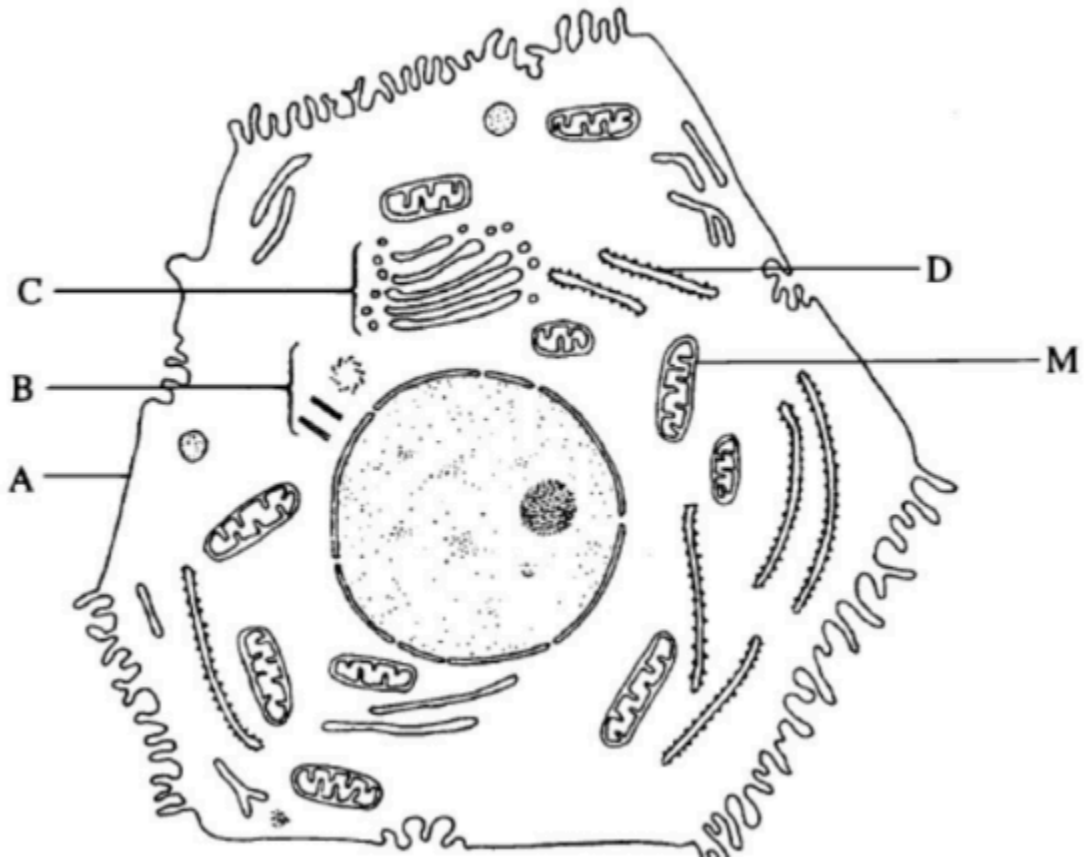
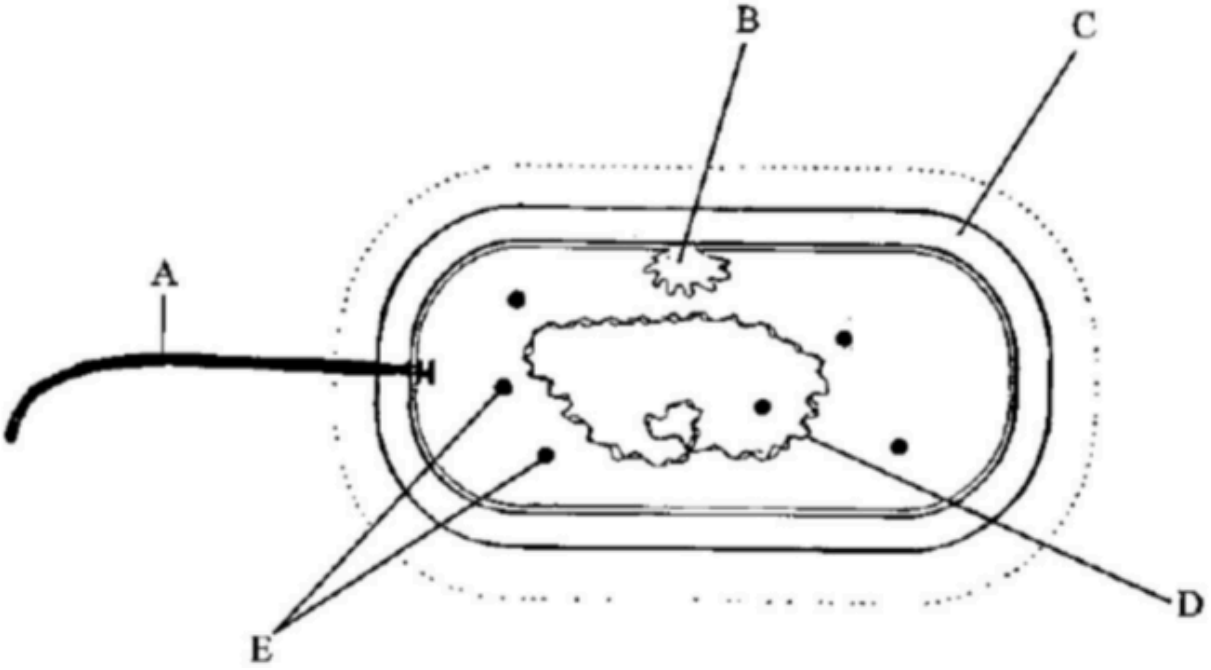
CELLS



A – cell plasma membrane
B – centrioles
C – golgi apparatus
D – rough endoplasmic reticulum



A – flagellum

C – peptidoglycan cell wall

D – chromosome

B – mesosome: location of enzymes associated with aerobic respiration

C – peptidoglycan cell wall: maintains shape/give structure/provide turgidity

E – starch granules: storage of carbohydrates

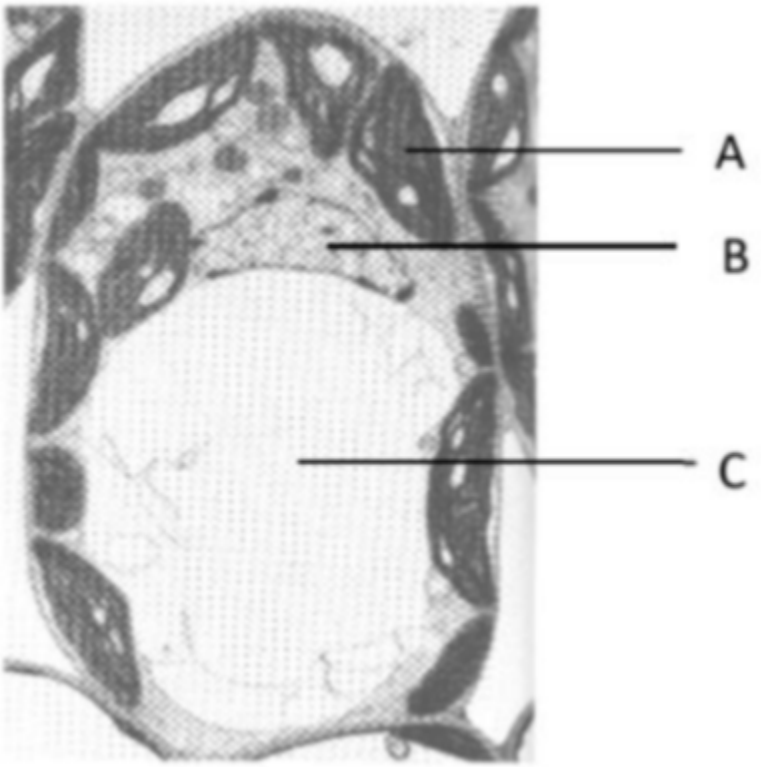
Feature	Cell			
	Red blood cell	Leaf cell	Bacterium	Epithelial cell from alveolus
Nucleus	X	✓	X	✓
Plasma membrane surrounding cell	✓	✓	✓	✓
Cell wall	X	✓	✓	X

Ribosomes: site of protein synthesis

Mitochondria: release energy as ATP

RBC: transport O_2 through body, biconcave disc shape increase SA : V for efficient diffusion of O_2 into and out of it

Root hair cell: long and narrow protrusion increases SA : V for efficient absorption of water and dissolved mineral salts

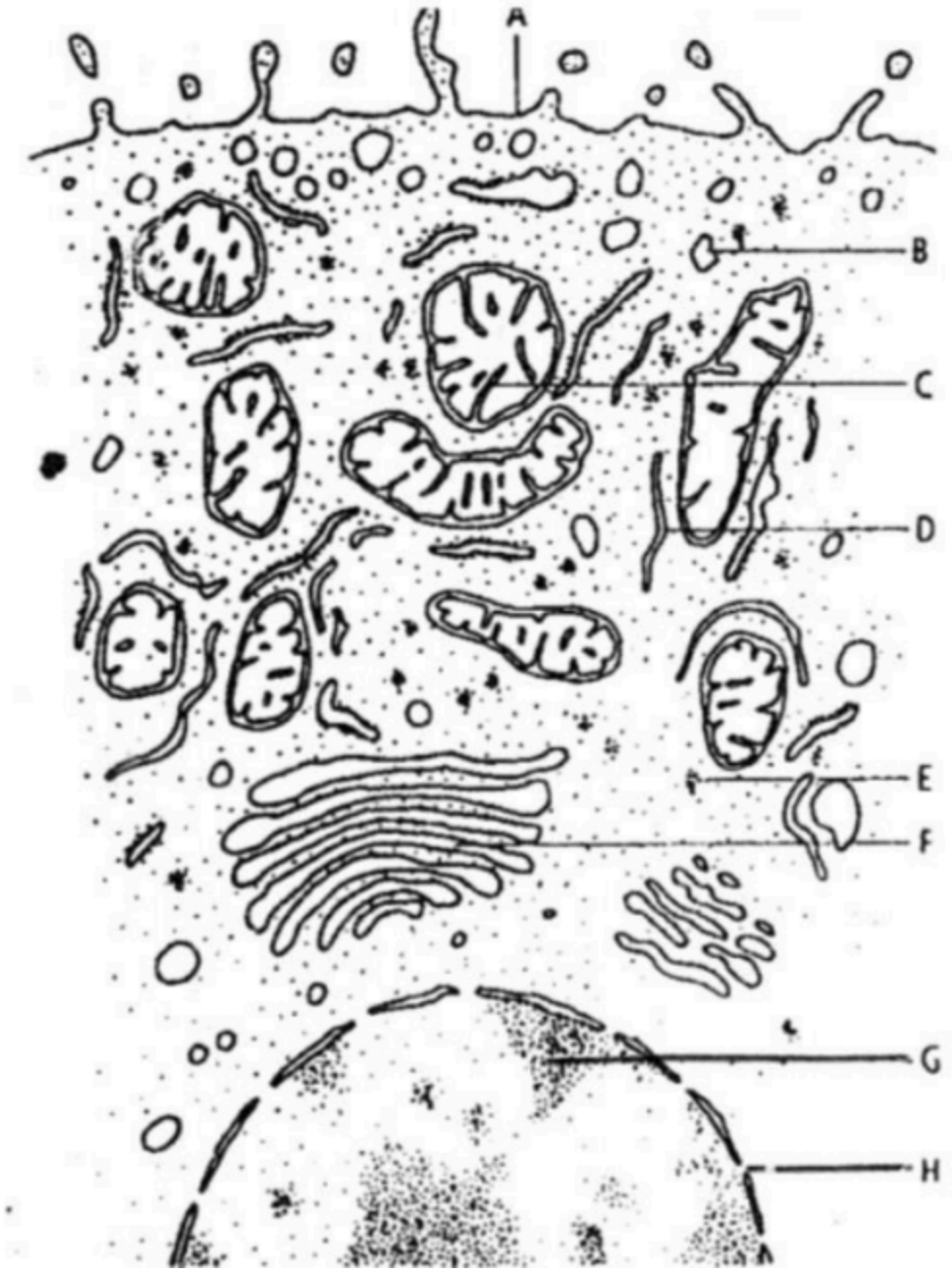


Plant cell: presence of chloroplast, large central vacuole, cellulose cell wall

A: Chloroplast

B: Nucleus

C: Vacuole



A: cell plasma membrane

C: mitochondrion

F: Golgi apparatus/smooth endoplasmic reticulum

H: nuclear pore

Phospholipid bilayer: each layer consisting of hydrophilic phosphate groups on the exterior and hydrophobic hydrocarbon chains of fatty acids in the interior

Membrane proteins (channel and carrier proteins) are found in the phospholipid bilayer

Fluid = phospholipid molecules move about in the plane of the membrane

Mosaic = membrane proteins are scattered randomly throughout the phospholipid bilayer

Secretory cell:

Presence of rough ER that produces polypeptides, Golgi apparatus chemically modifies and repackages proteins in secretory vesicles, and numerous mitochondria release energy in the form of ATP for exocytosis.

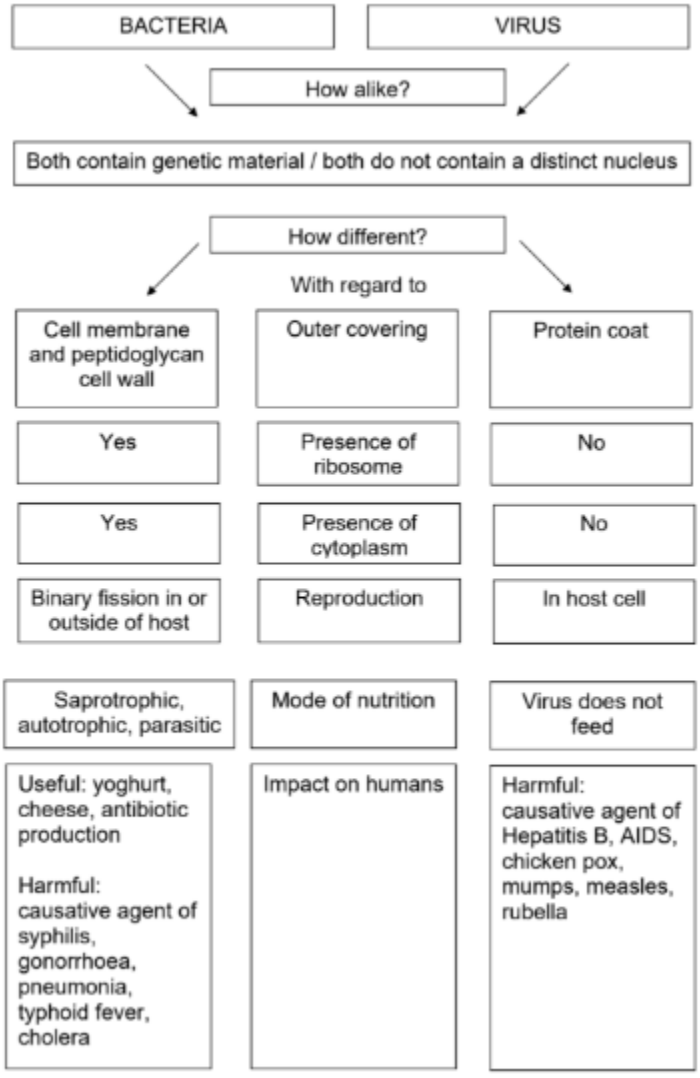
Bacteria obtain nutrients either as a parasite or as a saprotroph.

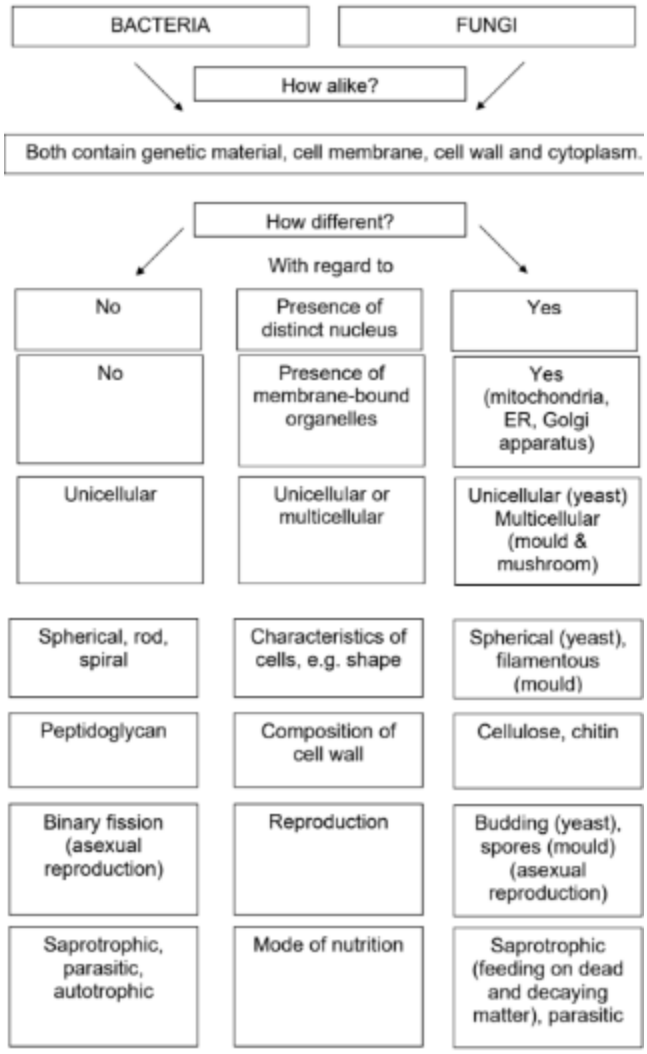
parasite – derives nutrients from cytoplasm of living cells

Saprophyte – derives nutrients from dead and decaying organic matter (decomposition)

Conditions provided to allow bacteria to reproduce rapidly:

suitable temperature, optimal pH, nutrients, moisture, availability of oxygen (for some bacteria)




BACTERIA
FUNGI
How alike?
Both contain genetic material, cell membrane, cell wall and cytoplasm.
How different?
With regard to
No
Presence of distinct nucleus
Yes
No
Presence of membrane-bound organelles
Yes (mitochondria, ER, Golgi apparatus)
Unicellular
Unicellular or multicellular
Unicellular (yeast) Multicellular (mould & mushroom)
Spherical, rod, spiral
Characteristics of cells, e.g. shape
Spherical (yeast), filamentous (mould)
Peptidoglycan
Composition of cell wall
Cellulose, chitin
Binary fission (asexual reproduction)
Reproduction
Budding (yeast), spores (mould) (asexual reproduction)
Saprotrophic, parasitic, autotrophic
Mode of nutrition
Saprotrophic (feeding on dead and decaying matter), parasitic

MOVEMENT OF SUBSTANCES

	Diffusion	Osmosis	Active Transport
A substance moves from a region of low concentration to a region of high concentration			√
Can happen in living cells	√	√	√
A substance moves and becomes more evenly spread out	√		
The movement does not require energy and is caused by the random movement of individual particles	√	√	
The movement requires energy from cellular respiration			√
Only water is involved in this type of movement		√	
Water molecules move from a less concentrated solution to a more concentrated solution*		√	
Membrane is required**		√	√

ENZYME

Enzymes catalyse reactions between reactants.
Temp increase to optimum→ kinetic energy of enzyme & and substrate increase → rate of effective collisions & enzyme-substrate complex formation increase
Temp increase over optimum→ thermal agitation breaks non-covalent bonds stabilising 3D conformation of active site→ distorted → not

complementary to substrate shape → denatured enzyme

Concentration of enzyme & substrat, pH, and temperature affects rate of rxn

Competitive inhibitors with structural resemblance to substrate fit into active sites of enzymes and block entrance of substrate. Its progressively displaced at active site by substrate.

PLANT NUTRITION

Sugar level:
daylight→rate of photosynthesis>respiration→sugar made in photosynthesis
Darkness→rate of photosynthesis<respiration rate→sugar used for respiration

Factors affecting photosynthesis:
Temperature, light, CO_2

Destarch leaf by leaving entire plant in darkness for 2-3 days so that storage starch is converted to sugars and used in respiration. Starch detected at

the end of the experiment is only from results of photosynthesis

Palisade mesophyll layer tightly packed at top of leaf→max absorption of light energy by chlorophyll→max photosynthesis rate

Spongy mesophyll many air spaces→facilitate diffusion of carbon dioxide into leaf cells for photosynthesis

Light intensity increase→higher rate of photolysis of water→higher rate of oxygen release→higher rate of production of ATP and NADPH→higher rate of reduction of carbon dioxide→higher rate of glucose production

PLANT TRANSPORT

Xylem vessel
No cytoplasm
Lignified walls: prevent collapse during transpiration pull
End walls broken down: continuous flow of water and dissolved mineral salts up plant

Phloem sieve tubes
Has cytoplasm
Perforated sieve plates: damaged sieve tubes can be sealed using P-proteins and callose→prevent loss of sap
Tensionless translocation occurs here

Thin film of water coating spongy mesophyll cell walls evaporates→Water vapor diffuses out leaves via stomata→Results tensions(transpiration pull) pulling water up xylem vessel→Results water uptake by shoot

Transpiration rate>water uptake→plant cells flaccid→wilting

High light intensity→stomata open wider→water vapor diffuse out faster→transpiration pull higher→water uptake faster
VICE VERSA

High temperature→thin film of water coating spongy mesophyll cell walls evaporate faster→water vapor

diffuse out faster→transpiration pull stronger→water uptake faster
VICE VERSA

Low humidity→steep vapor concentration gradient between intercellular air spaces and atmosphere→water vapor diffuse out faster→transpiration pull stronger→water uptake faster
VICE VERSA

Wind→blows away water vapour that has diffused out→steep vapor concentration gradient between intercellular air spaces and atmosphere→water vapor diffuse out faster→transpiration pull stronger→water uptake faster
VICE VERSA

High carbon dioxide→high reduction of carbon dioxide→high glucose production

NUTRIENTS
Amino acids: contain CHON elements
Protein:

made up of amino acids
17kj/g
Cell division, Repair, Anabolic rxns, Protoplasm buildup, Growth(CRAPG)
Function as enzymes, hormones, antibodies(EHA)

Fats:
Glycerol and fatty acids(contain CHO elements)
37kj/g
Store & source energy, insulation against heat loss,vitamin solvent, surround vital organs,sebum

Carbs provide energy in form of ATP from cellular respiration required for active transport, muscle contraction, anabolism, movement(AAMM)

Autotrophic: synthesize organic materials from inorganic materials using light energy
Heterotrophic: feed directly on organic materials

Monosaccharide(simple sugar): glucose fructose galactose (GGF)
Disaccharide(complex sugar): maltose lactose sucrose (MLS)

Starvation: lack nutrients→insufficient energy
Malnutrition: imbalance diet(deficient/excess intake of food components)

Balanced diet: right amount of carbs fats proteins(macros) minerals vitamins water roughage (MVWR) meeting daily requirements of body

Excess fat, salt, sugar intake→risk of coronary heart disease, hypertension, tooth decay

Special nutrient requirements:
Growing child:
Higher carbs→release energy in form of ATP during cellular respiration→muscle contraction, protoplasm buildup, cell division(MPC)
Higher protein→CRAPG
Calcium→growing bones

Pregnant:
Higher protein:CRAPG of foetus
Carbohydrate→higher energy demands of mother due to greater mass

Calcium→growing bones of the foetus
Iron→foetal haemoglobin in RBC

Labourer:
Carbohydrates→more energy in the form of ATP for muscular contraction via cellular respiration
Proteins→CRAPG

Constipation: insufficient roughage/fibre→less bulk added to stool & less water retained→less peristalsis→undigested food remains in L intestine longer→more water absorbed into bloodstream→stool becomes hard→difficult to defecate

Coronary heart disease: high intake of saturated fats→blood cholesterol raise→built up cholesterol deposited on lining of blood vessels→diameter of coronary artery
decrease→atherosclerosis→increase risk of blood platelets sticking to it→thrombus likely form→heart muscles receive insufficient oxygen and glucose to

respire for muscular contraction→myocardial infarction

Malnutrition diseases:
Lack deposition of calcium in bones and vitamin d for absorption of calcium from intestines→rickets
Vitamin C deficiency→scurvy
Low uptake of iron→low formation of haemoglobin in RBC→anaemia

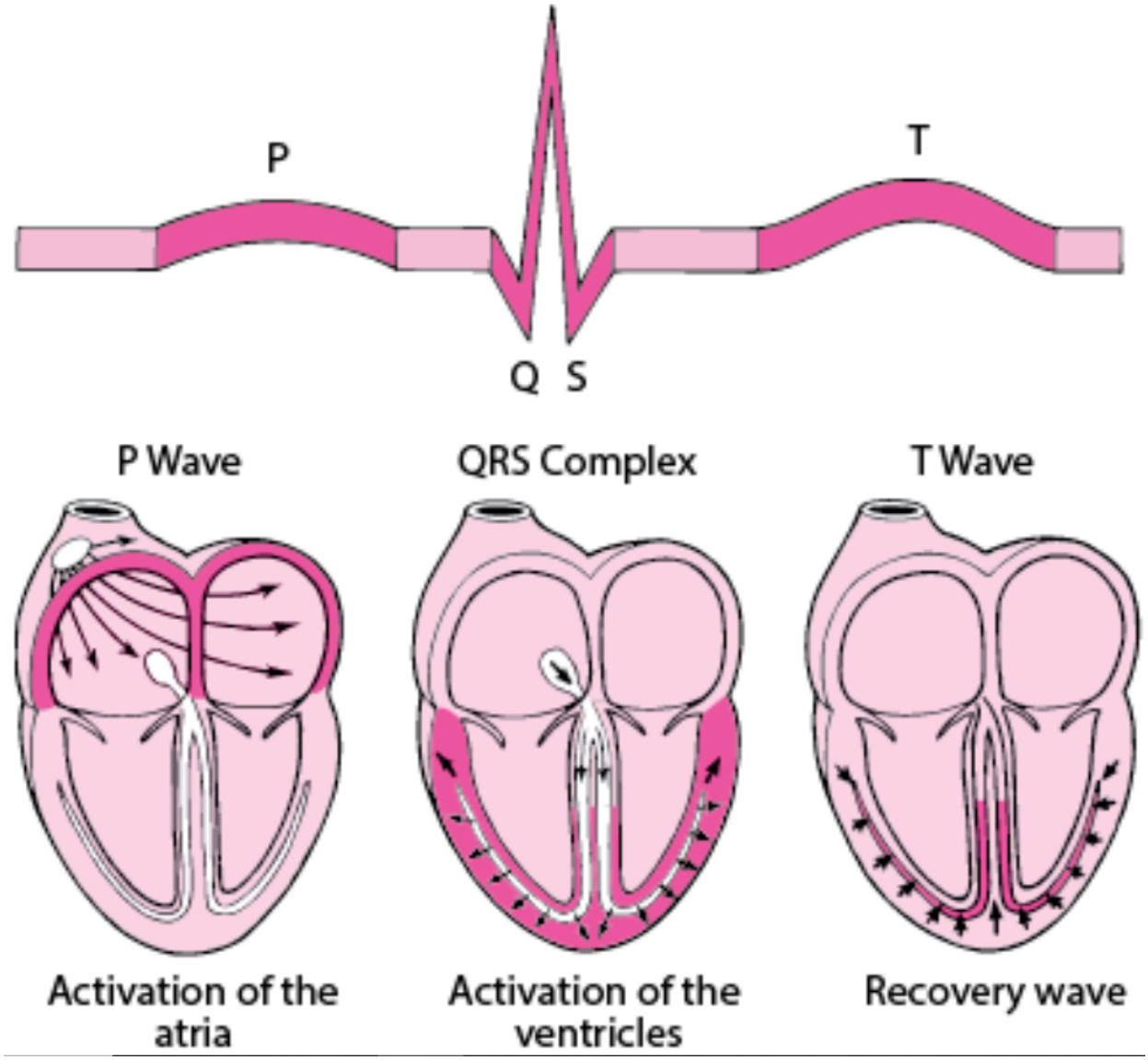
NUTRITION IN HUMANS
Pancreas produce pancreatic juice with pancreatic amylase, lipase, and trypsin which digest starch, fats, and polypeptides

Stomach:
HCl acid produced by gastric glands provides acidic medium(pH1-2) for pepsin and trypsin to activate & kill microorganism
Proteins digested by pepsin to shorter polypeptides
Renin converts caseinogen to casein(a protein)

Small intestine/Duodenum:

Sodium hydrogen carbonate produced by pancreas intestinal glands provides alkaline medium for pancreatic and intestinal(maltase, lactase, peptidase, sucrase(MLPS)) enzymes to activate

TRANSPORT IN MAN



Atrial systole→blood pressure in atria increase to more than ventricles'→blood flows into

ventricles→ventricular diastole→blood pressure in ventricles increase to more than atrias'→tricuspid and mitral valves shut to prevent backflow of blood from ventricles into atria→ventricular systole→blood pressure in ventricles increase to more than pulmonary artery's and aorta's→blood flows into pulmonary artery and aorta→blood pressure in pulmonary artery and aorta increase to more than ventricles'→pulmonary and aortic valve shut to prevent backflow of blood into ventricles' →blood pressure in vena cavas and pulmonary veins more than atrias'→blood flow into atria→atrial diastole

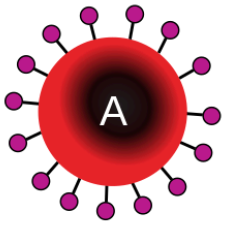
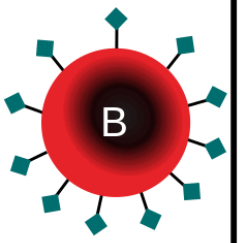
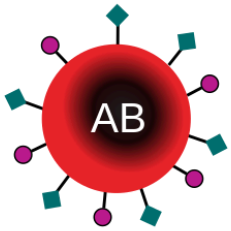
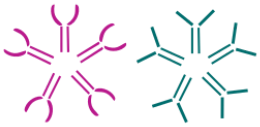
Ventricle muscles must contract at a larger force to pump blood throughout the entire body via the aorta and to the lungs via the pulmonary artery
Atrial muscles only needs to contract at a lower force to pump blood into the ventricles

Capillary:
One-cell thick wall increases the rate of diffusion of substances (oxygen, glucose and amino acids that are dissolved in the plasma) across it, shortens diffusion distance.

Allows phagocytes to pass through the spaces between the endothelial cells to engulf foreign particles (pathogens eg. Bacteria and viruses) in the tissues.

L vs R ventricles:
R ventricles force blood into the lung→short distance away→thinner R ventricular walls→force of contraction is weaker→pumps blood at a lower pressure →pressure in the pulmonary artery is generally lower than the aorta.
L ventricles force blood throughout body→longer distance away→thicker L ventricular walls→force of contraction stronger→pump blood at higher pressure→pressure in pulmonary artery comparatively higher

Agglutination: antigen of blood from recipient form complementary bind with antibodies of blood from donor in blood plasma→RBC clumping together

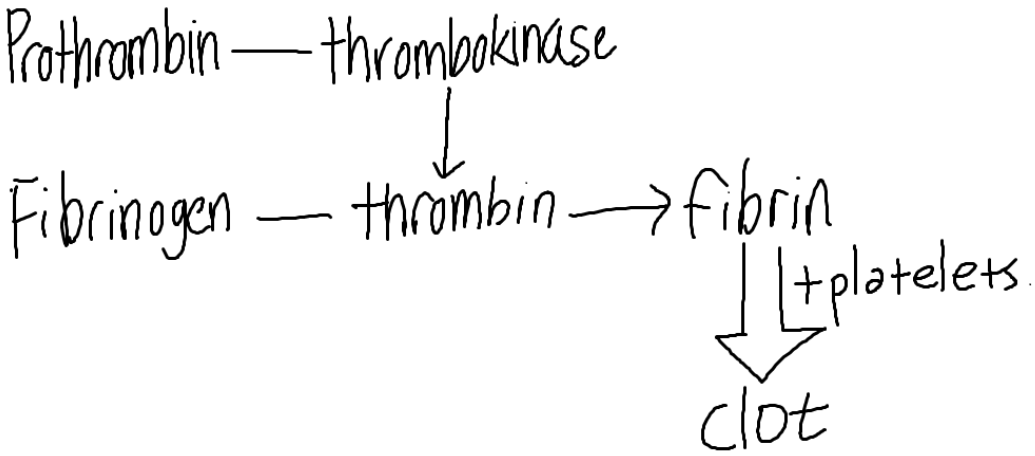
	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in red blood cell	 A antigen	 B antigen	 A and B antigens	None

	A	B	AB	O
Antibodies	B	A	-	A, B
Antigens	A	B	A, B	-
Donors	A, O	B, O	A, B, O	O

Thrombokinase converts prothrombin into thrombin.

Thrombin converts fibrinogen to fibrin.

Fibrin in combination with platelets forms a clot.



INFECTIOUS DISEASES

RESPIRATION

	Atmospheric air	Alveolar air
Carbon dioxide	0.03	4.0
oxygen	21	16.4
nitrogen	78	78
Water vapour	variable	variable
Dust particles	variable	Little to none
temperature	variable	Body temperature

Adaptations of alveolus for gaseous exchange

Rich, dense, extensive network of blood capillaries→blood flow→maintain steep concentration gradient of oxygen and carbon dioxide→carbon dioxide diffuse out and oxygen diffuse in faster
Alveolus have large surface area→diffusion of oxygen and carbon dioxide
Alveolus walls very thin→reduce diffusion distance of gases

aerobic	anaerobic
Glucose oxidised in presence of oxygen + water	Glucose broken down into lactic acid
38 ATP	2 ATP

Carbon monoxide binds strongly to haemoglobin, form carboxyhaemoglobin→reduce efficiency of red blood cells to transport oxygen
Carbon monoxide increase rate which fatty deposits buildup on endothelium of artery→increase risk of atherosclerosis

At high altitude, the atmospheric pressure decreases→corresponding partial pressure of oxygen decrease as well;
As the body acclimatize, the number of red blood cells in the body increases to cope with the lesser pressure of oxygen at high altitude
Initially the climbers will experience breathlessness as their heart beat faster to remove excess carbon dioxide that is produced via aerobic respiration;
The lower pressure of oxygen in the high altitude decreases the diffusion rate so the heart rate increases

The heart beats faster as the climbers moved towards the top;
This is due to the heart having to pump faster to transport carbon dioxide in the form of bicarbonate ions in blood to the lungs for removal;
The lower oxygen pressure would result in lower amounts of oxygen transported to the tissues with every heart beat;
To cope with the increasing demand for oxygen, heart rate increases so that more oxygen can be

delivered to the tissues for cellular respiration to release ATP

ECOLOGY

Pyramid of Energy

Base lvl consists of photosynthetic organisms.
It is always upright.
No. of organisms at higher trophic lvls is not always less than that at lower trophic lvls.

Upside down pyramid

Pyramid of numbers where parasites live in a tree.

Rivers with untreated sewage

High bacterial count, low oxygen lvl, few fish and plants

% of light energy converted into chemical energy in plants

Light energy not absorbed by chloroplasts, scattered/reflected by water surface, converted to heat energy, used to evaporate water.
Inappropriate wavelength: only blue & red wavelengths absorb best.

Light blocked.

Energy efficiency(consuming plants vs herbivores)

Energy flows via food chain→used, lost to environment as heat, thermal energy during respiration losses, excretion, egestion.

Only 10% energy is passed on to next organism at each trophic lvl.

Energy passed via more trophic levels when herbivore is consumed.

Insecticide cause decline in no. of secondary consumers

Bioaccumulation, biomagnification occurred, accumulate to toxic levels in secondary consumers.

Insecticide not biodegradable, more soluble in fats than in water, retained in producers, not broken down and excreted

Primary consumers ate producers and insecticide further accumulated in their bodies

secondary consumers ate primary consumers, more accumulated

Higher trophic levels consume more of lower ones, accumulate

Graph of predator population lags behind that of prey

When predator population increase, that of prey decrease

Prey outnumber predators

Prey-predator population oscillations, similar shapes

Predator increase, prey decrease→higher competition for food→decrease

Higher efficiency in meeting human energy requirements

A lot of energy lost as food transfers from one trophic level to next

Energy lost by processes as thermal energy during respiration, excretion, egestion.

Eating veg > eating animal

Decomposer

Break down organic remains of dead plants & animals into CO_2 when they respire, and other inorganic materials like phosphorus, nitrogen

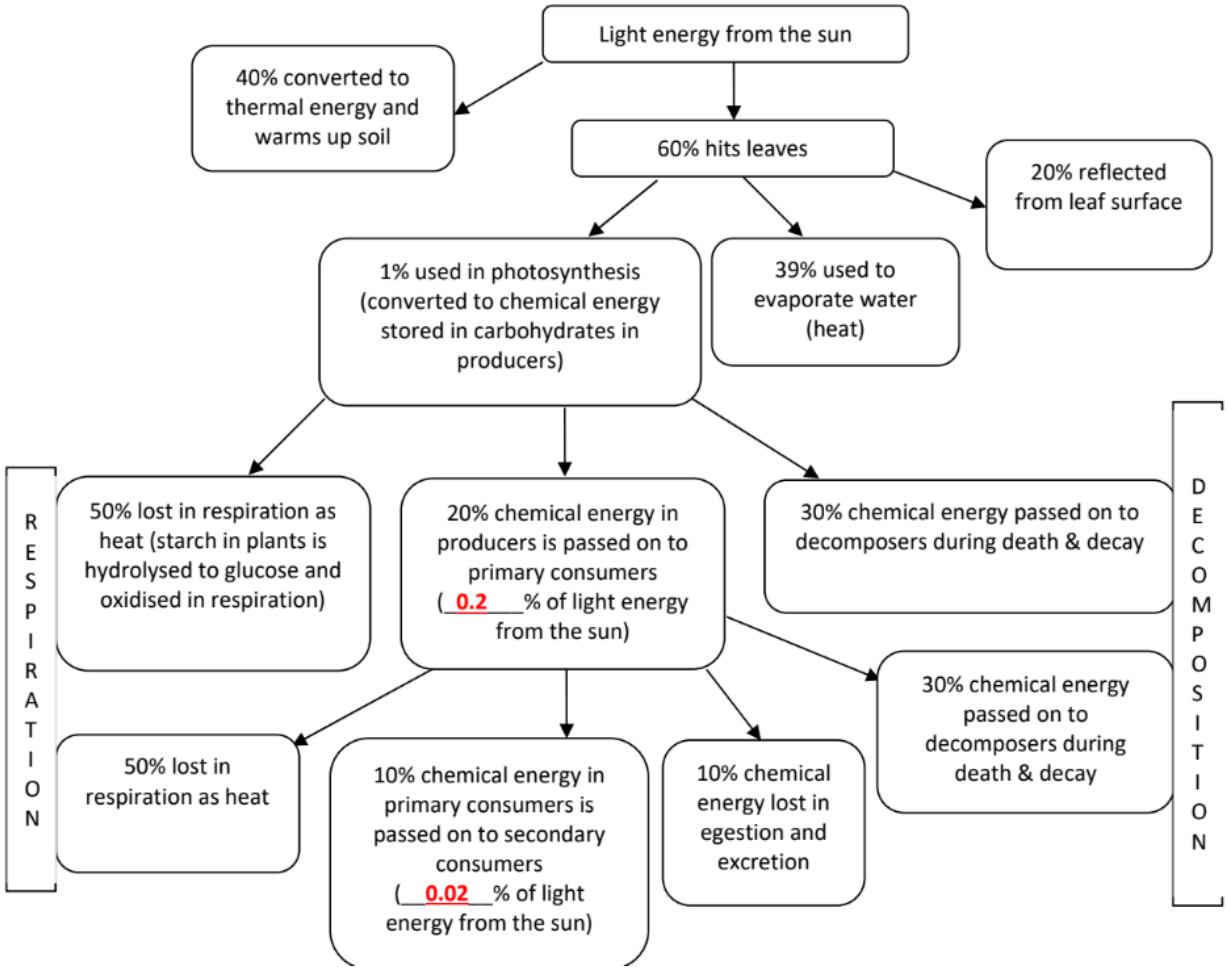
Can be incorporated into food web by plants

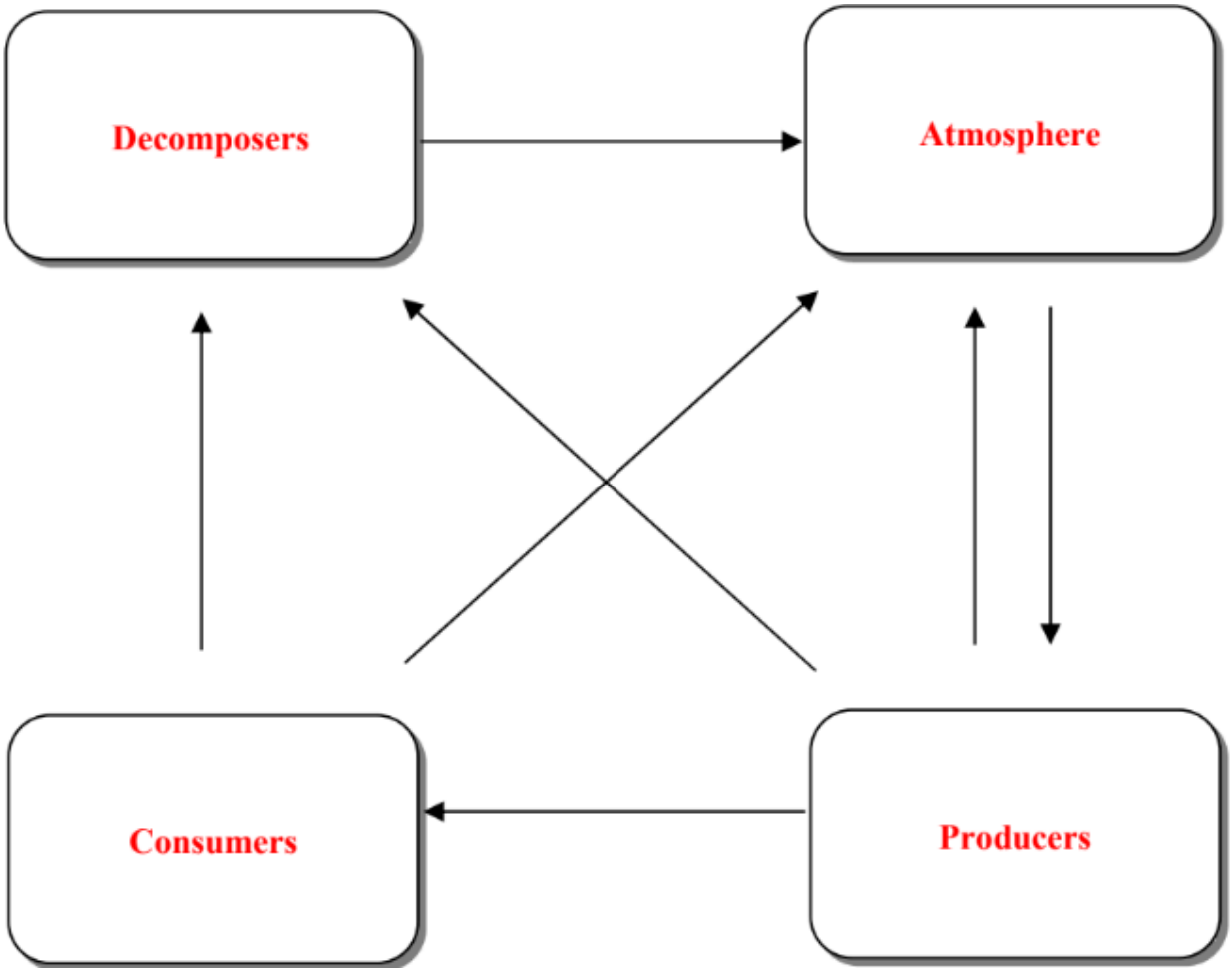
Pyramid of energy > pyramid of biomass
Accuracy: diff tissues have diff energy content
Biomass pyramid is snapshot at any one time and can change according to seasons
Energy pyramid takes into consideration duration over one year

Magnesium deficiency→reduced chlorophyll production→stunted growth

Aerobic bacteria and protozoa thrive with good supply of air, produce extracellular enzymes to digest organic particles
Products of digestion absorbed by bacteria and used for metabolic processes like respiration and growth.
Others convert urea into ammonia then into nitrates and nitrogen gas.
Bacteria get energy from reactions and absorb phosphate to form ATP for energy.

Energy flow through an ecosystem





HOMEOSTASIS

Negative feedback

Homeostatic control mechanism correcting deviations back to setpoint & reduced corrective action upon setpoint reach

High body temp

Skin thermoreceptors detect and send nerve impulses to heat loss centre of hypothalamus

→ hypothalamus send nerve impulses to parts of the skin for corrective action

Arterioles supplying skin capillaries dilate→greater blood flow via skin capillaries instead of constricted shunt vessels→increase heat loss by radiation

Sweat gland activity increase, take up more water from skin capillaries

→ Water travels up sweat duct to sweat pore

→ More sweat production

→ Latent heat of vaporisation removed

Metabolic rates decrease

→reduce release of thermal energy

Separate mechanisms for high & low body temp

Higher efficiency of temperature control

Temperature regulation can take place if one mechanism fails to function

Blood glucose conc. rises as its absorbed into blood from small intestine after digestion

→ High blood glucose conc. detected by β cells of islets of Langerhans in pancreas
→ Secrete insulin
→ Stimulate condensation of glucose into glycogen stored in liver
→ Lower to setpoint
→ Further insulin secretion suppressed via -ve feedback

Blood glucose conc. decreases as it is oxidised during cellular respiration to release energy as ATP for muscle contraction
→ Low blood glucose conc. detected by α cells of islets of Langerhans in pancreas
→ Secrete glucagon
→ Stimualate breakdown of stored glycogen into glucose
→ Rise to setpoint

Hypoglycaemia
Increased uptake of glucose into cell
→ Excessive condensation of glucose to glycogen, oxidation to release energy as ATP
→ Low blood glucose

→ Brain cells receive insufficient glucose
→ Lack respiration and ATP
→ Nerve cells don't function
→ coma

<u>Insulin resistance</u>
Lack of physical activity, obesity, high sat. fat diet
→ Free fatty acids supply to peripheral tissues
→ Impair glucose uptake into muscle cells
Decreased ability of target cells to respond to insulin

Symptoms: high blood glucose conc
Glycosuria
→ glucose in urine exert osmotic effect
→ draw water in
→ polyuria
→ excess fluid loss
→ dehydration
→ polydipsia
Intracellular glucose deficiency stimulates appetite
→polyphagia
Lipolysis & protein catabolism increase
→ Progressive weight loss
Slow wound healing and high bacterial infection risk

Long-range complications
Endothelial dysfunction
Atherosclerotic lesions of coronary vessels →heart attacks & high blood pressure
Lesions of blood vessels of retina and kidney→ diabetic retinopathy & nephropathy
Lesions in capillaries that nourish neurons→ neuropathy: numbness & tingling in extremities
Impaired delivery of blood in extremities →tissues to become gangrenous(death/necrosis of tissues)

<u>Hypothalamus</u>
Temp. reg. system pass info to effectors in body temp. reg. via nervous system as nerve/electrical impulses

<u>Low body temp</u>
Vasoconstriction of arterioles supplying capillaries in skin
→ Less blood flow to skin
→ More blood flow via dilated shunt vessels
→ Less heat loss by radiation
Shiver:involuntary muscle contraction emit heat

Sweat gland activity decrease
Metabolic rate increase → release heat
Hair erector muscles contract → hair stands upright → trap insulating air layer

Below 34°C
Inactive enzymes
→ Kinetic energy of substrate and enzyme molecules low
→ Low freq. of effective collision between enzyme active site and substrate
→ low rate enzyme substrate-complex formation
→ Metabolic rate low
→ Less heat released
→ Body temp drop further
→ Enzyme more inactive
→ +ve feedback
→ Hypothermia
→ Intense shivering
→ Muscle stiffening
→ Mental confusion
→ Gradual loss of consciousness

<u>Losing water</u>

Sweating, urination, defecation, exhalation

Dehydration treatment

Sodium chloride solution isotonic to blood plasma → restore water potential/ osmotic pressure of blood

Remove clothing → remove layer of insulation → heat loss by radiation

Soak in water → conduct heat away → remove latent heat of vaporisation from skin

Ice pack on head, neck, groin: thin epidermis, blood capillaries nearer to skin

Thermoreceptors

adapt/ reduce in sensitivity in presence of constant stimulus

detect stimulus quickly when temperature changes

Positive feedback

Response reinforcing change/ deviation

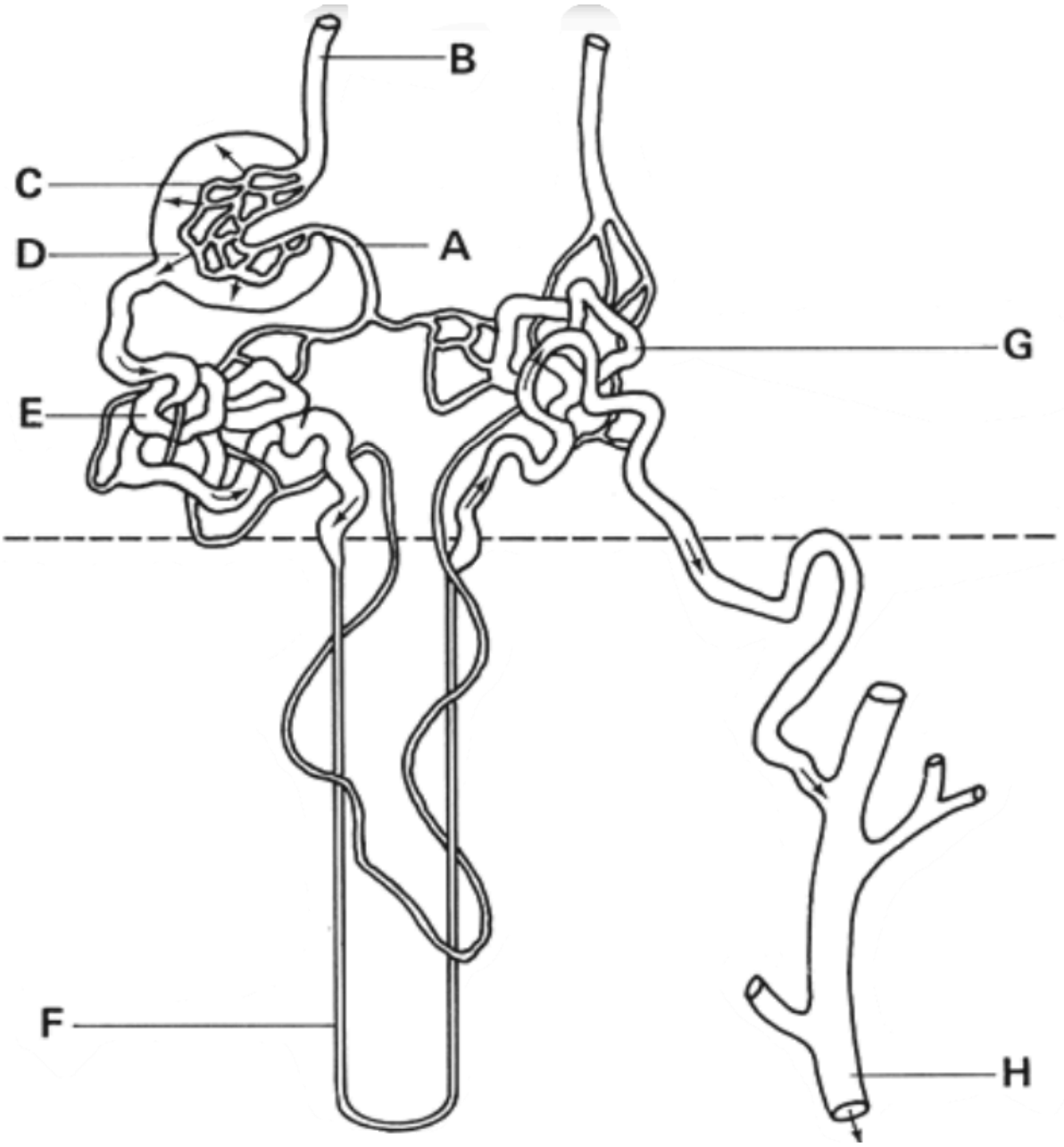
Childbirth

posterior pituitary gland releases oxytocin

→ Stimulates contraction of smooth muscles of uterus

→ Pushing the foetus against cervix
→ Stretching of cervix
→ Nerve impulses transmitted to brain
→ More oxytocin released
→ Stronger muscular contractions occur
→ Cervix stretched further
→ send nerve impulses at higher frequency to the brain

EXCRETION



A: efferent arteriole
B: afferent arteriole
C: glomerulus / glomerular capillaries
D: Bowman's capsule / renal capsule
E: proximal convoluted tubule

F: loop of Henle
G: distal convoluted tubule
H: collecting duct

	B afferent arteriole	D Bowman's capsule
Glucose	✔	✔
Blood cells	✔	✘
Water	✔	✔
Large plasma proteins	✔	✘

Proteins present in glomerulus, absent in Bowman's capsule onwards
Large plasma proteins too large to be filtered out of blood in ultrafiltration

Glucose present in bowman's capsule and glomerulus, absent in coiled tubule
Filtered out of blood in glomerulus by hydrostatic pressure to bowman's capsule in ultrafiltration.
Completely reabsorbed into bloodstream at proximal convoluted tubule by sodium-linked secondary active transport and facilitated diffusion.

Urea present in glomerulus and bowman's capsule and its concentration increases from coiled tubule to collecting duct
Filtered out at glomerulus, only 50% is reabsorbed into blood by simple diffusion
Most water reabsorbed into blood
→ Concentration of urea increase in collecting duct

Urea conc. lower in Bowman's capsule than in collecting duct
Only 50% of urea that is filtered out is reabsorbed into blood but most water is reabsorbed into blood along tubules by osmosis

Injury in bowman's capsule and glomerulus → proteins enter them → too large to be reabsorbed into blood

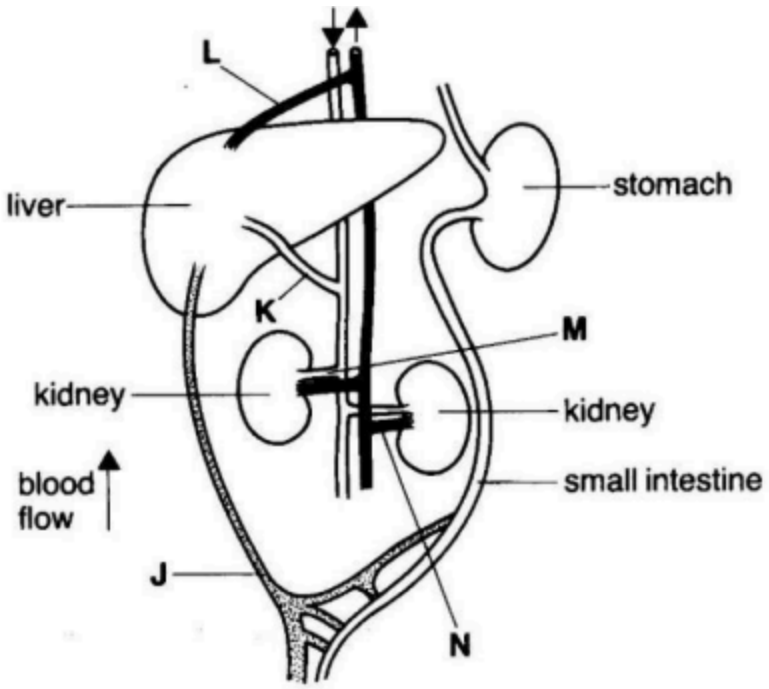


Fig. 2.1

Label J to N.

J **hepatic portal vein**

K **hepatic artery**

L **hepatic vein**

M **renal artery**

N **renal vein**

Hepatic portal vein

Highest amino acids conc. after meal.

Hepatic vein

Urea form in liver via deamination of excess amino acids → exit liver via hepatic vein.

Renal vein

Ultrafiltration → 50% not reabsorbed into blood but excreted in urine → renal vein brings blood out of kidney

<u>Ureter</u>

Glucose & amino acids filtered out of blood

→ Completely reabsorbed into blood at proximal convoluted tubule by secondary active transport & facilitated diffusion

<u>Artificial kidney machine</u>

Dialysing membrane substitutes slit diaphragms between nephrin molecules

Bath fluid contains dissolved salts isotonic to plasma in healthy person → prevent net diffusion of salts in/ out of plasma by diffusion

Pass bath fluid in opposite direction of blood flow → maintains steep conc. gradient of urea between blood and bath fluid

→ increase rate of diffusion

Ultrafiltration

Useful substances (glucose, amino acids, salts) filtered out of blood, later reabsorbed into blood.
Urea removed from blood through hydrostatic pressure.
Occurs at renal corpuscle
Substances filtered out of blood into tubule

Dialysis

Useful substances remain in blood
Urea removed from blood via diffusion into dialysis fluid

Selective reabsorption

occurs at tubules, DCT, PCT, loop of Henle, collecting duct
Useful substances reabsorbed from tubule back into blood
Occurs by facilitated diffusion, active transport, osmosis

	Haemodialysis	Peritoneal dialysis
Selectively permeable membrane	Artificial dialysis tubing	peritoneum, a natural membrane
Countercurrent flow	blood and dialysis fluid	no
Surface area of diffusion	High: urea diffuse out of blood	Low: urea diffuse out of tissue fluid
Movement of urea	Blood → dialysis fluid	Tissue fluid → dialysis fluid
Frequency of session	3x a week, 3-5h/session	3-5/day, 30-40min/session
Mobility of patient	immobile	mobile

<u>Water absorb into blood at small & large intestines after 20 min</u>

→ Osmoreceptors in hypothalamus detect decreased osmotic pressure of blood

→ Suppression of ADH secretion from posterior pituitary gland.

→ Permeability of cell membrane of epithelial cell of DCT & collecting duct to water remains low.

→ Less water reabsorbed into blood.

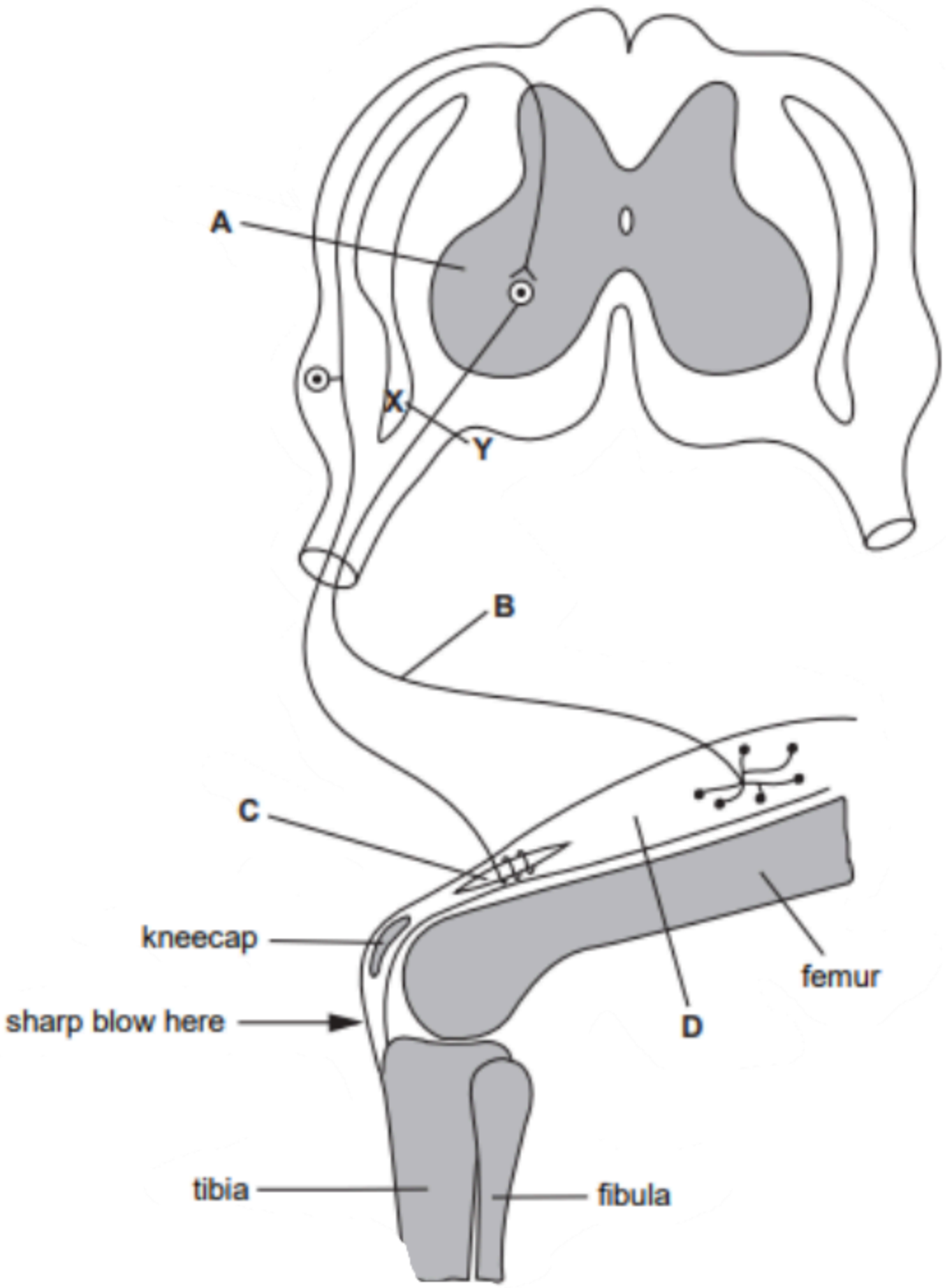
→ Volume of urine increases.
→ Osmoreceptors detect blood osmotic pressure increased to norm
→ Suppression of ADH secretion stops by negative feedback.
→ Permeability of cell membrane of epithelial cell of collecting duct to water increases
→ More aquaporin pores inserted into cell membrane.
→ More water reabsorbed into blood.
→ Volume of urine decrease to normal.

<u>Extremely conc. urine: mammals in deserts</u>
Juxtamedullary nephrons with long loops of Henle that extend into medulla.
High conc. of salt generated in interstitial fluid surrounding tubules by countercurrent multiplication
→ Reabsorption of more water into blood from collecting duct by osmosis

COORDINATION AND MOVEMENT
Heroin binds to same receptors as endorphins

Arrival of the nerve impulse at the axon terminal branch triggers the release of acetylcholine neurotransmitter from the synaptic knob
Acetylcholine binds to receptors on the muscle fibre, causing an action potential to be generated in the muscle fibre, leading to muscle contraction

Knee jerk reflex



A: grey matter

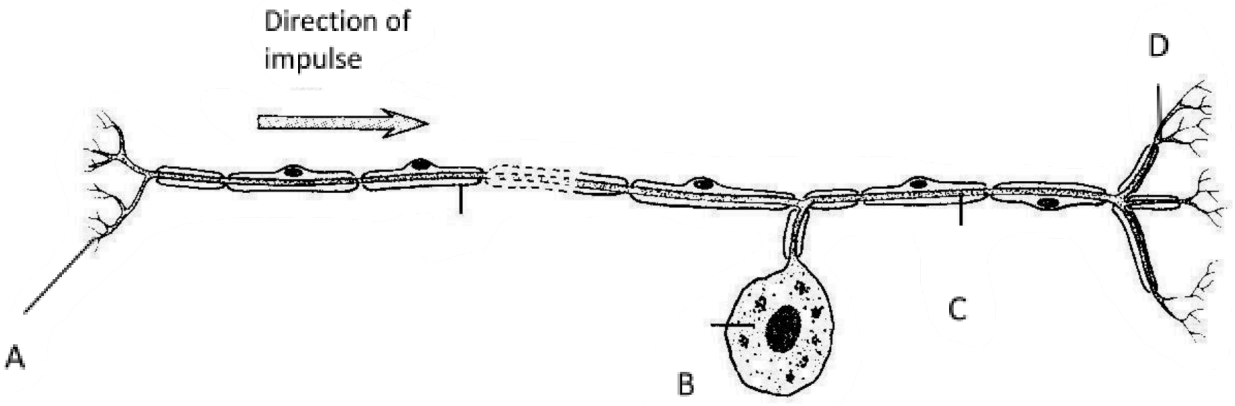
B: motor neurone

C: stretch receptor
D: muscle
Stretch receptors in skin detect and receive stimulus
→ Nerve impulses generated, travel along sensory neurone to spinal cord
→ Impulses travel across synapse to a motor neurone
→ leave spinal cord along motor neurone to effector(muscle)
→ thigh muscle contracts to extend leg

<u>Specialised neurones transmit messages quickly</u>
Each neurone has long cytoplasmic processes
→ transmit electrical impulses rapidly
Nerve fibre is myelinated except at nodes of ranvier
→ electrical impulses jump from node to node
→ speed up conduction via saltatory conduction
Voltage gated sodium ion channels are concentrated at nodes of ranvier → sodium ions diffuse in
→ depolarisation
Local current flow along myelinated region cause sodium ion channels to open at next node of ranvier
Many branching dendrites

→ more surface area to receive impulses from receptors/ previous neurones

Sensory neurone
Axon shorter than dendron
Conduct impulses from receptor to central nervous system
Action potential transmitted to brain via relay neurone



A: dendrite

B: cell body

C: axon

D: axon terminal branch

B in dorsal root ganglion

D in grey matter

Motor neurone

Axon longer than dendron

Conducts impulses away from central nervous system to effector

Bulbous endings of axon synapse tha synapse with muscle fibers

Where branch of axon contacts a muscle fiber, motor plate forms

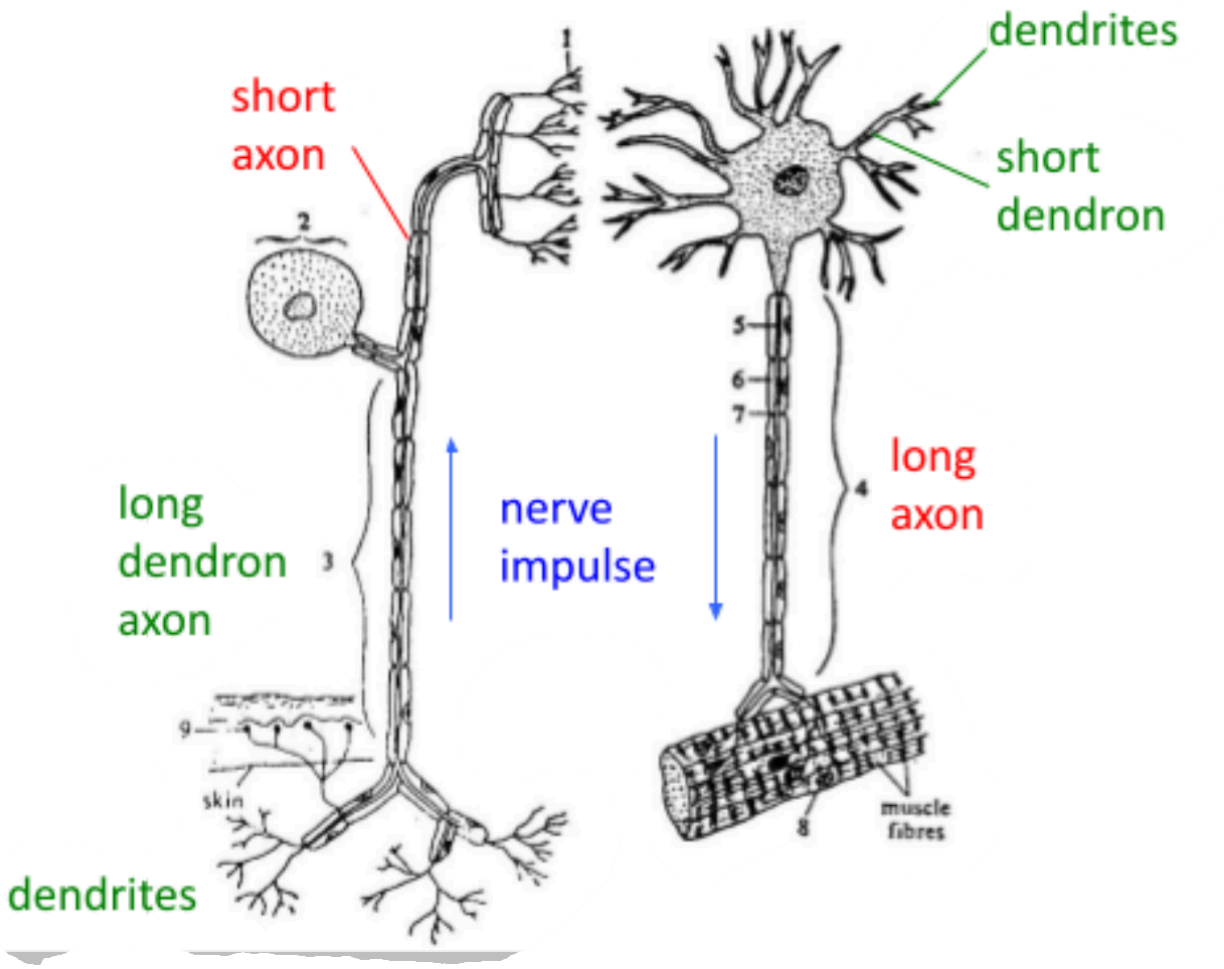
Allows for synaptic transmission to effector by releasing neurotransmitters that set off an impulse to next neuron

Release neurotransmitters when nervous impulse triggers the opening of voltage gated calcium ion channels

→ Exocytosis of vesicles containing neurotransmitters

Action potential generated in muscles after crossing synapse

SN and MN



1: axon terminal branch

2: cell body

3: dendron

4: axon

5: axolemma (axon cell membrane)

6

6: myelin sheath

7: node of Ranvier

8: motor end plate

9: sensory receptor

Brain

Label the following parts.

A: medulla oblongata	…….
B: pituitary gland	…….
C: hypothalamus	…….
D: cerebrum/ cerebral hemisphere	…..
E: cerebellum	…….
F: spinal cord	…….

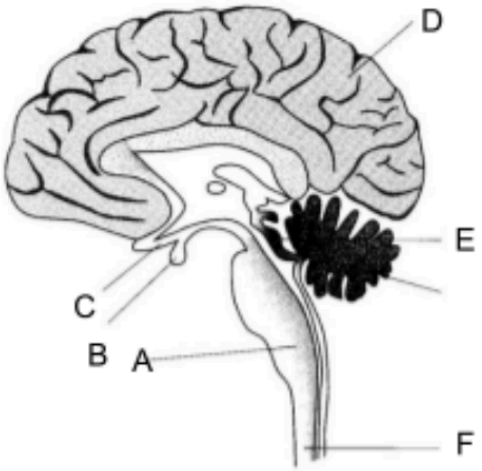


Fig.

Spinal cord

Grey matter contains cell bodies in central region surrounded by white matter

Controls reflex: immediate response to protect from danger

Cerebrum

Grey matter is at cortex

Controls voluntary actions

Higher mental activities (speech, IQ, memory)

Cerebellum

Muscle & eye muscle send nerve impulses to it

<u>Capillaries at brain ruptured</u>

Form blood clot → oxygen and glucose not delivered to nerve cells → respiration cannot occur → atp not produce

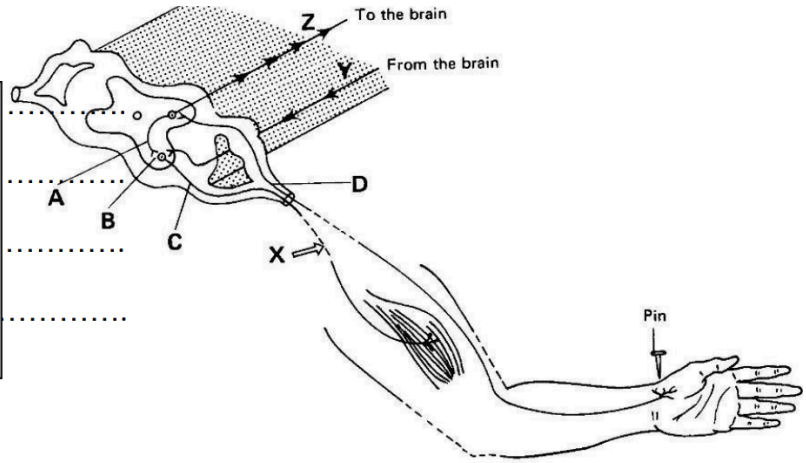
Label A to D.

A – relay neurone

B – synapse

C – motor / effector neurone

D – sensory neurone



X is a component of neurone C.

Name X... axon .....

Fig. 8.1

Nervous pathway: d→a→b→c

HORMONES

Increase in insulin→ decrease in blood glucose conc.

Adrenaline increases breakdown of glycogen to glucose, heart rate, breathing rate and in quantity when frightened

Insulin injection for low insulin secretion

Fasting for long periods increase glucagon secretion in blood

Escaping danger involves both the endocrine and nervous system

Insulin can't be orally consumed instead of injected because it is a chain of polypeptide and will be digested in the stomach

Healthy individuals have lower baseline blood glucose conc. lvls than diabetic

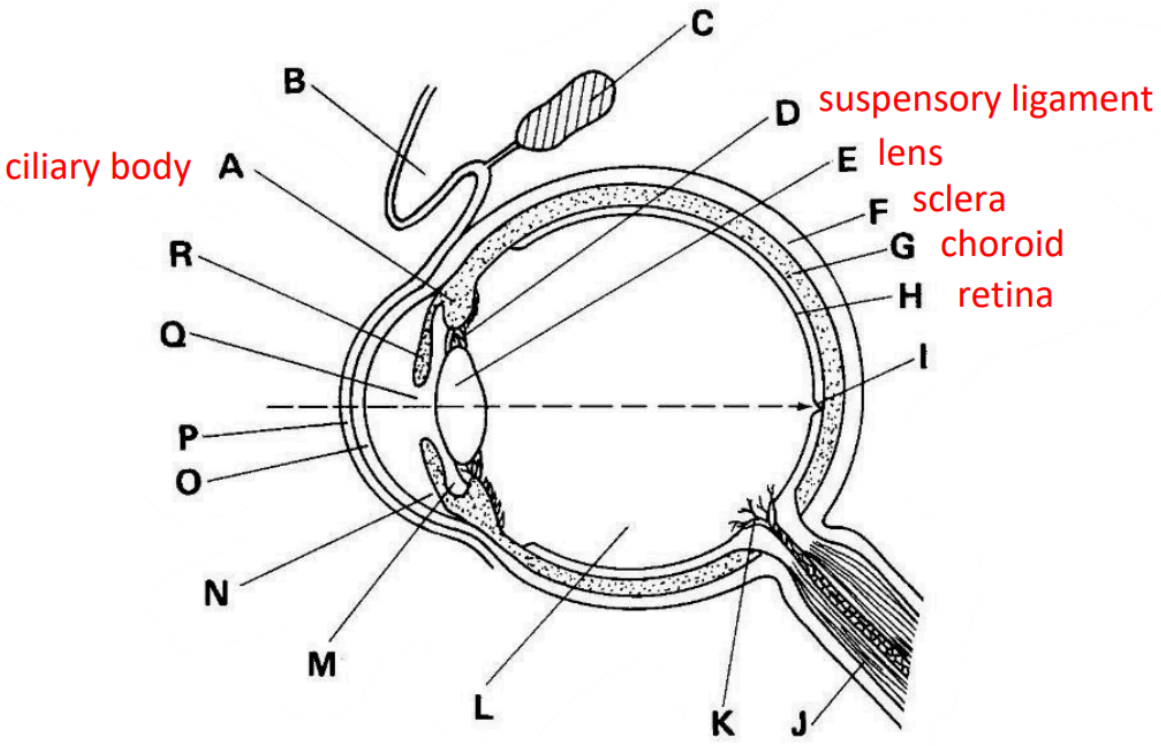
<u>Stress/anxiety/fear/anger</u>
Nerves of sympathetic division activate
Nerve impulse sent to adrenal medulla
→ secretes adrenaline
→ vasodilation of coronary vessels
→ more glucose and O_2 delivered to heart muscles
→ atp production increase
→ heart rate + force of contraction rise
→ higher rate of delivery of O_2 and glucose to skeletal muscles

→ higher rate of respiration
→ release more energy as ATP for contraction

Hormone: chemical substance produced in minute quantities by endocrine gland, transported in the bloodstream to target organs. Destroyed by liver after they have performed their functions.

	Nervous system	Endocrine system
Type of signalling	involves nerve impulses (electrical signals)	involves hormones (chemical signals)
Mode of transmission	transmitted via neurones	transmitted via bloodstream
Speed of response	quick	usually slow
Duration of response	short-lived	may be short-lived (eg adrenaline) or long lived (eg growth hormone)
Voluntary or involuntary	may be voluntary or involuntary	always involuntary
Extent of action	usually localised	may affect more than one target organ

EYES



Ciliary body

Lens

Elastic→change shape

→focus on far & near

Transparent → allow light to pass via

Sclera

Tough and fibrous → protect eyeball

Choroid

Circular muscles: ensure light converge on retina

Contract → suspensory ligaments loosen → lens thicken → focal length decrease → view nearer

Relax → suspensory ligaments tighten → lens thin → focal length increase → view further

Retina

Coated by fovea centralis that have photoreceptors that when stimulated send an impulse to the brain for interpretation

Vitreous humour

Incompressible→ exert outward pressure on sclera → maintains spherical shape of eyeball

	Rods	Cones
Number	Higher	Lower
Distribution	Periphery of retina	Concentrated at yellow spot of retina
Sensitivity	Dim light	Bright light
Vision	Black, white, grey	Colour
Deficiency symptom	Night blindness	Colour blindness
Cause of deficiency	Insufficient vitamin A, thus insufficient visual purple (rhodopsin)	Genetic defect produces defective cones

Rhodopsin is bleached in brightly illuminated place. Time required for regeneration for vision at dim light to occur

Radial muscles contract, circular muscles relax
→ iris dilates → more light enter eye

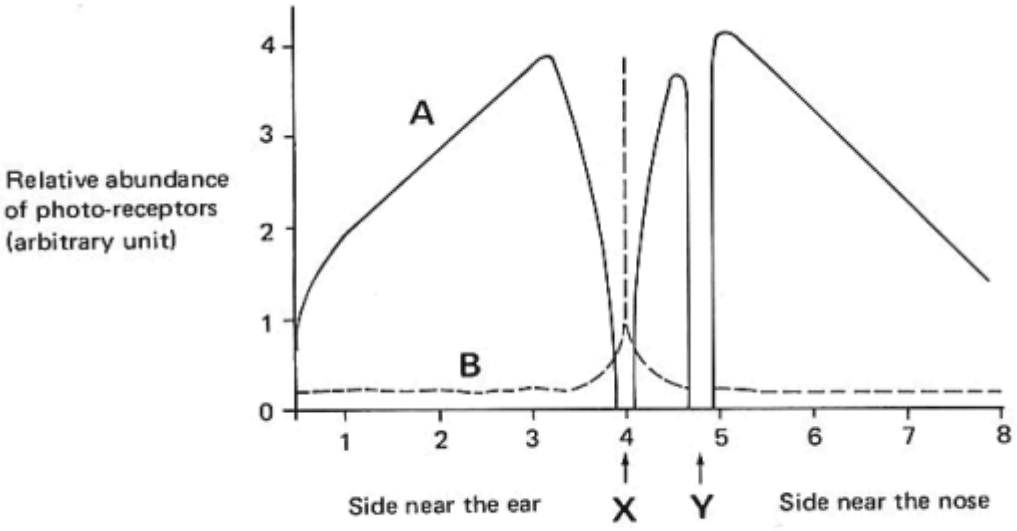
Iris regulate size of pupil

Blind spot: no photoreceptors → light reflected off object that converge on blind spot cannot be detected by brain
→ no nerve impulse generated

Presbyopia: lens lose elasticity → remain thin when focusing on nearby
Cured using converging lens

Degree of curvature in cornea varies from one axis to another. Light passing through cornea not refracted properly→ image distorted in some planes → astigmatism.

Lamp moves→light intensity decreases. →detected by photoreceptor cells on retina→ generate impulse sent to brain via sensory neurones in optic nerve
→ Impulse sent from brain via motor neurone to radial muscles of iris
→ Contract
→ Circular muscles relax
→ Dilates pupil
→ Allow more light to enter the eye
→ Enhance vision.



curve A ... rods

curve B ... cones

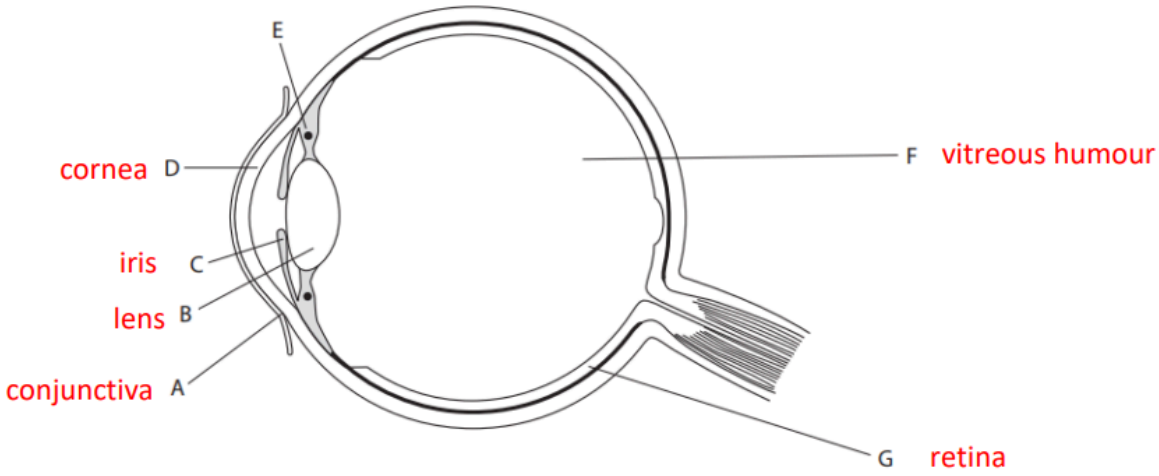
(b) Name the points labelled X and Y on the retina.

X ... fovea centrali .....

Y ..... blind spot .....

Name the part of the retina that is involved in the detection of a faint star at night.

... Periphery of the retina .....



Health problem	Description	Letter
conjunctivitis	inflammation of the conjunctiva	A
cataract	cloudy lens	B
Blindness	a detached retina	G
glaucoma	increased fluid pressure	F
astigmatism	change in shape of the cornea	D

Cataract

Eye disease where proteins in lens undergo oxidative damage caused by free radicals

Symptoms:

- Clouding of lens prevents light from passing through
- Scattered light causes multiple images formed on retina image not sharp
- Less light detected by photoreceptor cells
- Less nerve impulses are generated
- Decreased transmission of nerve impulse (action potential) to the brain

• Blurred vision perceived by the brain
• In long term, can lead to blindness.

Age-related Macular Degeneration (AMD)

Dry AMD:

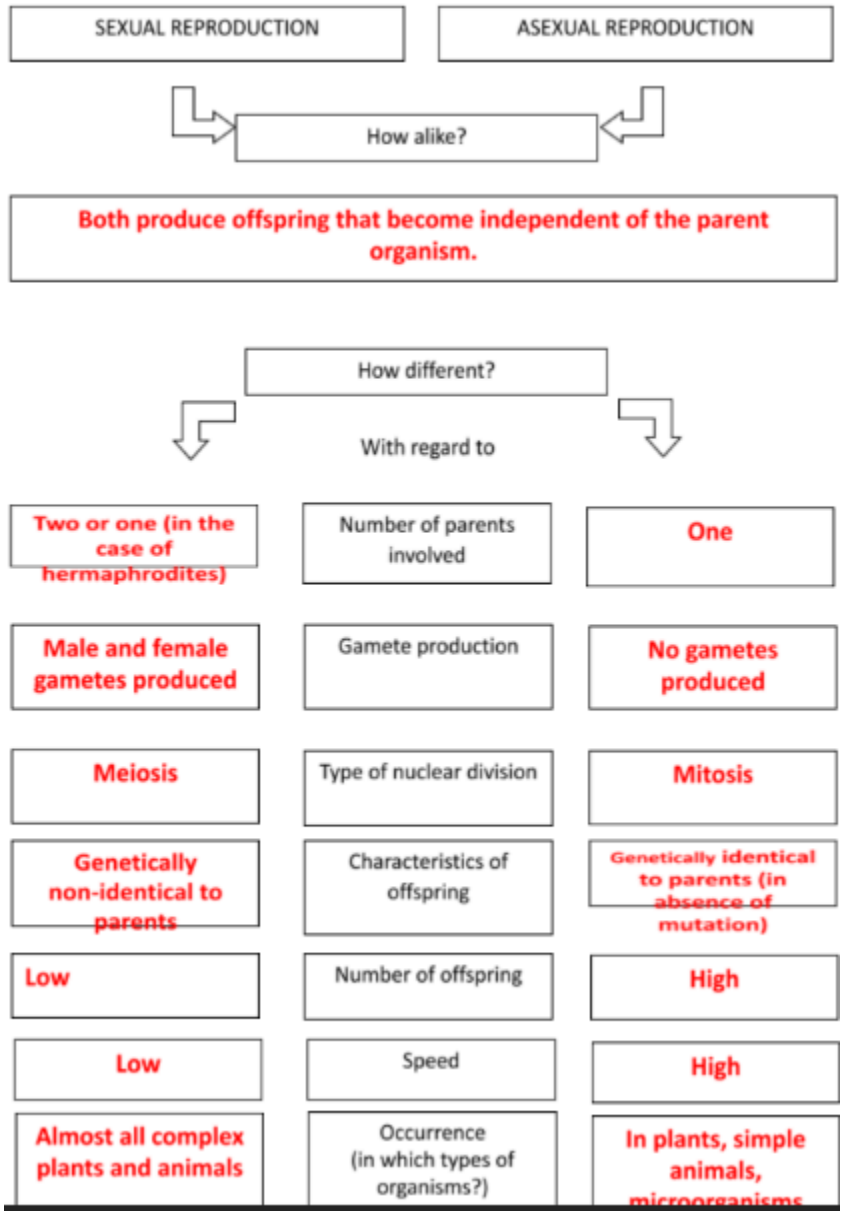
- Oxidised proteins and cellular debris accumulate in macula lutea (yellow spot).
- Damage to macula lutea and cone cells.
- Light not detected by cone cells.
- No nerve impulse (action potential) generated.
- No transmission of nerve impulse to brain, leading to undetected image.

- Wet AMD:
  - Blood vessels grow from choroid behind retina.
  - Can lead to retinal detachment.
  - Photoreceptor cells lack nutrients and oxygen.
  - Light may not converge on retina.
  - Haemorrhage causes macular swelling.
  - Photoreceptor cells not stimulated.
  - No nerve impulse (action potential) generated.
  - No transmission of nerve impulse to brain, causing loss of central vision.

Suggest why it is important for the blood glucose concentration to be maintained within narrow limits.

To ensure blood osmotic pressure or water potential remains constant to prevent crenation or lysis of blood cells / ensure all cells have glucose for respiration

REPRODUCTION IN PLANTS

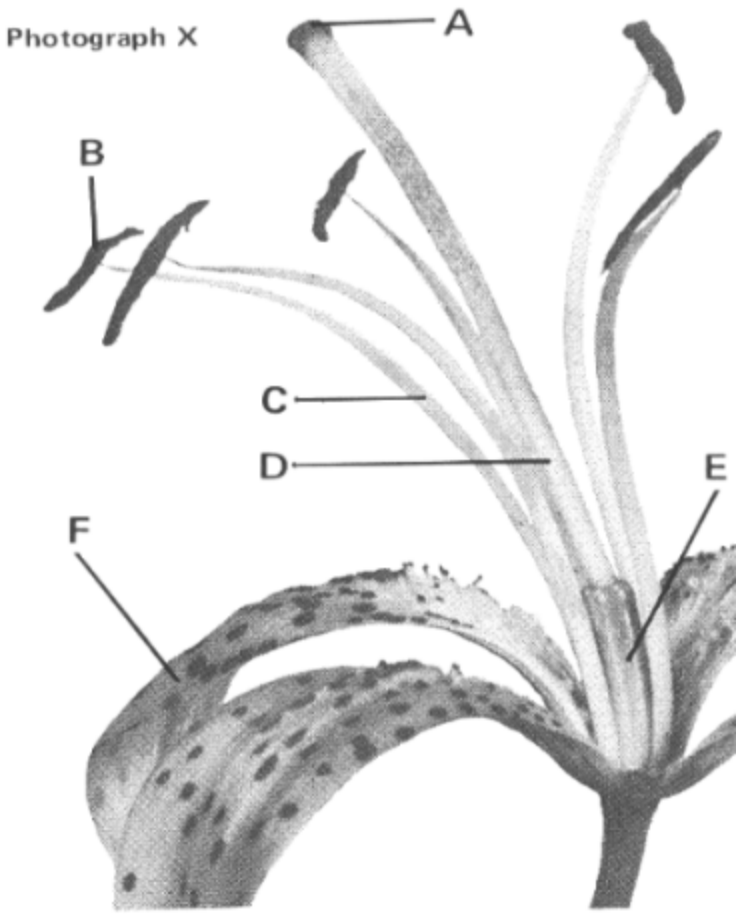


SEXUAL REPRODUCTION

Advantages	Disadvantages
Higher genetic variation among offspring – higher adaptability and chance of survival when environment changes	More time and energy are required in the production and maturation of gametes
Helps in colonisation of new environment when fruits and seeds are dispersed	Beneficial traits may not be preserved since offspring are genetically non-identical
Lower chance of overcrowding and competition among offspring	Generally fewer offspring, thus slower propagation

ASEXUAL REPRODUCTION

Advantages	Disadvantages
Genetically identical offspring preserves successful combinations of alleles / beneficial traits	No genetic variation among offspring – poor adaptability and lower chance of survival in a changing environment
Rapid multiplication and colonisation (e.g. spore formation in mould)	Wastage of energy and materials in producing spores that fail to find a suitable place for germination
One parent is involved – saves time and energy in finding a mate	Overcrowding and exhaustion of nutrients if an organism spreads in one area, e.g. strawberry runner, potato stem tuber



A: stigma - receive pollen grain

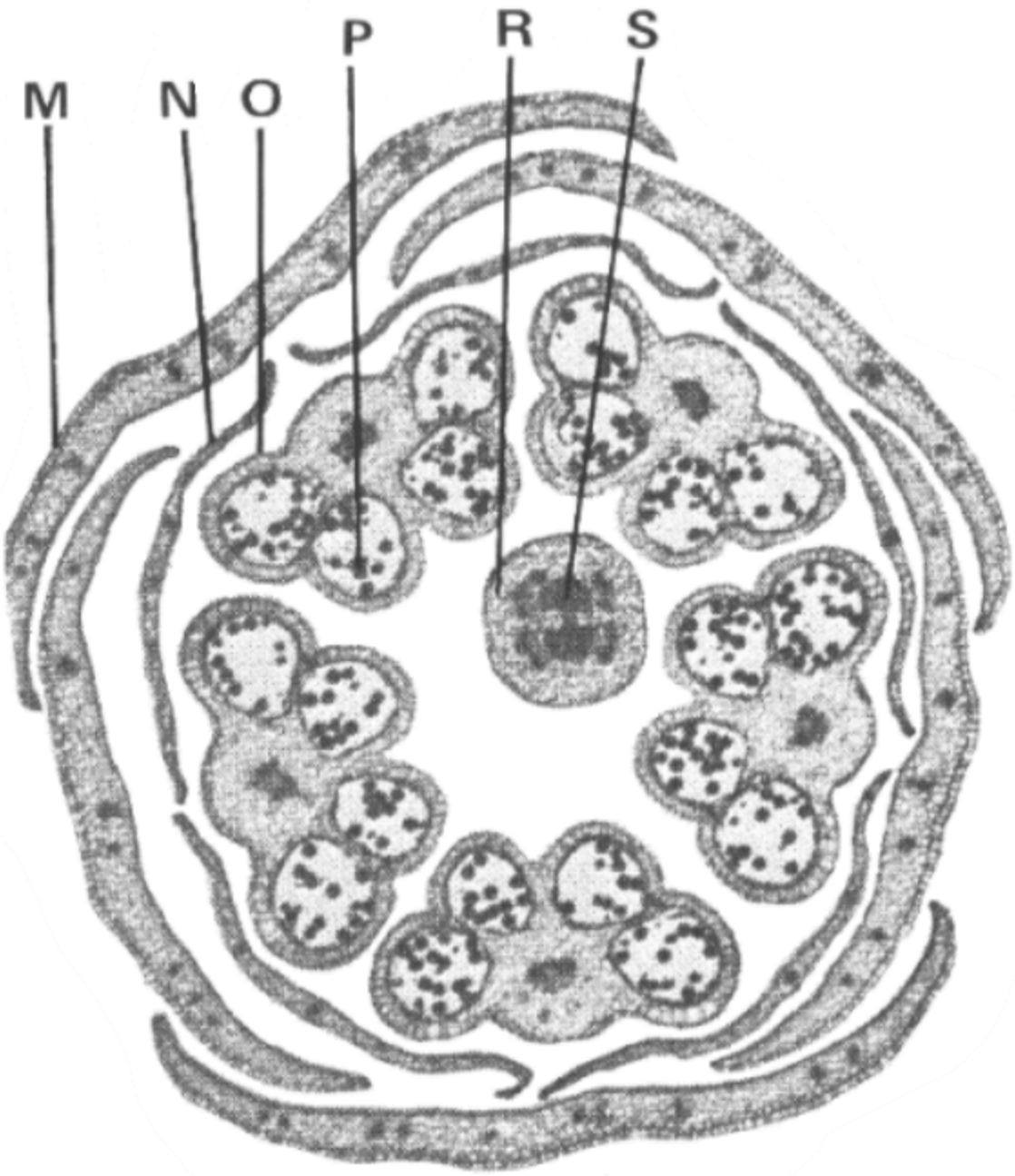
B: anther - produce & release pollen grain, non pendulous so insects brush it while obtaining nectar

C: filament - large & conspicuous to attract insects for pollination, landing platform for insects

D: style

E: ovary

F: petal



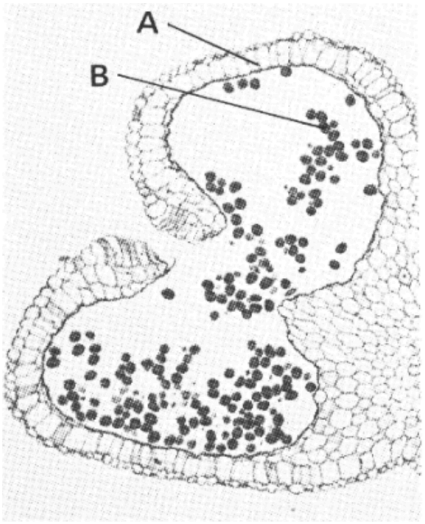
O: anther

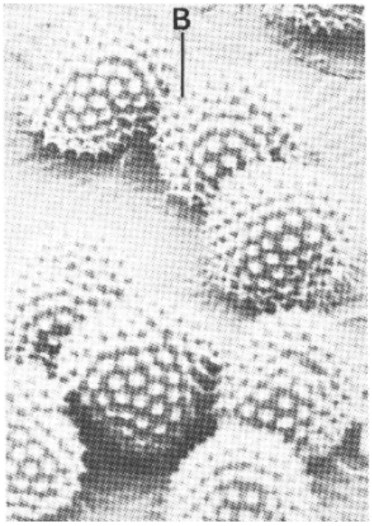
R: ovary

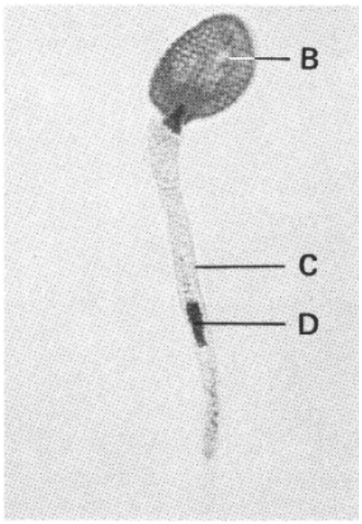
N: petal

M: sepal - protects flower in bud stage and contains chlorophyll to absorb light energy for photosynthesis

Cross pollination > self-pollination
Increase genetic variation & vigour, adaptability in a changing environment
Increases heterozygosity at most gene loci → reduce chance of expression of recessive alleles



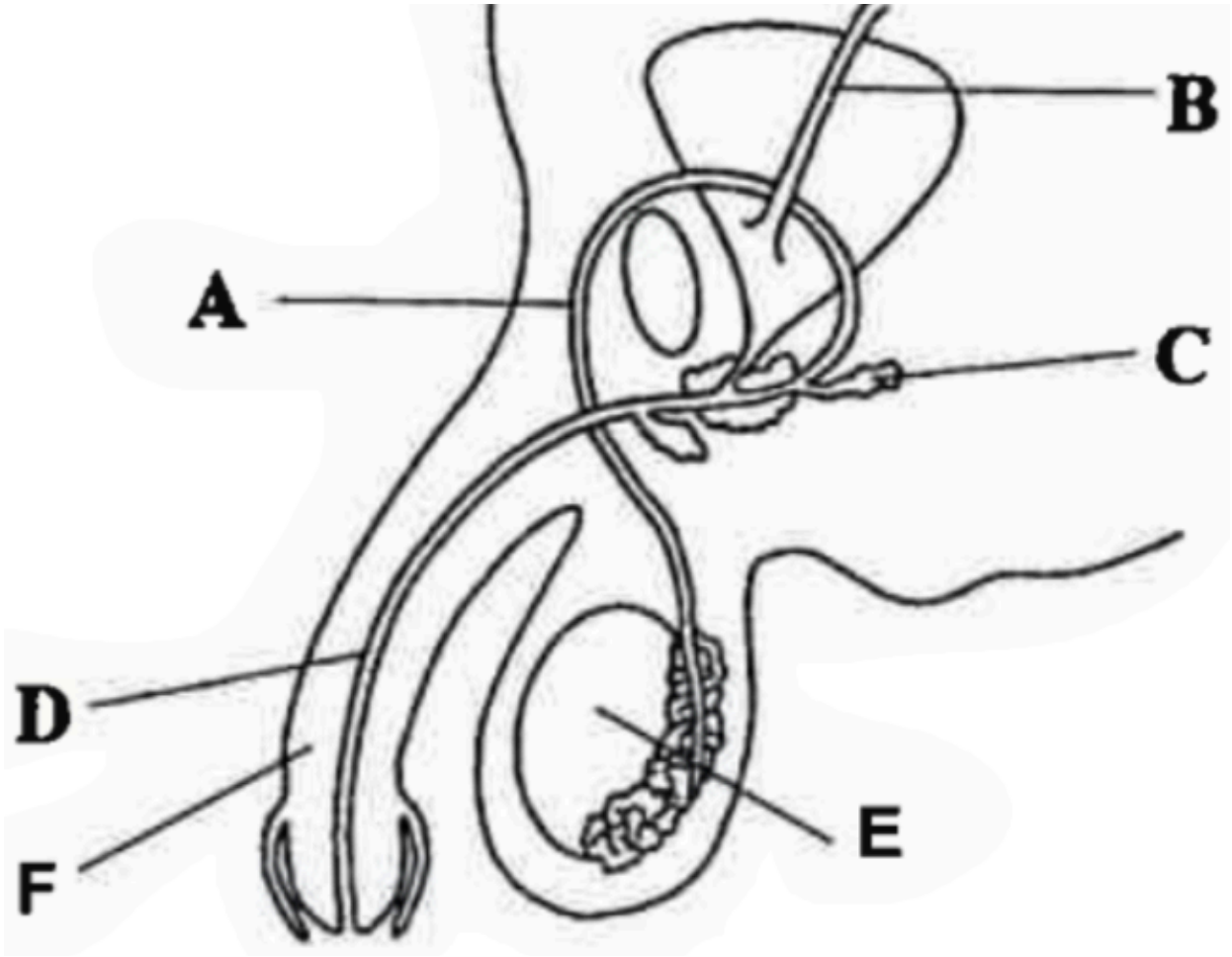




A: anther wall - diploid no. of chromosomes
B: pollen grain - produced by meiosis - produce gametes with haploid no. of chromosomes
→ fusion of nuclei of gametes during fertilisation restores diploid chromosome number
→ genetic variation enhances adaptability in changing environment
Spiky exine → attaches to insects body
C: pollen tube - penetrates via style, enter ovule via

micropyle to deliver male gametes to ovule for double fertilisation

REPRODUCTION IN MAN



A: Vas deferens: Carries sperm from epididymis to ejaculatory duct and urethra.

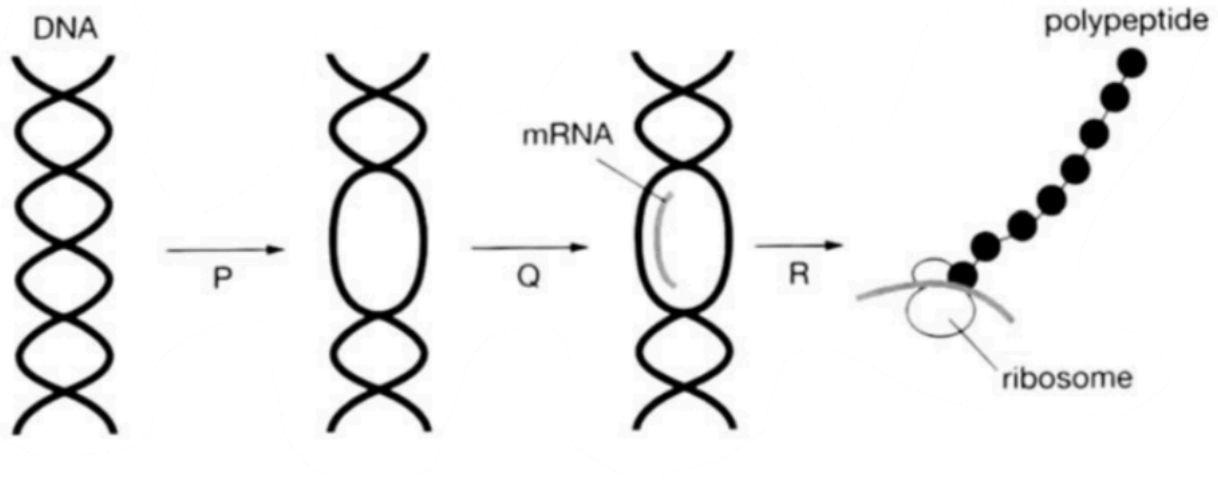
B: Ureter: Transports urine from kidney to urinary bladder for temporary storage.

C: Seminal vesicle: Secretes seminal fluid containing mucus, fructose and prostaglandins that form part of semen.
D: Urethra: Provides passage through which urine and semen are discharged outside the body.
E: Testis: Site where sperm and testosterone are produced.
F: Penis: Delivers sperm into female vagina for fertilisation when inserted into it.

Fluid secreted by accessory glands:
Provide alkaline medium that neutralises acidity of vagina to make sperm active
Contains fructose sourcing energy as ATP for sperm
Contains enzyme that break down cervical mucus and aid sperm mobility
Contains prostaglandins to stimulate uterine smooth muscle contractions to aid movement of sperm up uterus

Sperm has flagellum to swim towards secondary oocyte

MOLECULAR GENETICS



P: RNA polymerase bind to promoter site of DNA→DNA double helix unwind

Q: Transcription (transcribing strand used as template for
transcription)

Bonds that are broken in P: Hydrogen bonds between the nitrogenous bases

Free ribonucleotides complementary to bases in DNA are matched with DNA template by complementary base-pairing from the 5' to 3' direction.

… in DNA pairs with	… in mRNA
Adenine	Uracil
Thymine	Adenine

Guanine	Cytosine
Cytosine	Guanine

mRNA is released from DNA rewinds

pre-mRNA has poly A tail → enables ribosomes to attach to them (30-200 bp)

The 5’ cap with guanine protects the mRNA from degradation when it exits the nucleopore.

Prior to exiting, the pre-mRNA is spliced by spliceosome which removes all the introns and causes the exons to religate.

The mRNA then leaves the nucleus through pores in the nuclear envelope.

Nontemplate strand corresponds to DNA transcribing/template strand

Stop codon results in truncated polypeptide chain, altering insulin hormone 3D conformation, making it unable to carry out its metabolic activity

Haemophilia treatment regular injections of human factor VIII, necessary for blood clotting.

Ligase enzyme catalyses bond formation of phosphodiestor bond between phosphate and deoxyribose sugar group in DNA.

Bacterial plasmid is circular double stranded DNA present in cytoplasm of bacteria, used as vector to carry foreign DNA into bacterium, host of the plasmid.

Add ampicillin into the culture medium, grow the bacteria in it, and bacteria that grows will be ampicillin resistant, indicating that the plasmid has inserted itself into bacterium and conferred ampicillin resistance to
the bacterium.
After recombinant bacteria is obtained, they are replica plated onto medium with tetracycline.
The bacteria is cultured there, and if it dies, foreign gene has been inserted into tetracycline gene.

When agrobacterium infects a plant tissue, plasmids found in the bacterium are transferred to plant tissue. Agrobacterium is a host to the plasmid, which is the vector. The genes to be introduced into the plant are cloned into the Ti-DNA region of the plasmid modified with a selectable marker (antibiotic resistance) to enable selection for agrobacteria

which are used to transfect plants that have been successfully transformed.
Selective medium contains antibiotic. If plants cells transformed, they carry antibiotic resistant gene and survive in culture medium.

Plant hormones like auxin induce plant growth in shoot-inducing and root inducing culture medium.
Glucose needed for cellular respiration to release ATP for growth and metabolic processes is present in all selective and culture mediums.

Plant tissue culture ensure plants are cultured under sterile conditions and disease free plants are cultivated.
All plants cultivated like this are clones and desirable traits are passed on.

Extensive cultivation of recombinant plant will result in drastic changes to food chain. Animals & insects that feed on the crop will die, leading to widespread changes to the ecology and upset the balance.

Same restriction endonuclease (e.g. PvuII) should be used to cut open plasmid to give blunt ends

Recombinant factor VIII does not need constant blood transfusions exposing people to blood borne diseases like HIV, reducing risks of wound, blood infection or thrombosis from placing a central venous access device.

DNA	RNA
double stranded molecules	single stranded molecules
Molecules contain deoxyribose sugar within nucleotides	Molecules contain oxyribose sugar within nucleotides
Carbon at position 2 binds to hydrogen	Carbon at positon 2 binds to OH
Molecules have nitrogenous bases like adenine, thymine, guanine, cytosine.	Molecules have bases like uracil, adenine, cytosine, guanine.

Triplex drugs are complementary DNA strands binding to nitrogenous bases of DNA, forming triplex

DNA which cannot be transcribed, preventing synthesis/formation of mRNA and disease related protein.

Antisense DNA or RNA are RNA strands binding to mRNA, preventing it being translated into proteins, preventing expression/synthesis of disease related protein.

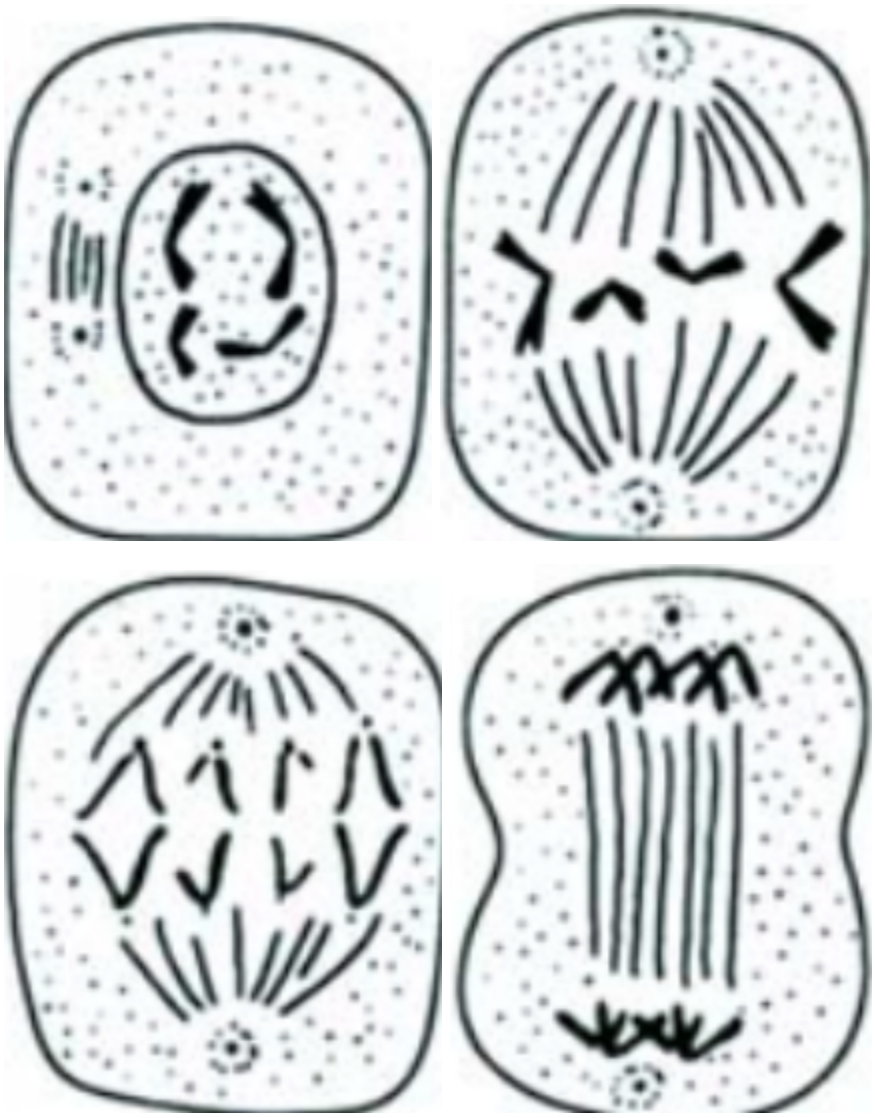
Recombinant DNA technology is the method for making genetically modified bacteria.

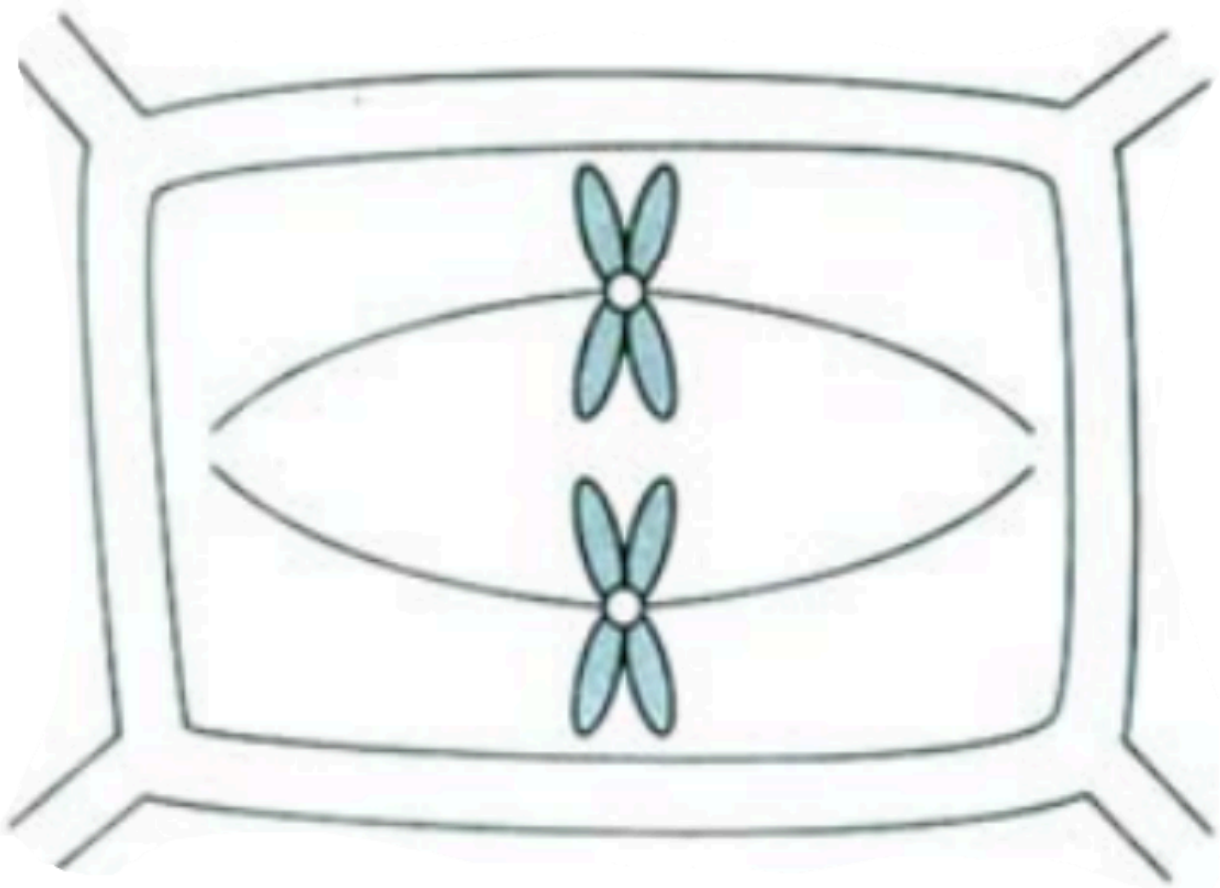
Xtra shit for application qn:
Transcriptional activation:
Ethylene binds to membrane-localised receptor. Transcription factor present in cell is activated, leading to induction of one or more early genes. One such early gene codes for a transcription activator that induces late genes. Late-induced genes code for enzymes which degrade the middle lamella during fruit ripening.
Antisense RNA shows complementary base-pairing with mRNA, preventing it from binding to the

ribosomal RNA in the ribosome and to the tRNA anticodon. Translation is stopped.
Transgenic tomatoes carry an artificial gene (DNA) that is transcribed into an antisense RNA complementary to the mRNA for the PG enzyme.

CELL DIVISION

IPMATC





Mitosis: 2 diploid daughter cells each have same number of chromosomes as parent cell & identical genetic material.

No pairing of homologous chromosomes.

Ensures equal division of nuclear materials.

Occurs in active growing body regions, all somatic cells.

Replaces cells that die by reproducing identical cells.

Increase total number of cells in organisms for growth.

Meiosis:
Occurs in sex organs during production of gametic cells, non identical genetic materials in 4 haploid daughter cells
Pairing of homologous chromosomes present.

Fertilization changes haploid cells into diploid cells.

Centromere links sister chromatids, had kinetochores spindle fibers attach to.

There are 46 chromosomes in a human body cell.

Organisms of same species have same number of chromosomes among somatic cells, & gametes have half the no.
Different species have different no.

Chromosomes are condensed from chromatin threads on which DNA is organized.
Before nuclear divison, chromosomes exist as chromatin fibres.

Homologous chromosomes are paired, one DNA from paternal and maternal each, have identical shape, size & gene loci.

G_1,
S(synthetic): DNA is replicated
G_2: chromosomes decondense in the form of chromatin fibres.

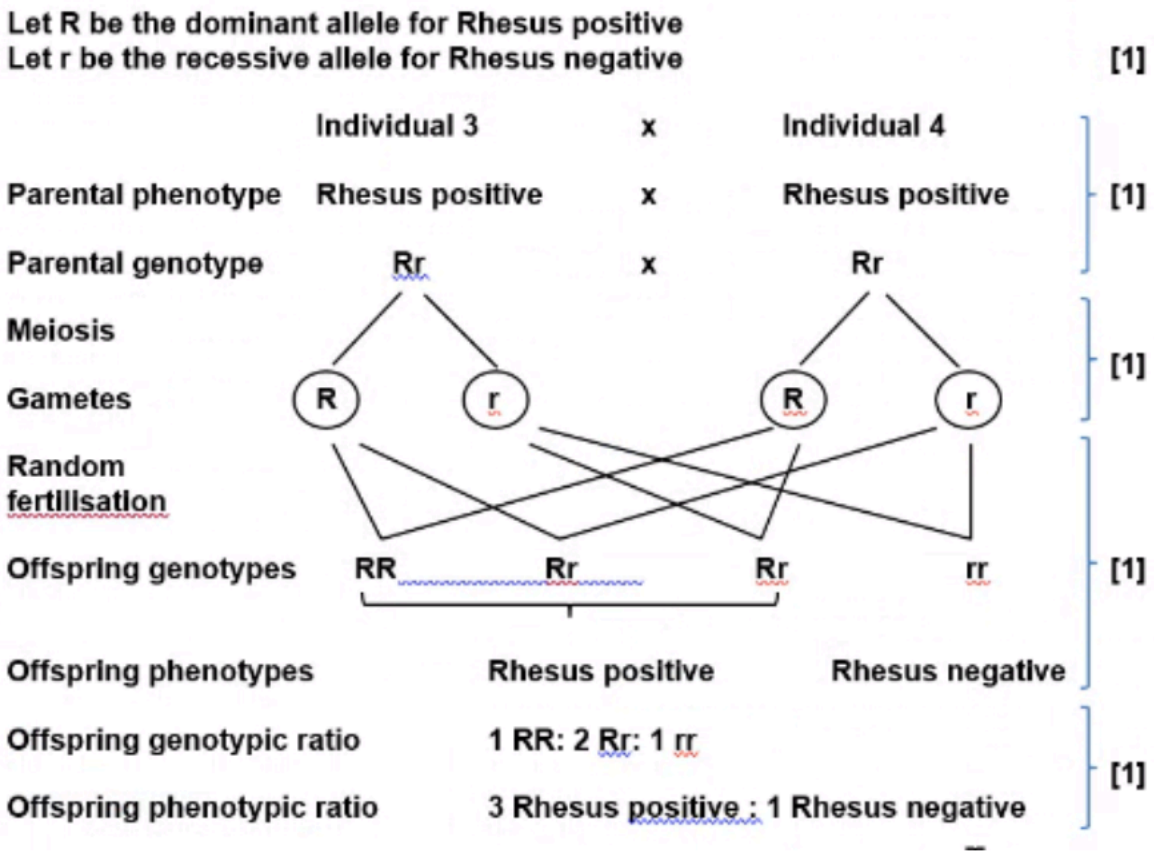
Onion root cell undergoes mitotic division only as cells in root tips are somatic cells, where all tissues are genetically identical to parent.

Onions also reproduce by asexual reproduction(vegetative propogation).

In interphase of cell cycle, cell undergo protein synthesis, growth, DNA replication.

Anaphase: centromeres divide into 2, sister chromatids of each chromosome separate and move, centromeres first, to opposite poles of spindle.

INHERITANCE AND EVOLUTION



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Parents of an individual are normal but individual have PKU disease, so parents are heterozygous and she has homozygous recessive traits.

Mutation is random change in the DNA of an individual. If PKU had resulted due to a mutation, it is unlikely that could have occurred in other siblings in the same family too, hence mutation isnt likely responsible.

A gene for a physical trait is present in all somatic and gametic cells.

Heterozygous: gene with 2 different alleles
Homozygous: gene with 2 same alleles.

Discontinuous variation:
The phenotypic trait shows limited distinct forms with no intermediate
Variations; controlled by single allele and does not have additive effect.

PTC taster / non-taster is a monohybrid inherited trait where tasters can either be Homozygous dominant or heterozygous for the condition.

Identical twins have identical genetic content as they are formed from one zygote which split into two so they must be of the same gender.

Colour-blindness is a sex-linked recessive condition. For her to be colour-blind, she must have inherited the genes from both parents. Her father must be

colour-blind but her mother might be a heterozygote or homozygote for the colour-blind condition.

The difference in IQ can be accounted for by different environmental conditions such as better nutrition, more exercise. These factors have an effect on physical traits determined by several alleles with additive effects which gives rise to continuous variation.

Identical twins have the same genetic make up and if they develop different IQ (that is assuming that the tests are conducted in a reliable and reproducible manner), it can then be attributed to the relative effect of the environment on IQ. The extent to which environmental factors like education and exposure the sufficient resources to develop mental capacity can be correlated to how the IQ varies.

Mutation is random change in genes.

Random changes occur during crossing over in Prophase I and the independent assortment of homologous chromosomes during meiosis which

can lead to the formation of gametes with different alleles for wing patterns.

Fertilisation that will result in the random combination of alleles for wing patterns in the zygote.

Over many generations, proportion of individuals possessing advantageous characteristic increases whereas those lacking the characteristics decreases. This leads to a change in allele frequency of the population and over time it can lead to evolutionary change or even the formation of a new species.

Genetic variation arises from spontaneous gene mutations, chromosomal mutations, meiosis and random fusion of gametes.

The process of meiosis (crossing over in Prophase I and the random assortment of homologous chromosomes in Meiosis I) provides new combinations of alleles, and hence genetic variation. This acts as raw material for natural selection to operate on. The gene pool of a species is the total of

all alleles at all gene loci. The gene pool increases when a mutation provides a new allele
and hence variation for natural selection to act on.

Excretion in humans

1. Glucose, urea, water and other small molecules and ions are filtered out of blood / glomerulus into the Bowman's capsule by hydrostatic pressure in ultrafiltration
2. Plasma proteins are not filtered out of blood / they remain in blood
3. Glucose is reabsorbed into blood by active transport and facilitated diffusion
4. Antidiuretic hormone increases permeability of cell membrane of epithelial cells of collecting duct and distal convoluted tubule to water

Homeostasis

1. For questions involving homeostasis, always identify the stimulus, detector, coordinator, corrective mechanism, effector and negative feedback mechanism that maintains it at setpoint / norm
2. Stimulus: skin/body temperature increases / decreases
3. Vasodilation / vasoconstriction of arterioles supplying skin capillaries → more / less blood flows through skin capillaries than constricted / dilated shunt vessels → more / less heat lost by radiation
4. Increased production of sweat → increased rate of evaporation of water in sweat → increased rate of removal of latent heat of vaporisation

Human eye

1. Ciliary muscles / circular muscles of ciliary body relax → suspensory ligaments are pulled taut → lens becomes less convex / thinner → light reflected from distant object converges on the fovea centralis / yellow spot of retina
2. Ciliary muscles contract → suspensory ligaments slacken → lens becomes more convex / thicker → light reflected from near object converges on the fovea centralis / yellow spot of retina
3. Light reflected from object converges on retina → photoreceptors are stimulated → electrical impulse is generated and transmitted via optic nerve to the cerebrum (for interpretation)

Nervous system

1. Thermoreceptors/free nerve endings detect the increase in skin temperature → generate an electrical impulse which is sent via sensory neurone to the spinal cord via the dorsal root
2. In the grey matter of the spinal cord, the impulse that reaches the axon terminal branches of the sensory neurone causes the release of neurotransmitter molecules across the synapse → sets off an impulse in a relay neurone → neurotransmitter molecules released at the axon terminal branches of the relay neurone result in the generation of an impulse in the motor neurone → impulse is transmitted in axon of motor neurone out of spinal cord via ventral root
3. Synaptic knobs at the axon terminal branches of the motor neurone release neurotransmitter molecules → contraction of muscles in the arm (reflex withdrawal of arm)
4. Another relay neurone transmits impulse to the brain → sensation of pain

Hormones

1. Anxiety and stress → hypothalamus is stimulated → sympathetic nervous system is activated → motor neurones transmit impulse to adrenal gland → adrenaline is secreted from adrenal medulla into the bloodstream → transported to target organs

Ecology and effects of human activities on the ecosystem

1. Loss of energy as heat during respiration
2. Insecticides are non-biodegradable, soluble in fat, not excreted → bioaccumulation of insecticide in bodies of consumers if they keep consuming food with insecticide
   Organism at a particular trophic level must consume many organisms at the lower trophic level to meet its energy demands due to energy loss at every trophic level → bioamplification / biomagnification (increase in concentration of insecticide up trophic levels / along a food chain)