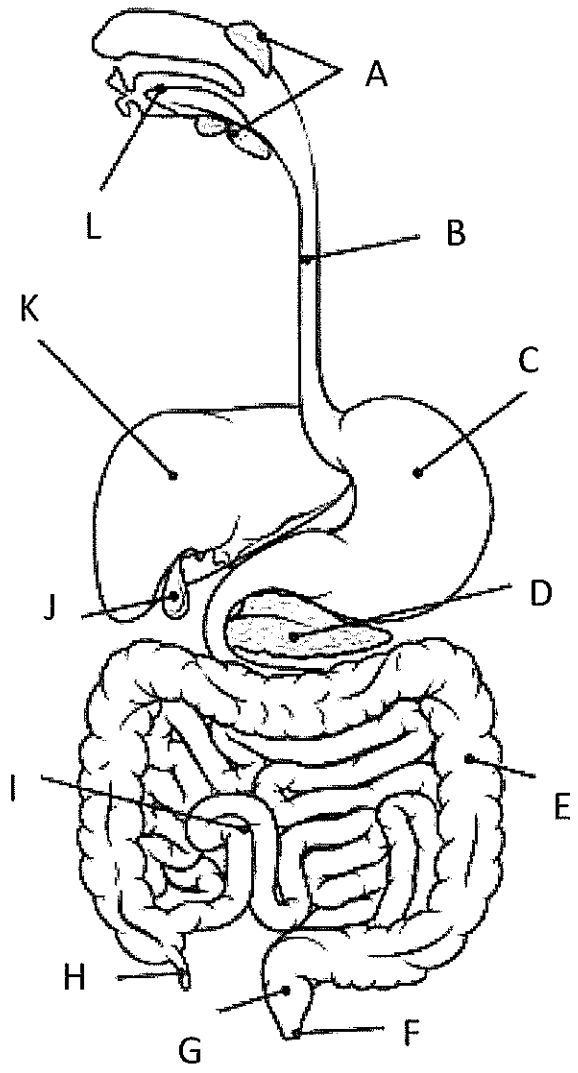
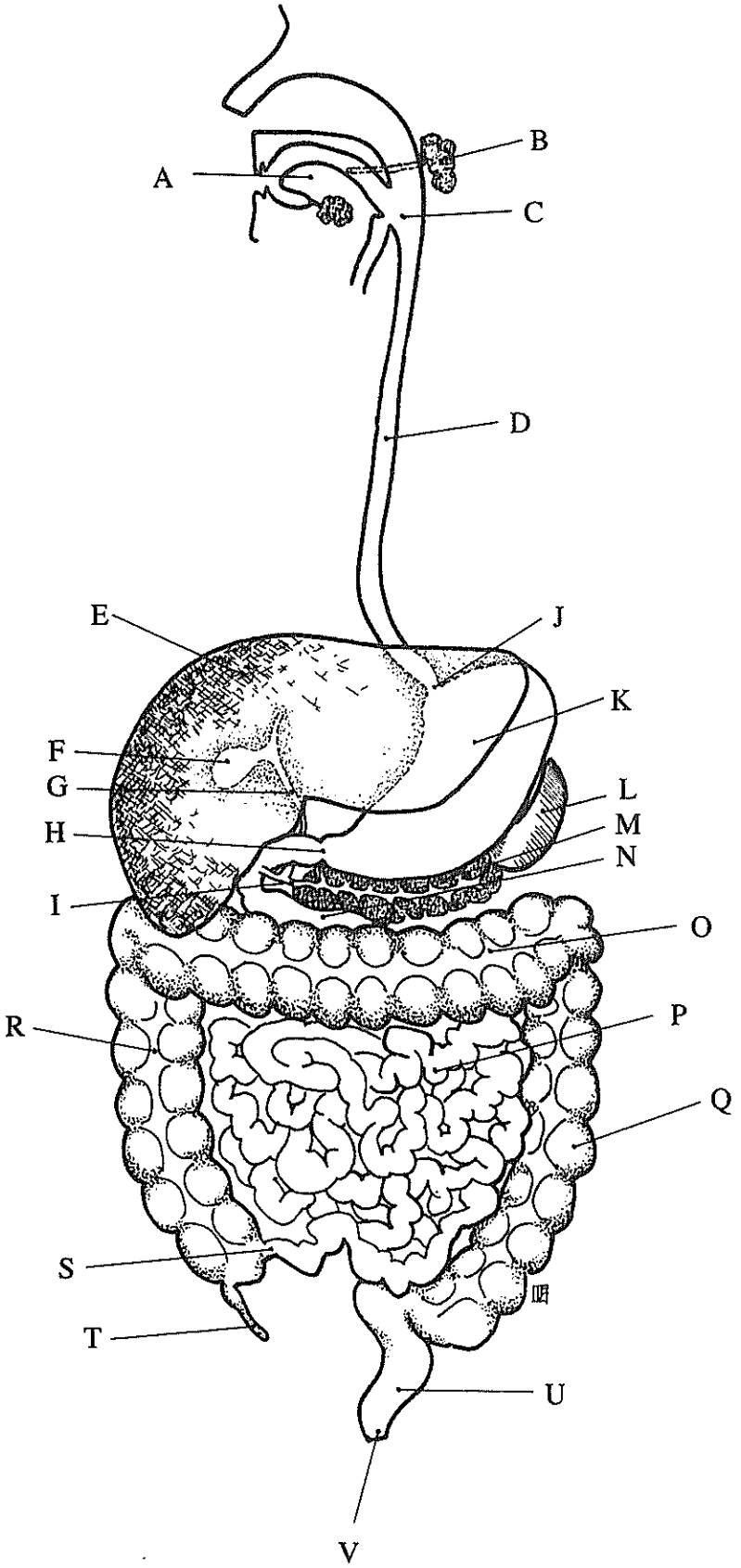
Human digestive system, digestive tract or alimentary canal



Digestion

Digestive system



A . . . . . .
B . . . . . .
C . . . . . .
D . . . . . .
E . . . . . .
F . . . . . .
G . . . . . .
H . . . . . .
I . . . . . .
J . . . . . .
K . . . . . .
L . . . . . .
M . . . . . .
N . . . . . .
O . . . . . .
P . . . . . .
Q . . . . . .
R . . . . . .
S . . . . . .
T . . . . . .
U . . . . . .
V . . . . . .

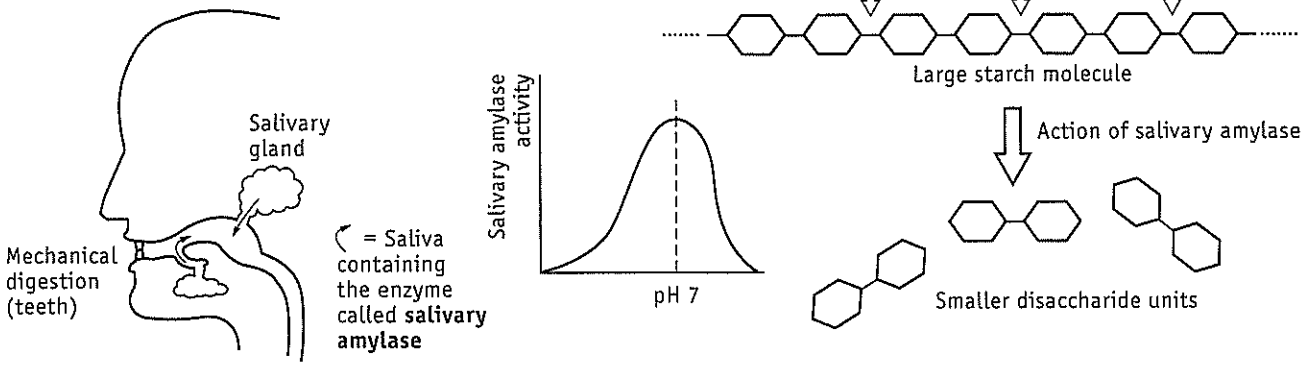
3 MAMMALS AND THEIR REQUIREMENTS

Digestion in mammals

3.1

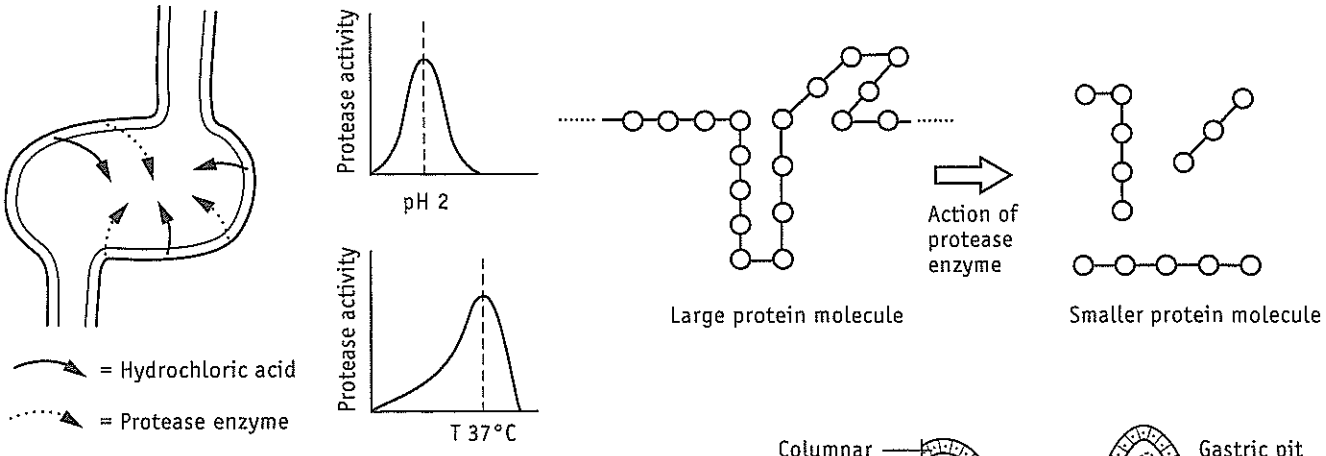
Show below are some of the main events that take place in the digestive system of a mammal.

Digestion in the mouth



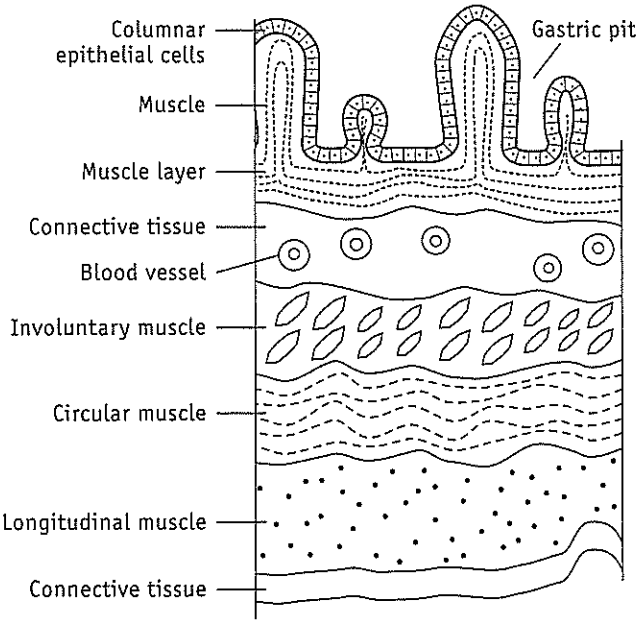
1 (a) How does chewing **(mechanical digestion)** help the chemical attack on starch by **salivary amylase**?
(b) Under which pH conditions is salivary amylase most active?
(c) Describe in words the action of salivary amylase on starch.

Digestion in the stomach



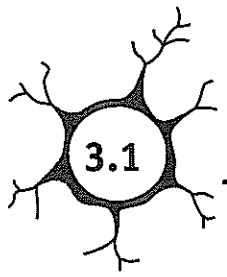
2 (a) Suggest a function for hydrochloric acid in the stomachs of carnivorous mammals.
(b) Describe in words the action of stomach protease enzymes.
(c) Under which conditions of pH and temperature are mammal stomach proteases most effective?
(d) Study the diagram at right of a section of the stomach wall.
(i) Suggest a function for:
- the columnar epithelial cells;
- the various muscle layers;
- the connective tissue; and
- the blood vessels.

(ii) Suggest a role for the mucus which is secreted onto the inner stomach lining.



3 MAMMALS AND THEIR REQUIREMENTS

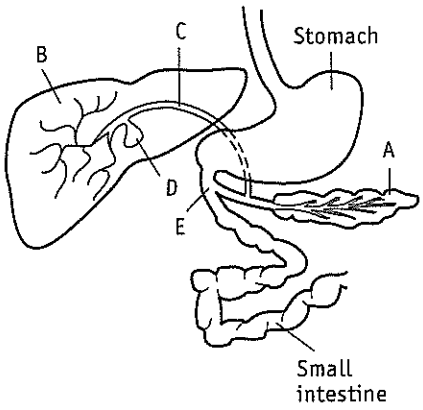
Digestion in mammals *(continued)*

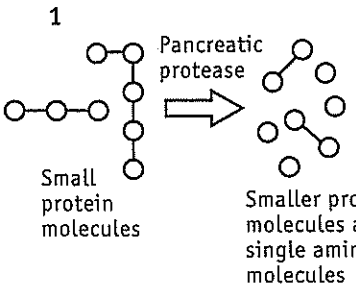


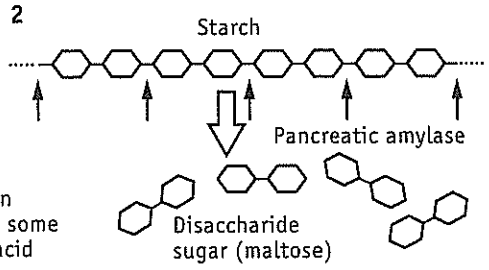
The duodenum

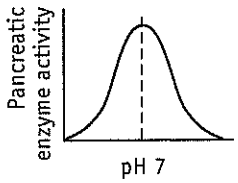
At point E in the digestive tract, pancreatic secretions are added to continue the chemical attack on food. Pancreatic secretions contain:

1. protease enzymes;
2. amylase enzymes;
3. lipase enzymes;
4. a bicarbonate solution.

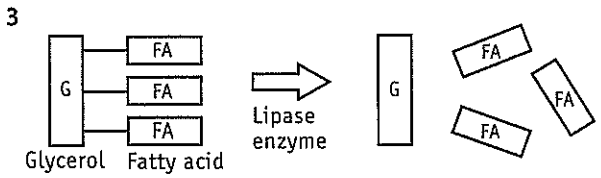








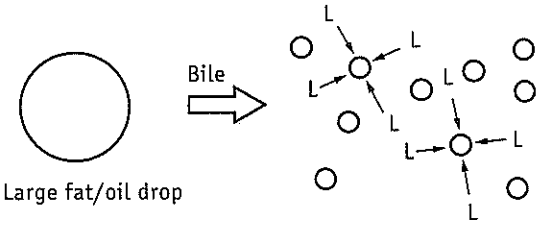
pH conditions for the action of pancreatic enzymes in the duodenum



Large fat molecule

Small digested molecules

Produced by the liver, bile is delivered to the duodenum by a bile duct. The action of bile is shown at right. The smaller lipid droplets present a larger surface area for lipase attack.



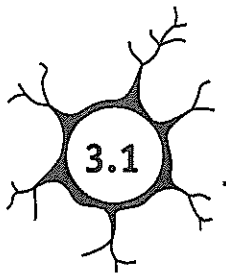
3 (a) Complete the following table.

Organ	Organ name	Organ function
A	(i)	(ii)
B	(i)	(ii)
C	(i)	(ii)
D	(i)	(ii)
E	(i)	(ii)

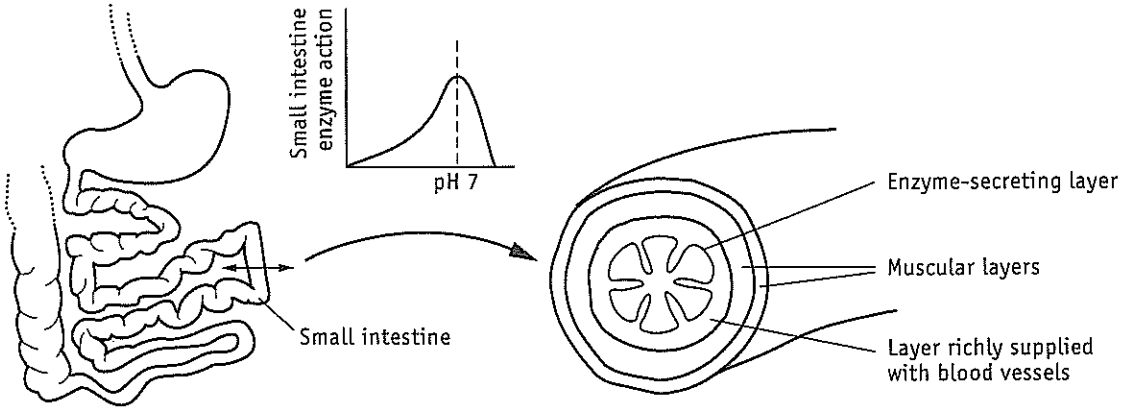
(b) Describe in words the action of:
- (i) pancreatic amylase
- (ii) pancreatic protease
- (iii) pancreatic lipase
- (iv) pancreatic bicarbonate solution

(c) How does bile help in the digestion of lipids?

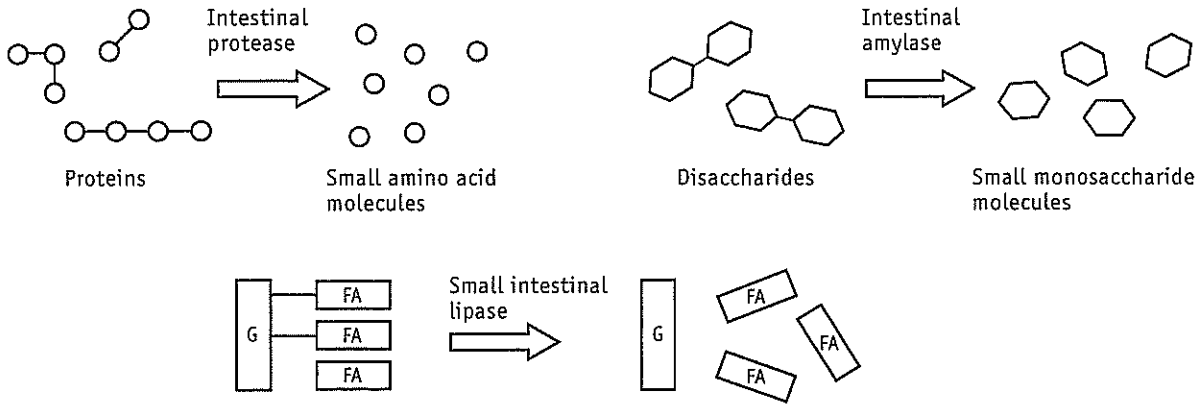
Digestion in mammals *(continued)*



Digestion and absorption in the small intestine



The lining of the small intestine secretes a range of digestive enzymes. The chemical digestion of **protein**, **carbohydrates** and **lipids** is completed in the small intestine, as shown.

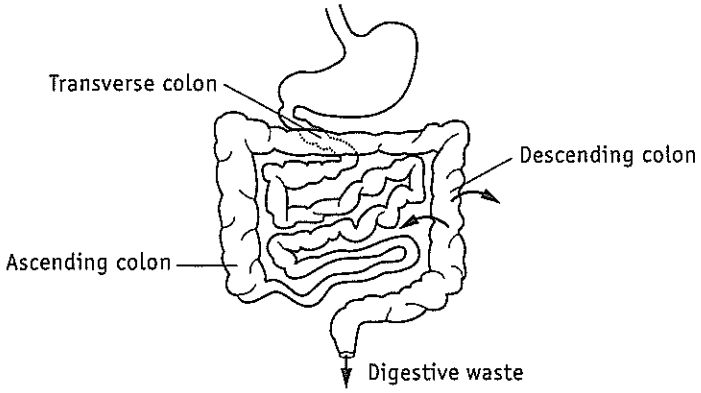


4 (a) In general terms, the chemical attack on **large food molecules** is completed in the small intestine. List the **small molecules** produced by chemical digestion in the small intestine.

(b) What happens to these small molecules in the small intestine?

The large intestine

This prepares digestive waste for removal and reabsorbs water from digestive waste.

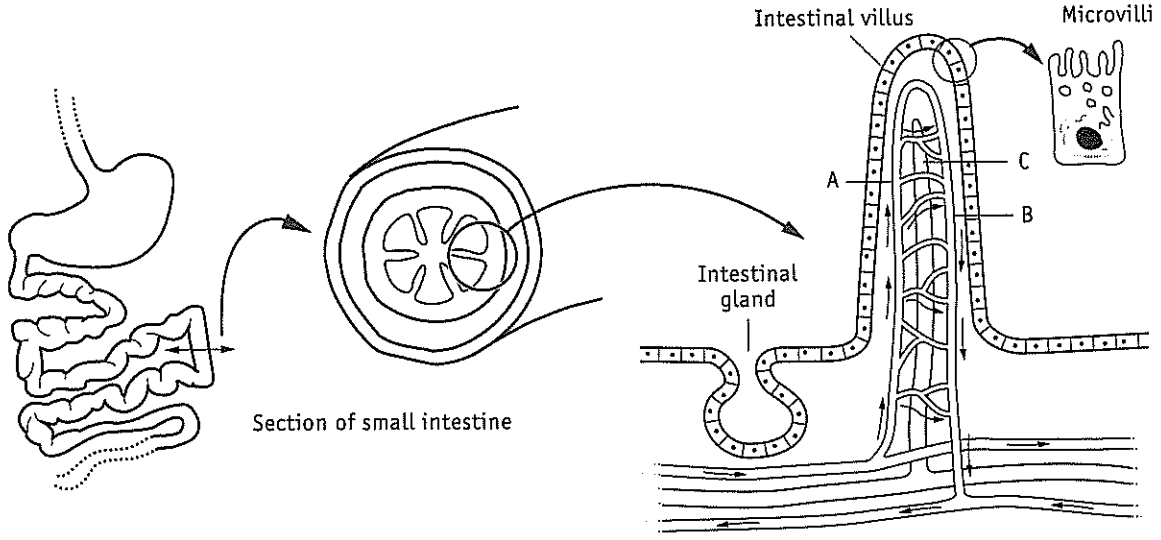


5 How does the large intestine contribute to the **homeostatic balance** in the human body? (*Note:* **homeostasis** is the maintenance of a constant environment for cells in the body.)

3 MAMMALS AND THEIR REQUIREMENTS

Digestion and absorption in the small intestine

3.2



1 List two important functions of the small intestine.

2 What are three features of the small intestinal surface that make it ideally suited to its functions?

3 By which processes do small food particles move into the blood across the intestinal villus surface?

4 Comment on the overall biological importance of:
(a) the flow of blood (at A and B); and
(b) the flow of lymph (at C)
through the intestinal villus.

5 In the table below compare the chemical composition of the blood at point A with that at point B as it circulates through the villus.

Chemical in blood	At A	At B
(a) O_2	(i)	(ii)
(b) CO_2	(i)	(ii)
(c) Glucose	(i)	(ii)
(d) Amino acids	(i)	(ii)
(e) Mineral ions	(i)	(ii)
(f) Water	(i)	(ii)

6 Name the two products of fat digestion that would be present in lymph leaving the villus via the **lacteal vessel** (C).

7 Choose appropriate biological terms to complete the following summary statements regarding the structure and functions of the small intestine.
The small intestine is one part of the (a) _____ canal, located between the (b) _____ and (c) _____ intestine. The structures known as the (d) _____ and (e) _____ greatly increase the absorptive (f) _____ area of the organ. The small intestine surface is richly supplied with (g) _____ and (h) _____ vessels for the absorption of (i) _____ molecules (the products of digestion). The numerous intestinal glands secrete (j) _____ which complete the chemical attack on the three major food groups: (k) _____ , (l) _____ and (m) _____ .

Part III

Cells and tissue

Generalised cell

A nucleus B nucleolus C nuclear membrane D nuclear pore E Golgi apparatus F centriole G cytoplasm H ribosome I endoplasmic reticulum J mitochondria K cell membrane

Simple epithelial tissue

Squamous, cuboidal and columnar: A cell membrane B cytoplasm C basement membrane

Ciliated tracheal tissue: A cell membrane B nucleus C basement membrane D connective tissue E cilia F cytoplasm

Connective tissue: cartilage

Hyaline, white fibrous and yellow elastic cartilage: A lacuna B matrix C cartilage cell D white fibres E elastic fibres

Other connective tissue

Simple: A elastic fibre B mast cell C collagenous fibre D fibroblast E matrix (semi-fluid)

Bone: A canaliculi B haversian canal C osteocyte in lacuna

Tendon: A white collagenous fibres B tendon cell

Muscle tissue

Smooth, cardiac and skeletal: A cytoplasm B cell membrane C nucleus D intercalated disc E cross branch F myofibrils G sarcolemma

Neurone

A dendrite B nucleus C myelin sheath D axon E Schwann cell nucleus F lateral branch G node of Ranvier H motor end plate I neurolemma

Bones

Skeleton

A cranium B mandible C cervical vertebrae D clavicle E scapula F humerus G rib H sternum I thoracic vertebrae J lumbar vertebrae K pelvis L sacral vertebrae M coccyx N cartilaginous disc O radius P ulna Q carpals R metacarpals S phalanges T symphysis pubis U femur V patella W tibia X fibula Y tarsals Z metatarsals

Long bone section

A epiphysis B diaphysis C bone marrow D compact bone E soft bone F articular cartilage

Synovial joints

A bone B joint capsule C articular cartilage D synovial cavity containing fluid E synovial membrane F fibro cartilage

Digestion

Digestive system

A tongue B salivary gland C pharynx D oesophagus E liver F gall bladder G bile duct H pyloric sphincter I pancreatic duct J cardiac sphincter K stomach L spleen M pancreas N duodenum O transverse colon P ileum Q descending colon R ascending colon S neo-caecal valve T appendix U rectum V anus

Villi

A goblet cell B capillary network C micro villi D lacteal E intestinal gland

Tooth

A pulp cavity B enamel C dentine D gum E blood vessels and nerves F bone G cementum H root

Respiration

Lungs

A nasal cavity B epiglottis C larynx D trachea E lung F bronchus G rib H intercostal muscle I bronchiole J pleural cavity K diaphragm

Excretion

Urinary system

A blood vessels B kidney C renal pelvis D pyramid E cortex F medulla G calyx H ureter I urinary bladder J sphincter muscles K urethra

Nephron

A glomerulus B Bowman's capsule C proximal convolutec tubule D capillary E loop of Henle F distal convoluted tubule G collecting tubule

Skin

A epidermis B dermis C sweat gland duct D capillary E sebaceous gland F germinative layer G hair follicle H sweat gland I pressure receptor J touch receptor K fre nerve ending L erector muscle M blood vessel

Circulation

Heart

A superior vena cava B right pulmonary artery C dorsal aorta D left pulmonary artery E pulmonary veins F semi-lunar valves G right atrium H tricuspid valve I inferior vena cava J chordae tendineae K right ventricle L papillary muscle M left atrium N bicuspid valve O lef ventricle P interventricular septum Q apex

Artery and vein

A tunica externa B tunica media C tunica intima D lume

Blood

A leucocyte B erythrocyte C plasma D platelet

Nervous system and sensory organs

Brain

A cerebrum B corpus callosum C thalamus D frontal lobe E hypothalamus F optic chiasma G pituitary H pons I medulla oblongata J third ventricle K fornix L occipital lobe M cerebellum N fourth ventricle

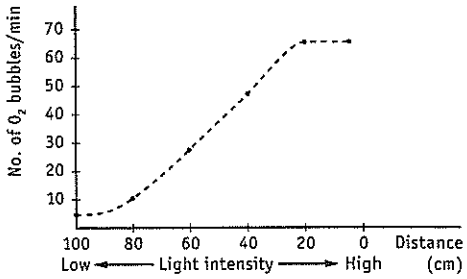
Simple reflex arc

A receptor B afferent neurone (sensory) C spinal ganglion D effector E efferent neurone (motor) F internuncial neurone G spinal cord

ANSWERS

2.6 Conditions affecting starch production, oxygen production and water loss

1 (a) To investigate the need for carbon dioxide for starch production in photosynthesis.
(b) A plant requires carbon dioxide for starch production (by photosynthesis) *or* CO_2 is necessary for photosynthesis.
2 (a) To investigate the need for light to drive photosynthesis.
(b) Light is necessary for starch production in a green plant *or* light is necessary for photosynthesis.
3 (a) To investigate the effect of humidity on the plant transpiration rate.
(b) Humidity affects transpiration rate *or* the drier the air, the greater is the transpiration rate.
4 (a) To investigate the effect of light intensity on oxygen production (photosynthetic rate) in a water plant.
(b) Increases in light intensity cause an increase in photosynthetic rate. However, the process is rate-limited at high light intensities.



2.7 Plant responses

1 (a) (i) To see if light can cause a response in coleoptiles.
(ii) Phototropism.
(b) (i) To see if gravity can produce a response in potted plants.
(ii) Geotropism.
(c) (i) To investigate plant responses to water.
(ii) Hydrotropism.
(d) (i) To investigate the effect of duration of lighting period on flowering response.
(ii) Photoperiodism.
(e) (i) To investigate the effect of low temperature on flowering response in bulb plants.
(ii) Vernalisation.
2 Hormones.
3 (a) Plants benefit by increasing their photosynthetic rate as they grow towards light.
(b) Shoots need to grow against gravity (towards light) and roots grow with gravity (towards soil water and minerals).
(c) Roots growing towards water increase the chances of water and mineral uptake by the plant.
(d) Flowering with lengthening periods of light (spring) increases chances of fertilisation, seed germination and seedling survival in warmer weather with greater insect activity, moisture availability and higher light intensity.
(e) Flowering triggered by winter temperatures ensures reproduction and seed dispersal in the favourable conditions of spring thus increasing chances of seedling survival.

3 Mammals and their requirements

3.1 Digestion in mammals

1 (a) Increases surface area for enzyme attack. (b) 7.
(c) The enzyme converts large starch molecules into smaller disaccharide molecules.
2 (a) Helps digest bone eaten with meat.
(b) The enzyme converts large protein molecules into smaller protein molecules. (c) pH = 2, T = 37°C.
(d) (i) Secretion of hydrochloric acid, protease enzymes and mucus; contractions of muscles churn and mix food with digestive chemicals; provides elasticity, strength and support to the stomach wall; as well as supplying muscle and epithelial cells with their requirements, the blood vessels can absorb alcohol and some other drugs from stomach contents.
(ii) The mucus protects the stomach lining from digestive action of the hydrochloric acid and various proteases.
3 (a) A: (i) Pancreas. (ii) Secretes a full range of digestive enzymes and bicarbonate solution.
B: (i) Liver. (ii) Makes bile.
C: (i) Bile duct. (ii) Delivers bile from liver to duodenum.
D: (i) Gall bladder. (ii) Stores bile.
E: (i) Duodenum. (ii) Continued chemical digestion of major food groups.
(b) (i) This enzyme continues the amylase attack started in the mouth, converting starch into smaller disaccharide sugar molecules.
(ii) This enzyme converts small protein molecules into smaller protein molecules and single amino acid molecules.
(iii) This enzyme converts large lipid molecules into smaller molecules (e.g. large fat molecules are converted to smaller glycerol and fatty acid molecules).
(iv) Neutralises stomach acidity to restore a pH of 7.
(c) Bile breaks up lipid drops, presenting a much larger surface area for lipase attack.
4 (a) Amino acids, monosaccharides, glycerol, fatty acids.
(b) Absorbed into the blood.
5 By reabsorbing water from the large intestine contents, body cell water balance is maintained.

ANSWERS

3.2 Digestion and absorption in the small intestine

1 (a) Secretes digestive enzymes to complete chemical digestion.
(b) Absorption of small molecules (the products of digestion) into the blood.
2 (a) High surface area. (b) Highly vascularised.
(c) Presence of secretory intestinal glands (*or* thin, one-cell thick layer between blood and food particles).
3 Diffusion and active transport.
4 (a) Blood enters villus to pick up digested food particles (amino acids, monosaccharides).
(b) Lymph enters villus to pick up glycerol and fatty acids.
5 (a) (i) High. (ii) Low. (b) (i) Low. (ii) High. (c) (i) Low. (ii) High.
(d) (i) Low. (ii) High. (e) (i) Low. (ii) High. (f) (i) Low. (ii) High.
6 Glycerol, fatty acids.
7 (a) Alimentary. (b) Stomach. (c) Large. (d) Villi. (e) Microvilli. (f) Surface. (g) Blood. (h) Lymph.
(i) Small. (j) Enzymes. (k) Carbohydrates. (l) Proteins. (m) Lipids.

3.3 The circulation of blood in a mammal

1 A: (a) Caval vein. (b) Carries deoxygenated blood from body to heart.
B: (a) Right atrium. (b) Receives deoxygenated blood from body veins.
C: (a) Right ventricle. (b) Pumps deoxygenated blood to lungs.
D: (a) Pulmonary artery. (b) Carries deoxygenated blood to lungs.
E: (a) Pulmonary vein. (b) Carries oxygenated blood from lungs to heart.
F: (a) Left atrium. (b) Receives oxygenated blood from lungs.
G: (a) Left ventricle. (b) Pumps oxygenated blood to body.
H: (a) Aorta. (b) Carries oxygenated blood to body.
2 Red = pulmonary vein → left atrium → left ventricle → aorta;
Blue = vena cava → right atrium → right ventricle → pulmonary artery.
3 Needs to pump oxygenated blood to body extremities and back to heart.
4 Prevent backflow of blood.
5 (a) (i) Away from heart. (ii) None (except within the heart). (iii) Yes — thick.
(iv) Thick muscular walls help flow of blood away from heart under high pressure.
(b) (i) Yes — especially along length of inferior vena cava. (ii) Low. (iii) Valves and contractions of surrounding skeletal muscle help flow of blood towards heart under low pressure.
(c) (i) From arteriole to vein. (ii) None. (iii) High. (iv) Exchange of materials between blood and body cells.
6 Prevent backflow of blood trying to return to heart against gravity and with low blood pressure.
7 Arteries: contraction of left ventricle; expansion and contraction of artery walls.
Veins: skeletal muscle contraction; valves.
8 (a) Capillaries have a very high surface area to volume ratio; capillaries are thin-walled vessels, being only one cell thick; every tissue cell is in direct contact with a blood capillary.
(b) Any three of the following: oxygen; glucose; amino acids; water; minerals; vitamins.
9 (a) Carry oxygen. (b) Fight disease and infection. (c) Play a role in clotting of blood.
(d) Carries dissolved nutrients to cells and metabolic wastes to sites of removal.
10 High surface area to maximise oxygen transport as oxy-haemoglobin on cell surface.
11 (a) The high surface area of red blood cells; a high number of red cells per 100 cm^3 blood; a high number of haemoglobin molecules per cell.
(b) (i) The mammal, since its blood has the highest oxygen-carrying capacity ensuring a good supply of oxygen to muscle cells.
(ii) The squid (or earthworm), since its blood does not carry much oxygen and this minimises activity in muscle cells (the rate of cellular respiration in muscle cells would be low).
(c) When haemoglobin is located on a cell surface, more pigment (haemoglobin) molecules can be carried per unit volume of blood and the oxygen-transporting capacity of the blood is correspondingly increased. (Also such a high concentration of haemoglobin protein in the plasma would cause osmotic imbalances between the body cells and the blood.)

3.4 The circulation of lymph in a mammal

1 (a) Swell up. (b) Oxygen, glucose, amino acids and (water, vitamins, minerals).
(c) Red blood cells in blood; different chemical composition. (d) Both contain white blood cells.
2 (a) Valves; blind-ended; lymph nodes.
(b) Both have walls, one cell thick.
3 Skeletal muscles contract and press on lymph vessels, forcing lymph along. Valves direct flow.
4 (a) In lymph nodes (glands). (b) To engulf and destroy foreign invaders (e.g. micro-organisms).
(c) The lymph nodes (glands), because of their 'maze-like' structure, trap foreign particles (germs, dust), allowing time for lymphocyte attack.
5 (a) To draw excess fluids away from tissues.
(b) To defend the body against infection (*or* to transport products of lipid digestion).

3.5 Respiration and the alveolus gas exchange surface

1 L = larynx; T = trachea; B = bronchus; BT = bronchiole tubes; A = alveolus; D = diaphragm; X = blood capillary.