

- i) Epidermis
ii) Dermis
iii) Subcutaneous layer
iv) Pacinian corpuscle (pressure)
v) Free nerve endings (pain and temperature)
vi) Meissner's corpuscle (touch)

Change	Consequence
1. Rise in body temperature.	Sweating, or flushing of the skin by vasodilation, to lower it.
2. Carbon dioxide level in the blood rises.	Increased ventilation to remove it from the blood.
3. Your hand touches a hot iron.	Contraction of arm muscles to remove hand from the heat.

4: HOMEOSTASIS

Terminology

- (i) *behaviour* – how an organism responds or reacts to a stimulus.
- (ii) *concentration* – refers to the amount of a substance (solute) in a solution.
- (iii) *dynamic* – not still, constantly moving.
- (iv) *effector* – a structure which carries out a response that counteracts the effect of the stimulus.
- (v) *excretion* – removal of cell wastes.
- (vi) *feedback loop* – a feedback circuit that modifies the original stimulus in order to achieve a steady state system.
- (vii) *homeostasis* – the maintenance of a constant internal environment.
- (viii) *hormone* – a chemical produced from an endocrine gland which affects the functioning of the body in some way.
- (ix) *lipolysis* – refers to the breakdown of lipids into fatty acids and glycerol. These products are then available for cellular respiration.
- (x) *metabolism* – refers collectively to all the chemical reactions that occur in the body. There are two types of metabolic reactions. – anabolism in which molecules are built, e.g. protein synthesis, and catabolism in which molecules are broken down, e.g. respiration.
- (xi) *nephron* – the unit of filtration in the kidney.
- (xii) *optimum* – the best or most suitable condition for functioning.
- (xiii) *physiology* – how the body functions or works.
- (xiv) *receptor* – a specialised cell or nerve ending which detects a change in the internal or external environment.
- (xv) *response* – how the body reacts to a stimulus or what the effector does.
- (xvi) *steady state system* – is a self-regulating system which constantly monitors aspects of the internal environment and notifies the appropriate body systems so that changes can occur to return the situation to the original or optimum level.
- (xvii) *stimulus* – a change in either the internal or external environment that triggers a response in the body.
- (xviii) *tolerance limit* – the limit of an environmental factor an organism can withstand before suffering physiological stress leading to death.

Review Questions

- Nervous, endocrine.
- Homeostasis ensures that: (a) various substances dissolved in the fluids of the body are maintained at optimum concentrations, (b) body temperature stays around 37°C, (c) the volume of the liquids and thus the

pressure gradients in the body stay relatively constant.

3. Temperature, water level, pH, blood sugar levels, oxygen levels, ion concentrations.
4. A steady state control system or feedback system is a self-regulating system which continuously monitors aspects of the internal environment and notifies the appropriate body systems so that changes can occur to return the situation to the optimum level.
5. Stimulus – the change in the environment that alerts the system and initiates it to take action.
 Receptor – detects the change in the internal or external environment, e.g. taste bud.
 Regulator or modulator – is the control mechanism, it processes information from the receptor and directs the effector's action.
 Effector – is a structure which carries out a response counteracting the effect of the stimulus, e.g. muscle, endocrine gland.
 Response – what the effector does, e.g. a muscle contracts, or a gland secretes more hormone.
 Feedback – modifies the original stimulus in order to achieve a steady state.
6. In positive feedback the stimulus enhances or increases the original stimulus. It is used for conditions that do not need to be constantly fine tuned or do not happen very often, e.g. labour in child birth. Negative feedback reverses the original stimulus. It is used when conditions or situations need constant monitoring and adjustment, e.g. body temperature, blood glucose levels.
7.
 - (a) The metabolic rate is the rate at which heat is produced by the oxidation of food in cells. Given as kilojoules/square metre of body surface/hour.
 - (b) Exercise, hormones, body temperature, age, ingestion of food, sex, stress, climate, sleep, malnutrition, illness (fever).
 - (c) An increase in the metabolic rate causes an increase in the rate at which food is oxidised in the cells. This releases a lot of heat energy and hence body temperature rises.
8. Hypothalamus.
- 9.

Mechanisms to produce or retain heat	Mechanisms to lose heat
Shivering. Vasoconstriction of blood vessels in skin. Increased metabolic reactions. Behavioural, e.g. wear more clothes, eat hot food.	Sweating. Vasodilation of blood vessels in skin. Behavioural, e.g. swimming, sitting in breeze.

10.
 - (a) Sweating cools the body when the water evaporates from our skin. For water to evaporate heat is needed to change the water molecules from a liquid to a gas (or vapour). This heat is obtained from our skin and the body temperature drops.
 - (b) On humid days, the amount of water vapour already in the air is high. Therefore water will not evaporate readily. Under these conditions you do not cool down efficiently and can feel quite uncomfortable. When conditions are dry, however, evaporation occurs rapidly, thus cooling the body.
 - (c) New born babies are wet and have no temperature control so need to be dried to reduce the effects of evaporation and wrapped to keep them warm.
11.
 - (a) Radiation is the continual loss of heat from a body that is warmer than its surroundings. No physical contact between the body and its surroundings is necessary for this heat loss to occur, e.g. when we are warmed by radiation from the sun or a fire.
 - (b) Conduction is the transfer of heat to another object by contact. Heat will move from the warmer object into the cooler object. E.g. cold hands are warmed when they are wrapped around a hot cup.
 - (c) Convection refers to the process in which air next to the body is heated, moves away and is replaced by cool air. This in turn is heated too and moves away.
12. Vasodilation - blood vessels in skin (arterioles) expand because smooth muscles relax and blood flow through them is increased - skin goes red. Vasoconstriction - blood vessels in skin (arterioles) reduce in size because smooth muscles contract (diameter decreases) and blood flow through them is reduced. Skin turns pale.
13. Shivering is the very rapid contraction and relaxation of skeletal muscles. It is initiated by the hypothalamus. These contractions are not used in moving parts of the body so the heat generated by the metabolic reactions involved contributes to the internal heat of the body.
14.
 - (a) (i) Insulin. (ii) Glucagon.
 - (b) (i) Insulin increases uptake of glucose into cells, stimulates formation of glycogen from glucose, converts glucose into fat, increases protein synthesis, (ii) glucagon stimulates breakdown of glycogen to glucose, stimulates gluconeogenesis.
15. The liver stores glycogen and converts it to glucose when required. The pancreas produces insulin (from the beta cells in the islets of Langerhans). Insulin lowers the level

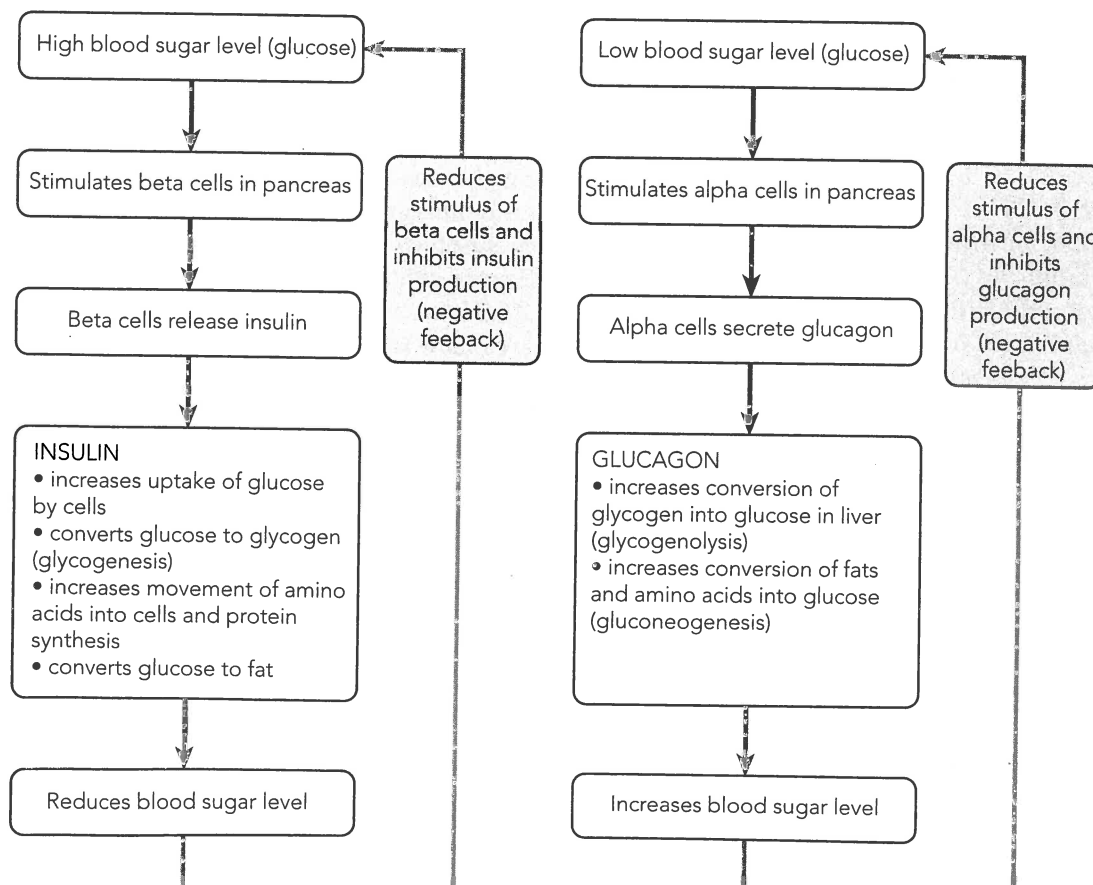
of glucose in the blood. The pancreas also produces glucagon (from the alpha cells in the islets of Langerhans). This raises the level of glucose in the blood.

16.
 - (a) Glycogenesis – formation of glycogen from glucose.
 - (b) Glycogenolysis – the breakdown of glycogen into glucose (occurs in the liver).
 - (c) Gluconeogenesis – the synthesis of glucose from lipids and amino acids (occurs in the liver).
17. (a) Low. (b) High (because stored glycogen is released over the night).
18. See diagram below.
19.
 - (a) These are both eating disorders which result in less food being ingested. If there is less food in the diet, then there is less glucose in the blood available for respiration.
 - (b) Less water and nutrients can be absorbed. This affects the water levels in the plasma and other body fluids, as well as the nutrition of the body.
20.
 - (a) Plasma is the liquid portion of the blood and is found in blood vessels. Lymph is a liquid found inside lymph vessels. It does not contain red blood cells or platelets and usually has a low protein concentration
 - (b) Intracellular fluid is the fluid inside cells (about 50% of our body weight).

Extracellular fluid is all the fluid found in the body outside cells, e.g. tissue fluid, plasma, lymph, cerebrospinal fluid, etc. (about 20% of our body weight).

21. Plasma, lymph and intercellular fluid (also called interstitial or tissue fluid).
22. Urine is the fluid that is produced by the kidneys. It contains unwanted or excess water and other substances such as urea, creatinine, uric acid, and inorganic ions such as sodium, chloride, potassium, sulfates, hydrogen, phosphates, ammonium, magnesium and calcium. It is approximately 96% H₂O, 2% urea and 2% salts.
23. Plasma contains all the substances listed above as well as proteins such as fibrinogen, antibodies, enzymes and hormones; nutrients, vitamins and gases.
24.
 - (a) The movement of water through a semi-permeable (differentially-permeable) membrane creates a pressure or force called the osmotic pressure. It is due to a difference in concentration of solute on either side of the membrane. Increasing the concentration of solutes on one side of the membrane will increase the osmotic pressure as water will move towards that side. Diluting a solution will lower the osmotic pressure.
 - (b) Drinking lots of liquid or the absence of anti-diuretic hormone (ADH).
 - (c) Increased sweating due to exercise, loss of

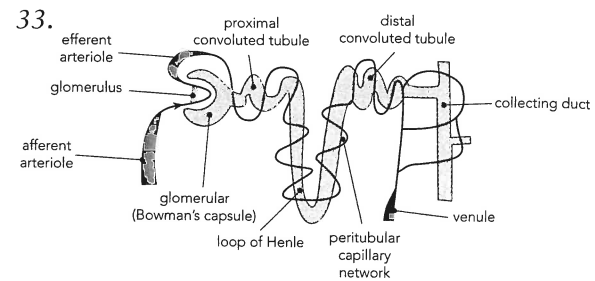
18.



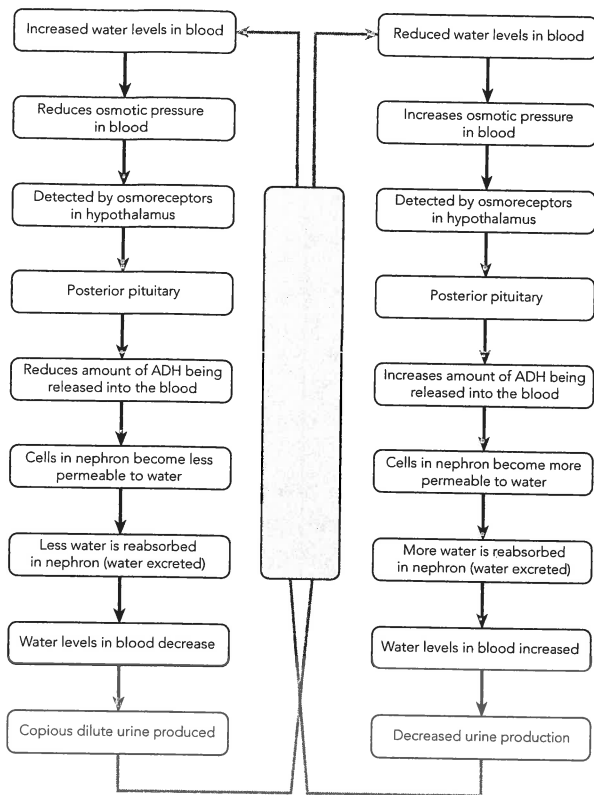
- fluids due to bleeding, burns, diarrhoea.
25. Diuretics are substances that increase urine production and therefore water loss from the body, e.g. caffeine – inhibits the reabsorption of sodium ions; alcohol – inhibits the secretion of antidiuretic hormone.
- 26.
- (a) An average around 180 L (125–130 mL/minute).
- (b) 1200 – 1500 mL/day.
- (c) It is reabsorbed back into the body via the nephrons.
27. From the food we eat and also from the process of cellular respiration (metabolic water).
28. Urea is a nitrogenous waste formed in the liver. There the deamination of amino acids produces the highly toxic substance, ammonia. Carbon dioxide combines with it to form the much less poisonous substance, urea, which is a soluble organic salt of small molecular size easily transported in the blood and eliminated via the kidneys. If it was not removed, it would poison us.
29. (a) hypothalamus, (b) thirsty, (c) thirst reflex, increased secretion of antidiuretic hormone (ADH).
- 30.

Metabolic Wastes	Excretory Organ
carbon dioxide	lungs
water	kidneys, skin, lungs
nitrogenous wastes (urea, creatinine)	kidneys, skin
inorganic salts	kidneys, skin
heat	skin, lungs, kidneys

31. The kidneys regulate the composition and volume of blood. Wastes are removed in the form of urine. Wastes include excess water, nitrogenous substances from protein catabolism (such as urea), hydrogen ions, and inorganic ions (electrolytes) such as sodium, chloride and potassium.
- 32.
- (a) a. renal vein i. adrenal gland
 b. right kidney j. urethra
 c. renal artery k. renal pyramid in medulla
 d. aorta l. renal capsule
 e. ureter m. renal pelvis/calyx
 f. bladder n. renal cortex
 g. vena cava
 h. left kidney
- (b) glucose
- (c) urea
- (d) urine
- (e) increase in volume, decrease in concentration.



33. Glomerular (Bowman's) capsule, proximal convoluted tubule, loop of Henle, distal convoluted tubule, collecting duct.
34. Filtration means the separation of materials on the basis of the size of particles. In the kidney it refers to the movement of some substances of small molecular size from the glomerulus into the glomerular capsule to form the filtrate.
- (b) Water, glucose, amino acids, ions (sodium, chloride, potassium, bicarbonate) urea, uric acid, vitamin C.
- (c) Blood cells and plasma proteins.
- (d) (i) The glomerular capillaries are very long providing a large surface area.
 (ii) The membranes through which the substances pass are very thin and porous.
 (iii) The blood pressure in the glomerulus is high as the afferent arteriole has a larger diameter than the efferent arteriole.
- 36.
- (a) Selective reabsorption refers to the movement of substances by both active and passive processes from the filtrate (in the nephron) back into the blood.
- (b) Water, glucose, ions (sodium, potassium, chloride, bicarbonate) amino acids and a little urea.
- (c) Proximal convoluted tubule – reabsorbs glucose, amino acids, urea, ions (sodium, potassium, chloride, bicarbonate), water.
 Loop of Henle – water, sodium, potassium and chloride ions.
 Distal convoluted tubule – sodium, chloride, bicarbonate ions, glucose and water.
 Collecting duct – sodium ion under the influence of aldosterone, chloride ion and urea and water under the influence of antidiuretic hormone.
- 37.
- (a) Tubular secretion refers to the movement of substances from the blood into the filtrate in the nephron.
- (b) Ions (such as hydrogen, potassium, and ammonium), creatinine, uric acid and some drugs such as penicillin.
- (c) Distal convoluted tubules.
- (d) Secretion removes unwanted substances from the blood, and helps to control blood pH.



39.

- (a) Dialysis is a process of separating large particles from small particles by a differentially-permeable (semi-permeable) membrane.
- (b) In an artificial kidney machine, a tube made of cellophane (acting as a semi-permeable membrane), is connected to an artery on the patient (usually the radial artery in the arm). This tube is bathed in a special solution that is constantly replaced. The solution is warm and contains a carefully balanced mixture of substances such as glucose, amino acids and ions. This maintains a concentration gradient between the solution and the blood which causes waste materials to leave the blood. The blood minus the waste materials then flows back into the body via a vein. This form of dialysis is known as haemodialysis. More commonly used by patients at home is Continuous Abdominal Peritoneal Dialysis (CAPD). This involves a tube being connected into the belly, into the peritoneal space and the urea that has collected there, being flushed out of the abdominal cavity.
- (c) As the kidney is from another person, the body into which the kidney has been transplanted recognizes it as foreign. Then the immune system reacts as if it was pathogenic and tries to get rid of it. (Infections are also possible at the site of dialysis either haemodialysis in the arm or CAPD in the belly). Patients with transplants have to take immunosuppressant drugs to prevent rejection of the kidney and this can then reduce their immune response to

other antigens making them more susceptible to other diseases. A combination of drugs is used to reduce the chances of rejection. These could include tacrolimus, prednisone, azathioprine and micophenolate.

40.

Receptor	Where found	Function
Aortic body	Aorta	Chemoreceptor – monitors the concentration of carbon dioxide and oxygen in the blood.
Carotid body	Carotid artery	Chemoreceptor – monitors the concentration of carbon dioxide and oxygen in the blood.

41. Adrenalin produces effects similar to the sympathetic nervous system, i.e. it increases blood pressure by increasing heart rate and constricting blood vessels, increases sweating, causes dilation of pupils and decreases activity of the gut and glands. It stimulates metabolism, lipolysis and glycogenolysis, increases blood sugar level and increases production of ATP.

42.

- (a) The number of alveoli decrease and their walls collapse producing fewer and bigger air sacs.
- (b) As there are less alveoli, the total surface area thorough which gases could exchange is a lot smaller. As blood is moving more slowly through the lungs due to the collapse of lung tissue, less gas can be exchanged. With fibrosis, the elasticity of the lungs is affected and they do not expand as much as they used to, which also decreases gas exchange.
- (c) Stop smoking, avoid air pollution.

5. RESPONSE TO INFECTION

5.1 Bacteria and Viruses

Terminology

- (i) aerobic – uses or needs oxygen.
- (ii) agar – a jelly produced from seaweed used to culture or grow microorganisms.
- (iii) anaerobic – does not need or use oxygen.
- (iv) autotrophic – makes its own food, a producer.
- (v) bacteria – single celled microorganisms with no membrane-bound organelles. Many are harmless, many are decomposers but some cause diseases in humans.
- (vi) binary fission – how bacteria reproduce: when one cell divides into two identical cells.
- (vii) contaminate – means to pollute or infect.