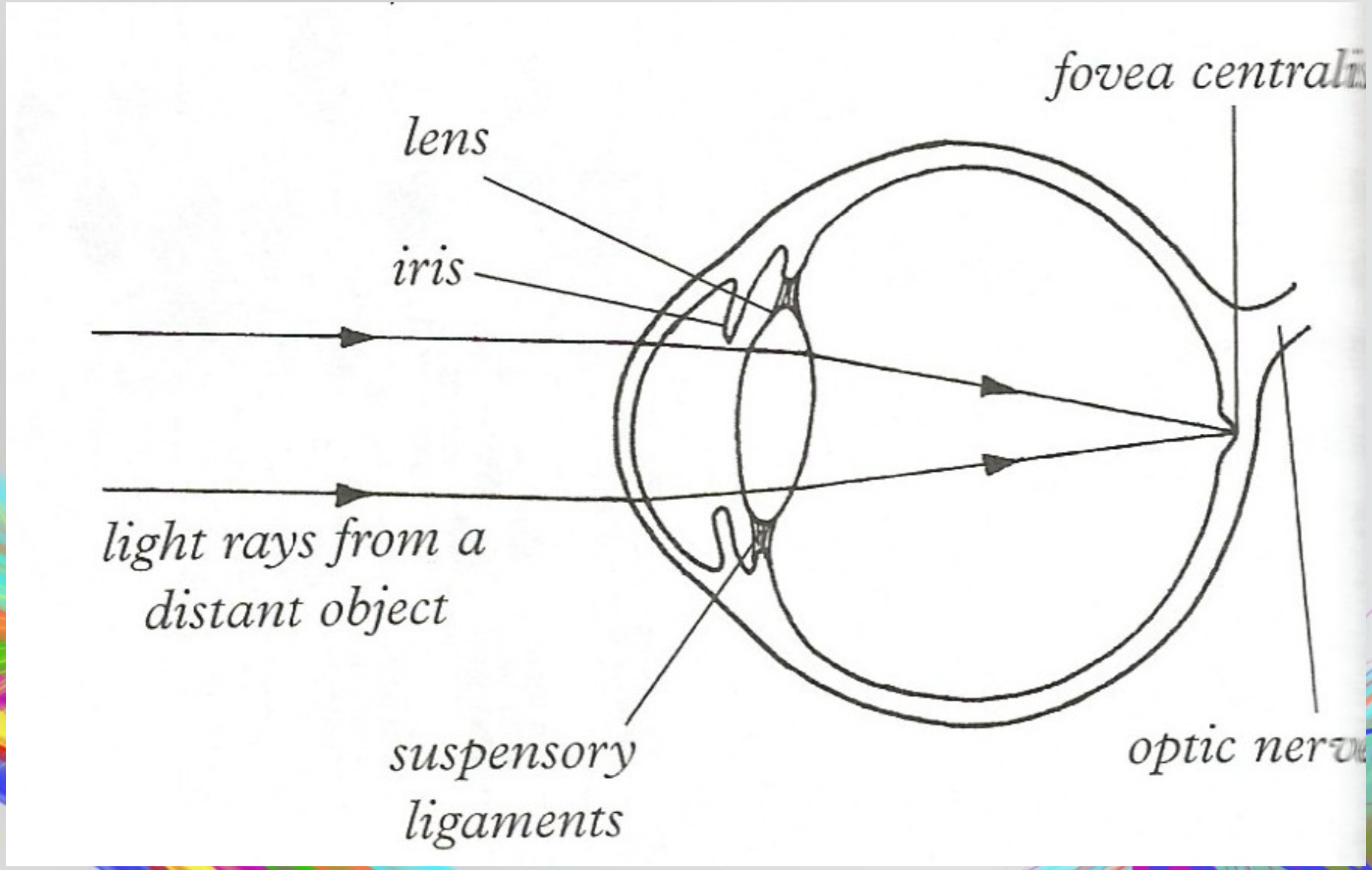


Fig. 3.23 Focussing of a near object

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Image formation

- Light from external source passes through the cornea, aqueous humour, lens and vitreous humour before reaching the retina.
- This refracts light and focus it into the Fovea.
- Refraction causes the image to be upside down and smaller than the object
- The image on the retina causes stimulation of photoreceptor cells

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- This leads to a change in photoreceptor pigments
- This makes the impulse transmitted to the central nervous system(brain)where interpretation is done.
- When rhodopsin is acted on by light, it splits into opsin and retinol.
- Synthesis of this pigment occur slowly in light but fast in dark
- Iodopsin work in the same manner as

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- Iodopsin is more than rhodopsin hence split and operate in light.
- It splits into iodine and opsin

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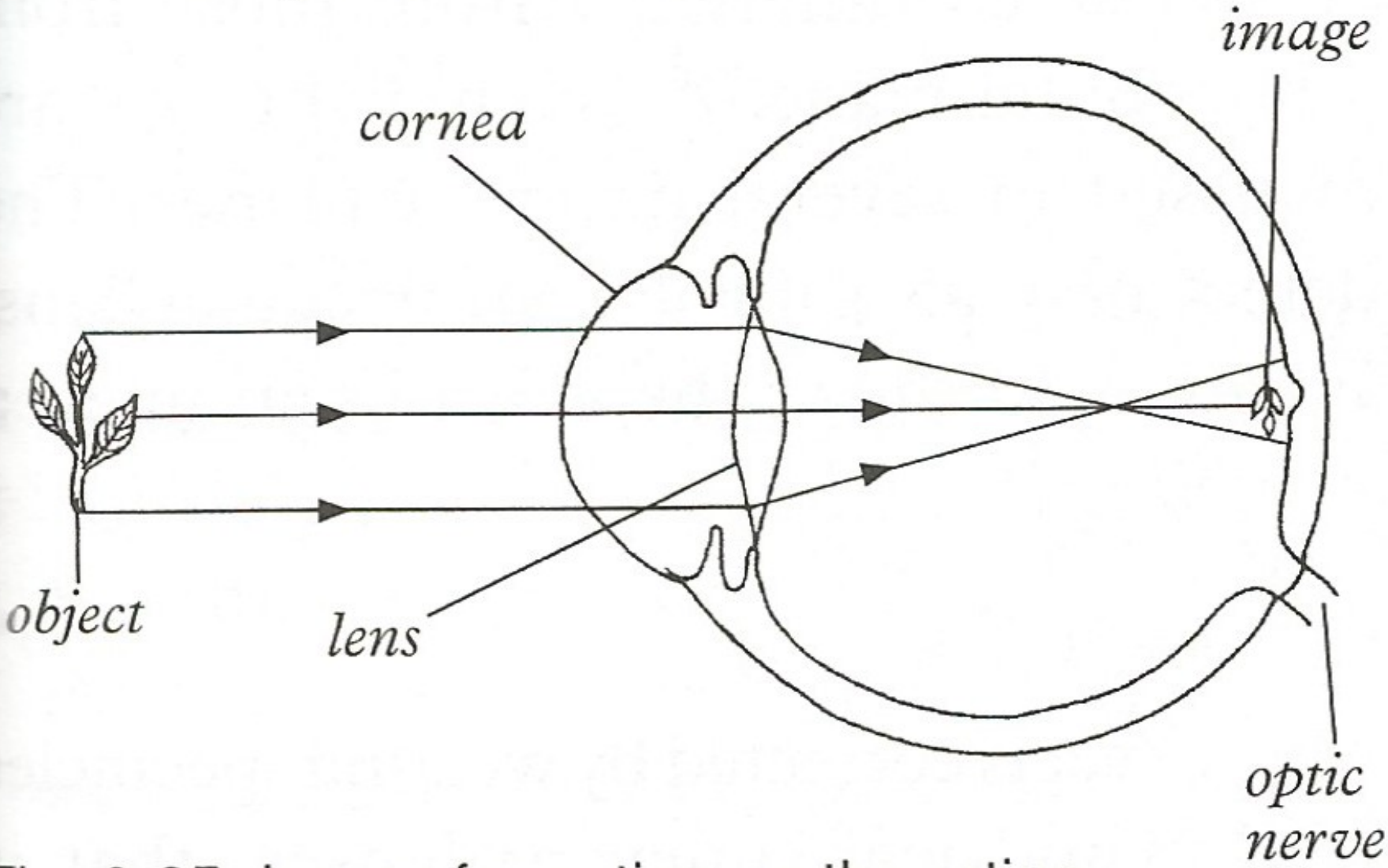


Fig. 3.25 Image formation on the retina

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Binocular vision.

- Occurs when visual fields of both eyes overlap hence fovea of both eyes focus on same object.
- It is the basis of stereoscopic vision
- Here both eyes produce slightly different images which the brain resolves as one image.

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Advantages of binocular vision.

- Larger visual field
- Damage to one eye is compensated by the other.
- Much more accurate assessment of depth, height& width of an object.

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Defects of the eye.

- Short Sightedness (Myopia)
- It is caused by long eyeball
- Too much refractive power of eye lens
- It is a condition in which light rays from a distant object focus in front of retina while those from near objects clearly focus on retina.

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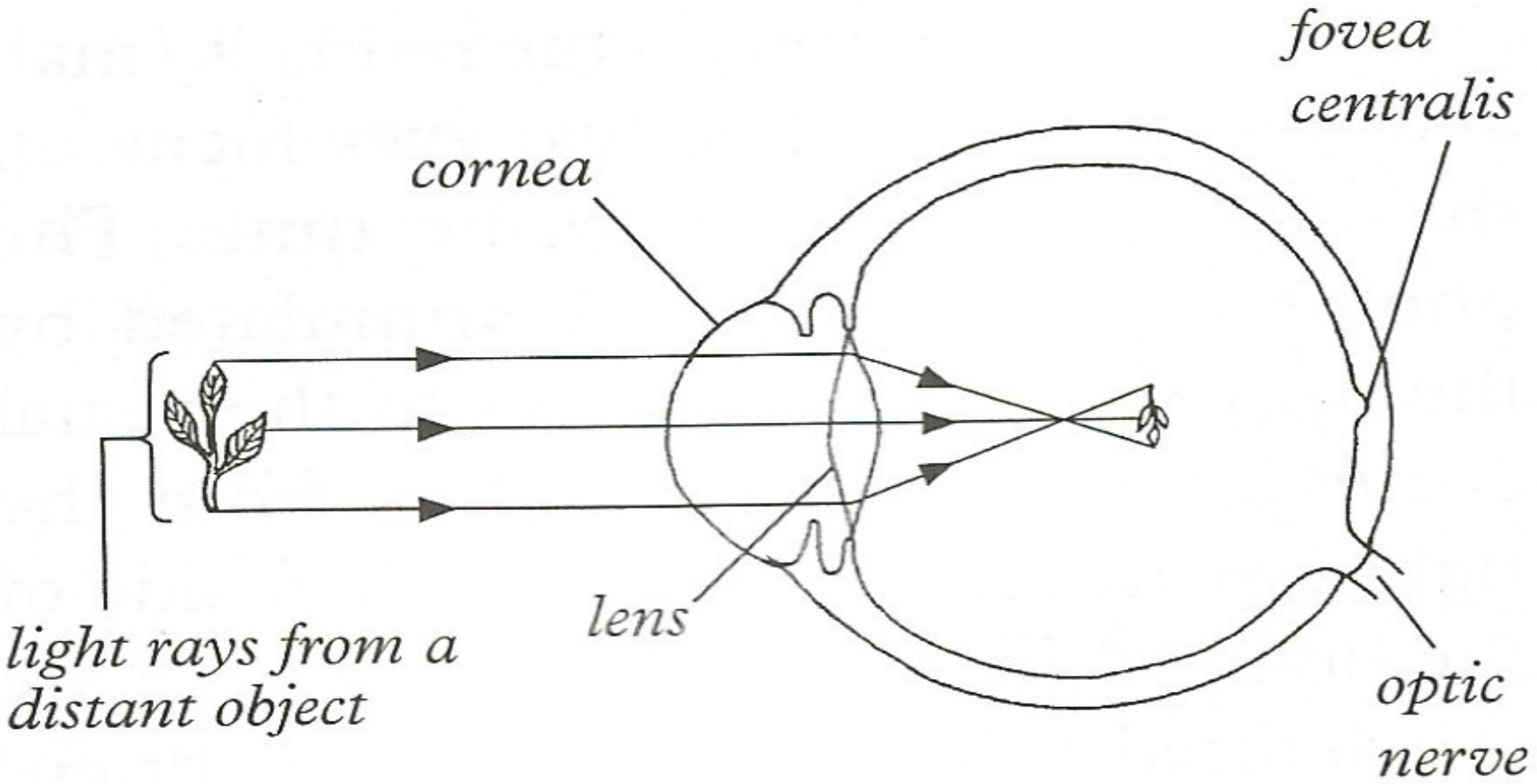


Fig. 3.26 Short-sightedness

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Correction

- Wearing biconcave/concave/diverging lenses that diverges light rays before reaching the eye and focuses on the retina.

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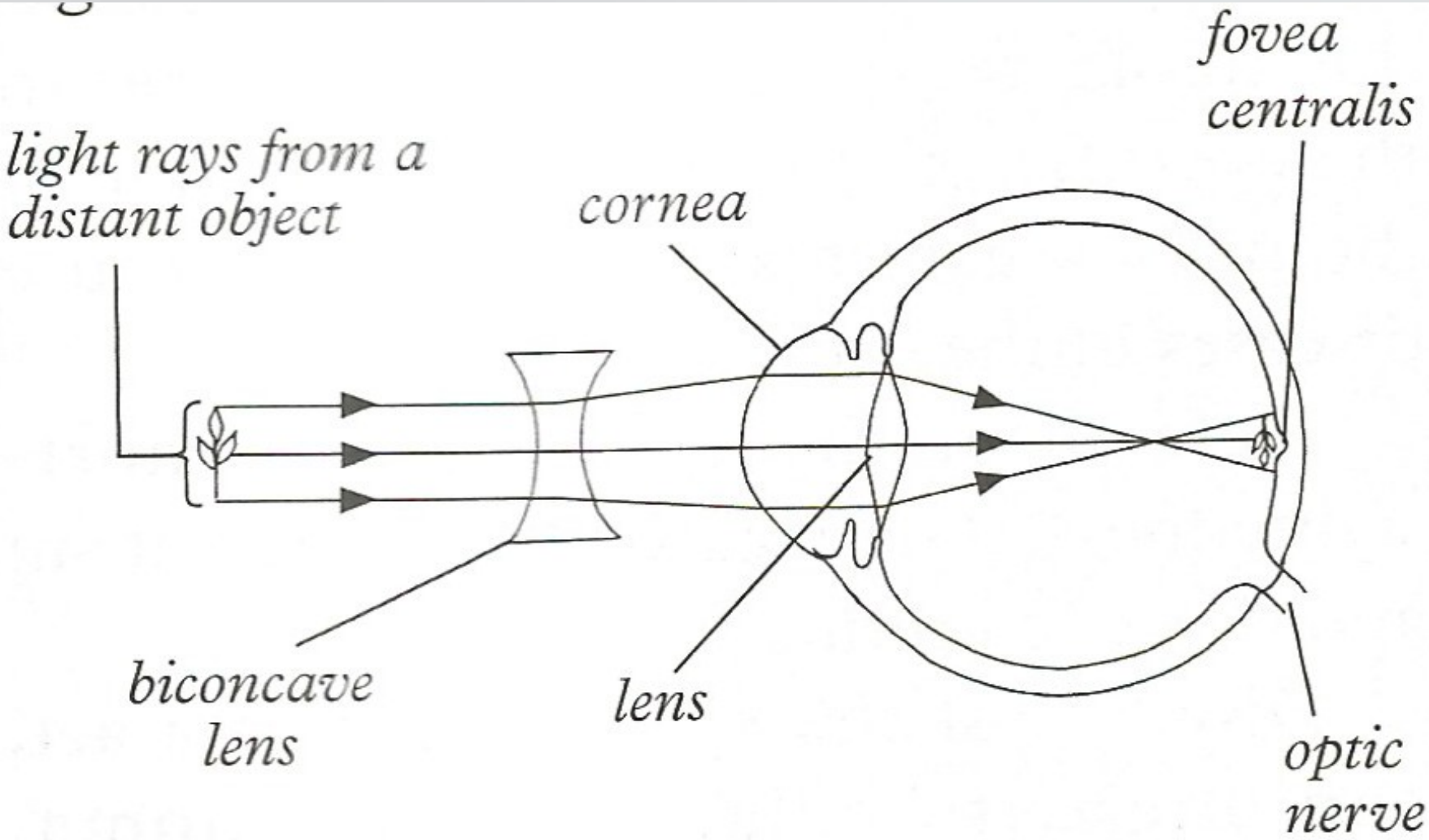


Fig. 3.27 Correction of short-sightedness

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Long Sightedness(hypermetropia)

- Caused by too short eyeball or weak lens system
- Here an individual focuses clearly on distant objects but images of nearby objects are formed beyond the retina.

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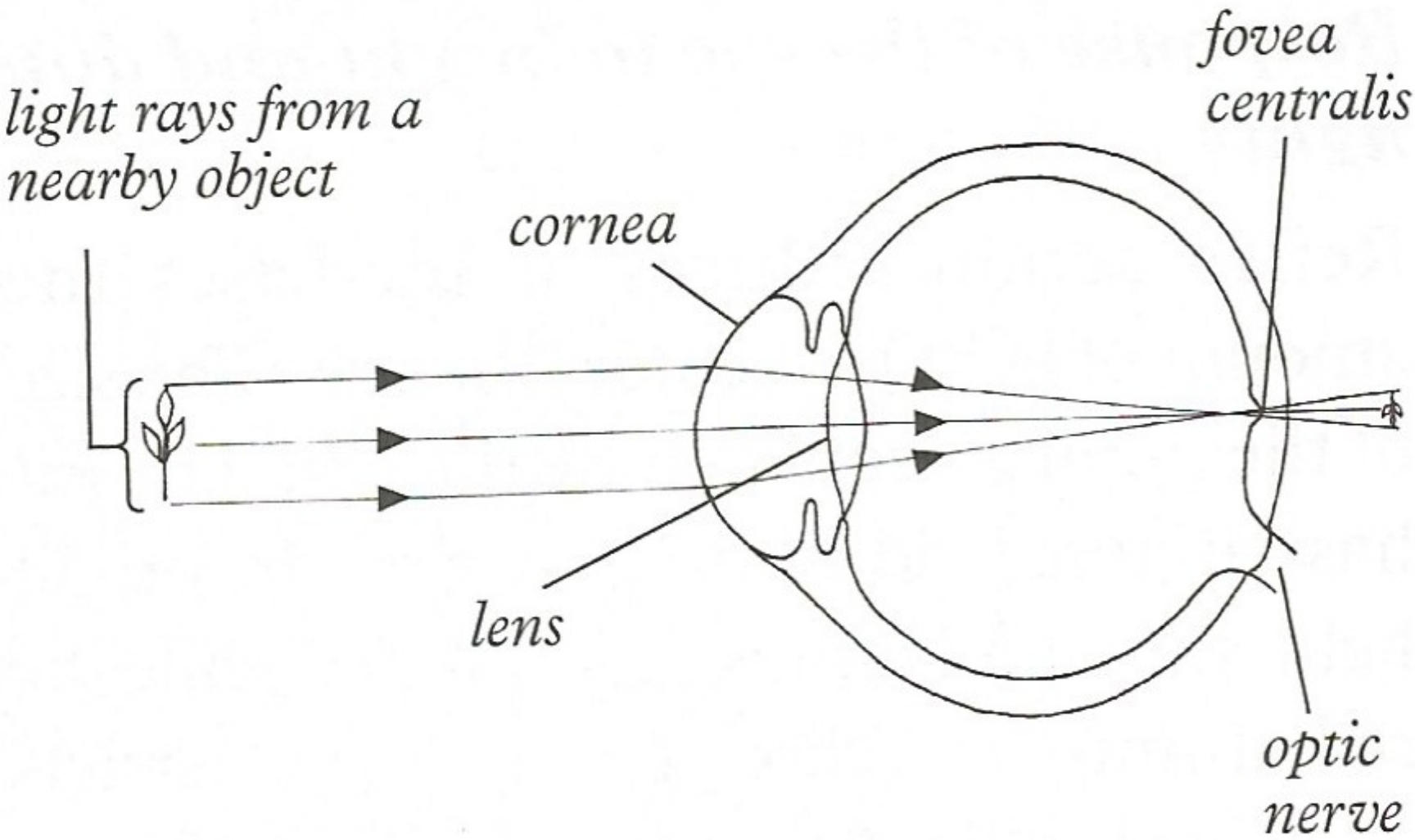


Fig. 3.28 Long-sightedness

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Correction

- Wear biconvex lens/converging lens that converge light rays from nearby objects onto the retina.

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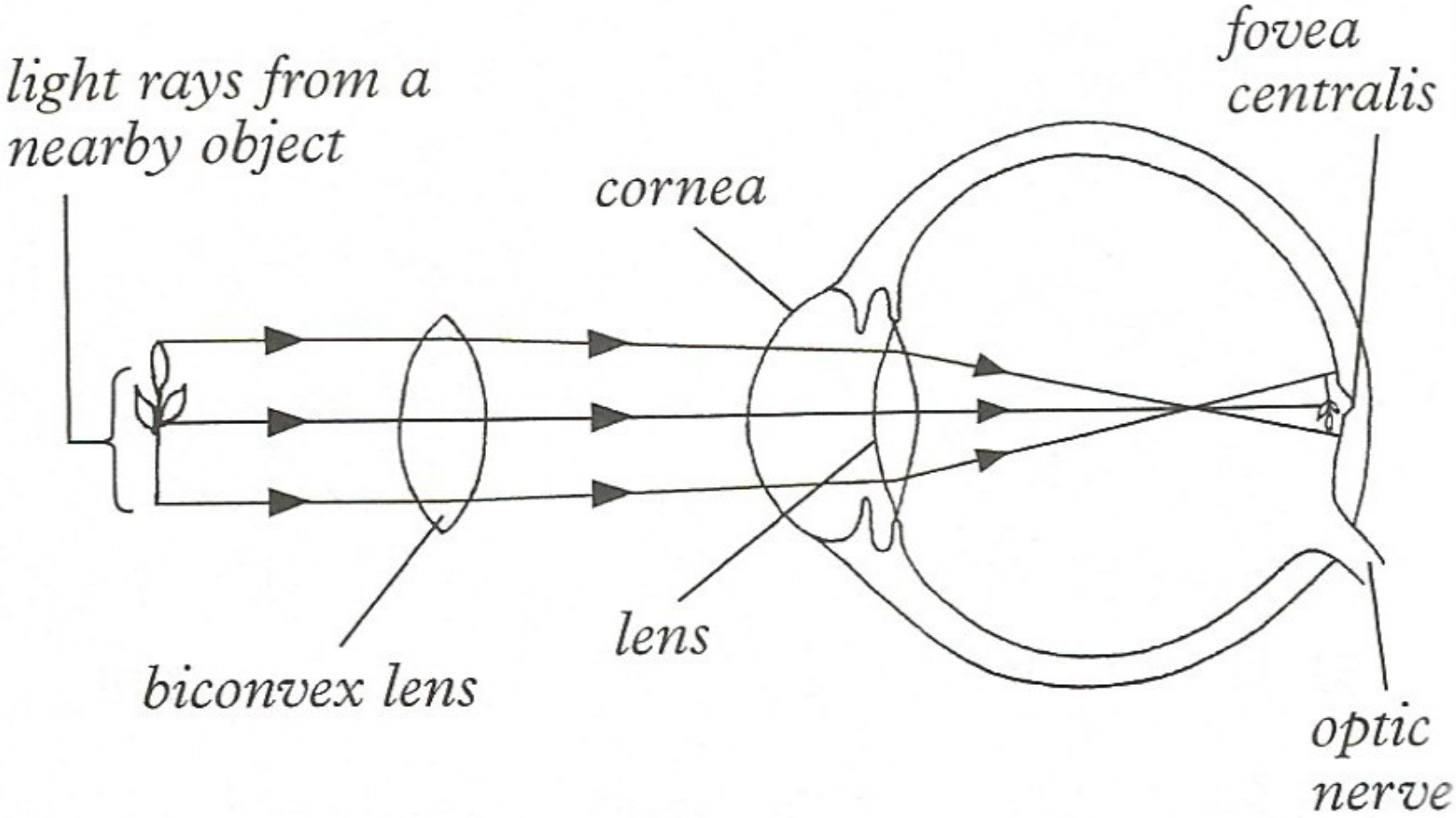


Fig. 3.29 Correction of long-sightedness

Astigmatism

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Astigmatism

- Caused by unequal curvature of the cornea or lens hence unequal refraction of light entering the eye.
- Light rays from an object are brought to focus in different planes.

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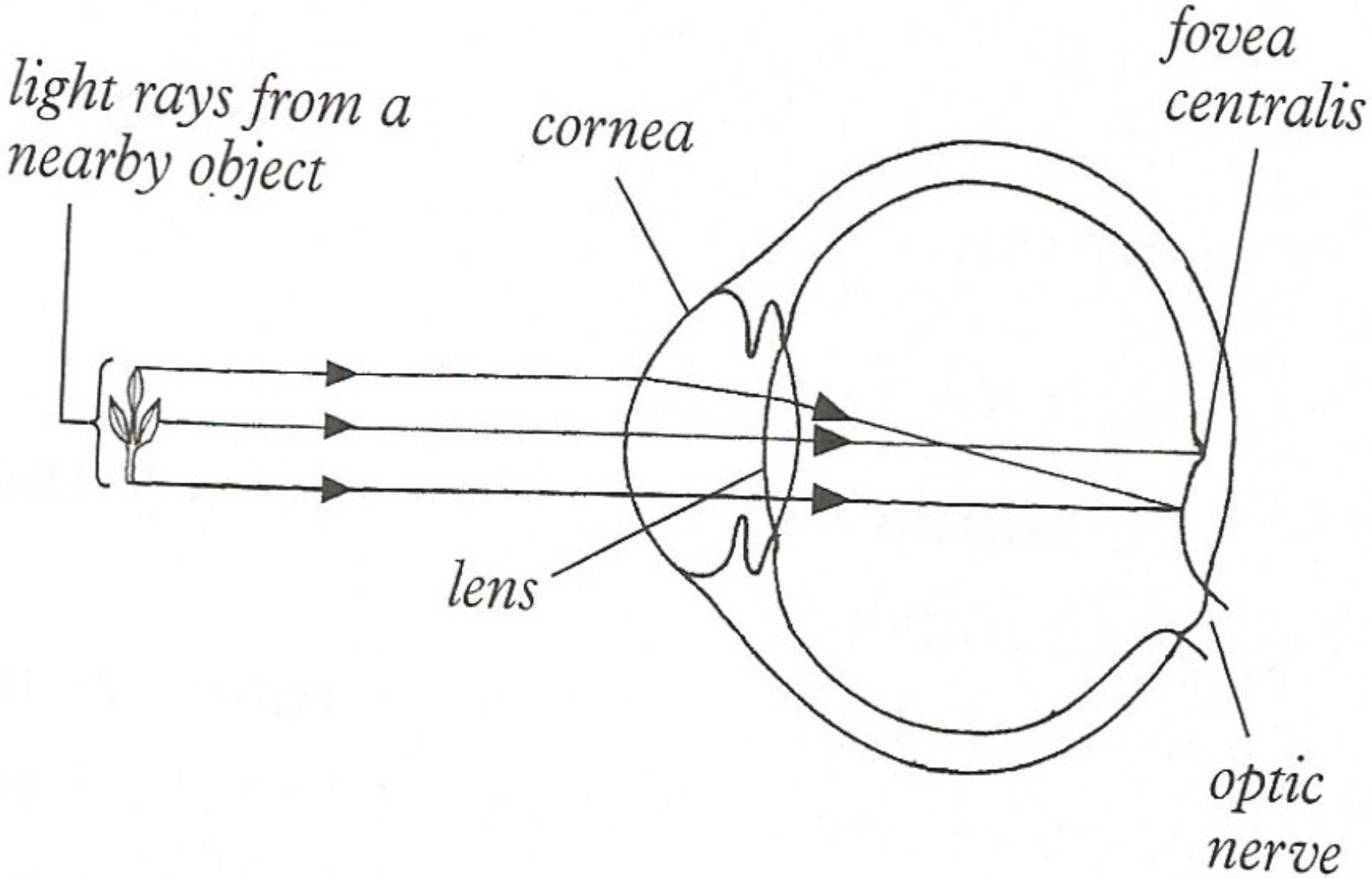


Fig. 3.30 Astigmatism

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Correction

- Wearing special cylindrical lens in front of the eye that corrects the focus in the defective planes.

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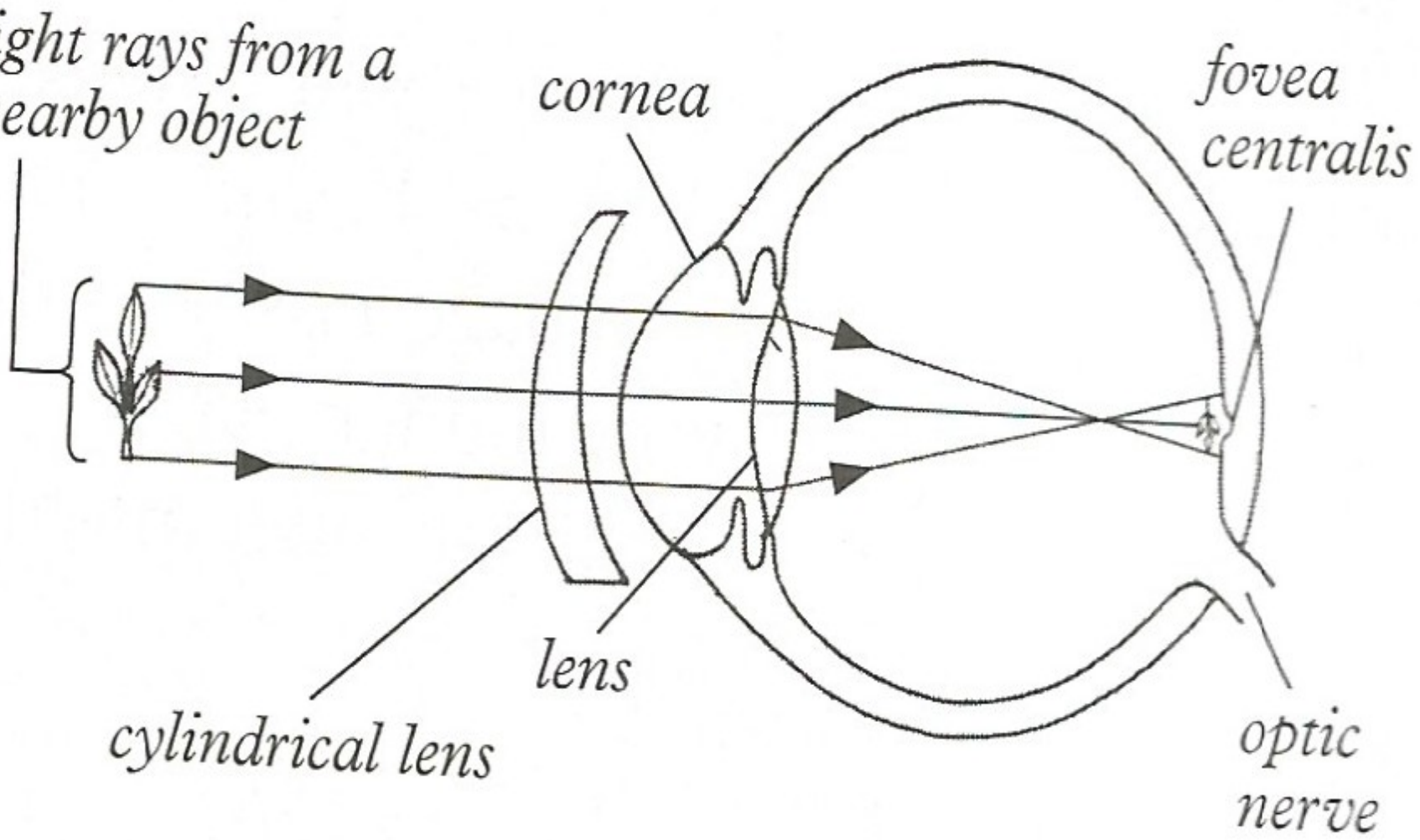


Fig. 3.31 Correction of astigmatism

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Squintedness

- In this condition the eyeball face different direction.

Focusing and accommodation are achieved with difficulty.

- The defect is difficult to

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Old Sight(Presbyopia)

- Caused by hardening(loss of elasticity) of lens and weak ciliary muscles due to old age.
- Light from a near object focus behind retina while distant object is sharply focused.
- Corrected by wearing convex/converging lens or bifocal lenses(pair of glasses with different lenses)

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Colour blindness.

- A genetical defect where an individual is unable to distinguish between red and green colours.
- The individual lacks cones with pigments that respond to green and red colours.
- Correction
- In future through genetic engineering.

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Cataracts

- Associated with old age.
- Caused by eye injury or complications of *diabetes mellitus*
- The lens become cloudy or opaque blocking transmission of light rays.
- Correction is by surgically replacing the defective lens with a good one from the donor or artificial lens.

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