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QUESTIONS AND SOLUTIONS: BIOLOGY

Questions 1 to 3 refer to the information given in the table below. The table shows the rate of blood flow through different parts of the body as increasingly strenuous exercises are carried out. Study the information and answer the questions.

Part of body	Blood flow in cm^3 per minute			
	At rest	Light exercise	Strenuous exercise	Maximum exercise
Brain	750	750	750	750
Skin	500	1500	1900	600
Heart Muscle	250	350	750	1000
Skeletal muscle	1200	4500	12500	22000
Kidneys	1100	900	600	250
Small intestine	1400	1100	600	300
Other	600	400	400	100

1. Which conclusion based on the above results is correct?

   1 Man's brain activities are reduced with increasing strenuous exercise

   2 Less waste material is formed during more strenuous exercise and filtered through the kidneys

   3 More blood flows to the muscles and less to the digestive organs during increasingly strenuous exercise

   4 During more strenuous exercise, more oxygen is directed towards the muscles than to the lungs

Answer: 3

The neurons of the brain constantly require a lot of energy. Although the brain represents only 2% of the body weight, it receives 15% of the cardiac output, 20% of total body oxygen consumption, and 25% of total body glucose utilization. Thus, blood supply to the brain is never sacrificed, as evident from the table!

Heat is produced in large amounts by physiological oxidative reactions and even more so during strenuous activity, and the blood is essential for its distributing and disposing of this heat. The circulation assures relative uniformity of temperature throughout the body and also carries the warm blood to the surface, where heat is lost to the external environment. A heat-regulating centre in the hypothalamus of the brain functions much like a thermostat. It is sensitive to changes in temperature of the blood flowing through it and, in response to the changes, gives off nerve impulses that control the diameter of the blood vessels in the skin and thus determine blood flow and skin temperature. A rise in skin temperature

increases heat loss from the body surface. Heat is continuously lost by evaporation of water from the lungs and skin, but this loss can be greatly increased when more water is made available from the sweat glands. The activity of the sweat glands is controlled by the nervous system under direction of the temperature-regulating centre. Constancy of body temperature is achieved by control of the rate of heat loss by these mechanisms.

2. Why is more blood transported to the skin during strenuous exercise?

   1 To make sweat glands more active
   2 To radiate less heat
   3 To excrete more waste products formed during exercise
   4 To take in more oxygen

Answer: 1 (Encyclopaedia Britannica)

The following is an expansion to the detailed explanation given in Question 1.

As the interface with the surroundings, skin plays the most important role in protecting (the body) against pathogens. Its other main functions are insulation and temperature regulation, sensation, and synthesis of vitamin D. Humans have 2,000,000 to 5,000,000 eccrine sweat glands, with an average distribution of 150 to 340 per square centimetre of skin. They are most numerous on the palms and soles and then, in decreasing order, on the head, trunk, and extremities. Some individuals have more glands than others, but there is no difference in number between men and women. The specific function of sweat glands is to secrete water upon the surface so that it can cool the skin when it evaporates. The purpose of the glands on the palms and soles, however, is to keep these surfaces damp, to prevent flaking or hardening of the horny layer, and thus to maintain tactile sensibility. A dry hand does not grip well and is minimally sensitive. The eccrine glands, then, can be divided into those that respond to thermal stimulation, the function of which is thermoregulation, and those that respond to psychological stimuli and keep friction surfaces moist. When the body temperature rises, the sympathetic nervous system stimulates the eccrine sweat glands to secrete water to the skin surface, where it cools the body by evaporation. Thus, eccrine sweat is an important mechanism for temperature control. In extreme conditions, human beings may excrete several litres of such sweat in an hour.

3. Which blood vessel transports oxygenated blood from the lungs to the heart?

   1 Aorta
   2 Pulmonary artery
   3 Pulmonary vein
   4 Coronary artery

Answer: 3 (Encyclopaedia Britannica)

A vein is any of the vessels that, with four exceptions, carry oxygen-depleted blood to

the right upper chamber (atrium) of the heart. The four exceptions—the pulmonary veins —transport oxygenated blood from the lungs to the left upper chamber of the heart. The oxygen-depleted blood transported by most veins is collected from the networks of microscopic vessels called capillaries by thread-sized veins called venules. As in the arteries, the walls of veins have three layers, or coats: an inner layer, or tunica intima; a middle layer, or tunica media; and an outer layer, or tunica adventitia. Veins are more numerous than arteries and have thinner walls owing to lower blood pressure. They tend to parallel the course of arteries.

4. Why doesn't blood clot in the bags stored at the Blood Transfusion Service?

   1 It is not in contact with oxygen
   2 It is kept at human body temperature
   3 A substance like heparin is added to the blood in the bags
   4 Thrombin is added to the blood in the bags

Answer: 3 (Encyclopaedia Britannica)

Heparin is an anticoagulant drug that is used to prevent blood clots from forming during and after surgery and to treat various heart, lung, and circulatory disorders in which there is an increased risk of blood clot formation. Discovered in 1922 by American physiologist William Henry Howell, heparin is a naturally occurring mixture of mucopolysaccharides that is present in the human body in tissues of the liver and lungs. Most commercial heparin is obtained from cow lungs or pig intestines. Heparin was originally used to prevent the clotting of blood taken for laboratory tests. Its use as a therapy for patients who already have a blood clot in a vein (venous thrombosis) began in the 1940s; low-dose heparin treatment to prevent blood clots from forming in patients who are at high risk for pulmonary embolisms and other clotting disorders was introduced in the early 1970s.

Coagulation is the replacement of a relatively unstable platelet plug with a stronger, more resilient blood clot through a series of interdependent, enzyme-mediated reactions that bring about the generation of *thrombin;* a coagulation enzyme, a serine protease (EC 3.4.21.5) that converts soluble fibrinogen into insoluble strands of fibrin, as well as catalyzing many other coagulation-related reactions. The intrinsic and the extrinsic pathways of coagulation are involved in regulating coagulation; each is activated by a different trigger, although they share many steps in the course of the generation of *thrombin*. All the components necessary for the clotting process to proceed are found in the blood. As such, the proteins required for such clotting to take place are part of the intrinsic pathway of blood coagulation. This pathway involves a series of proteins, protein cofactors, and enzymes, which interact in reactions that

take place on membrane surfaces. These reactions are initiated by tissue injury and result in the formation of a fibrin clot.

5. Which fluid is different from the other fluids with regard to composition?

1 Lymph
2 Saliva
3 Tissue fluid
4 Blood plasma

Answer: 2 (Encyclopaedia Britannica)

Lymph is the pale fluid that bathes the tissues of an organism, maintaining fluid balance, and removes bacteria from tissues; it enters the blood system by way of lymphatic channels and ducts. Prominent among the constituents of lymph are lymphocytes and macrophages, the primary cells of the immune system with which the body defends itself from invasion by foreign microorganisms. Lymph is conveyed from the tissues to the venous bloodstream via the lymphatic vessels. On the way, it is filtered through the lymphatic organs (spleen and thymus) and lymph nodes. Although the primary function of the lymphatic system is to return proteins and fluids to the blood, this immune function accounts for the tendency of many infections and other disease processes to cause swelling of the lymph nodes. Bacteria, allergenic particles, and cancerous cells from elsewhere in the body that have collected in the nodes stimulate lymphocyte proliferation, thereby greatly enlarging the node. Interference with lymphatic flow may cause an accumulation of fluid in the tissues that are drained by the blocked vessel, producing tissue swelling known as lymphedema.

Plasma is the liquid portion of blood. Plasma serves as a transport medium for delivering nutrients to the cells of the various organs of the body and for transporting waste products derived from cellular metabolism to the kidneys, liver, and lungs for excretion. It is also a transport system for blood cells, and it plays a critical role in maintaining normal blood pressure. Plasma helps to distribute heat throughout the body and to maintain homeostasis, or biological stability, including acid-base balance in the blood and body. Plasma is derived when all the blood cells—red blood cells (erythrocytes), white blood cells (leukocytes), and platelets (thrombocytes)—are separated from whole blood. The remaining straw-coloured fluid is 90–92 percent water, but it contains critical solutes necessary for sustaining health and life. Important constituents include electrolytes such as sodium, potassium, chloride, bicarbonate, magnesium, and calcium. In addition, there are trace amounts of other substances, including amino acids, vitamins, organic acids, pigments, and enzymes. Hormones such as insulin, corticosteroids, and thyroxine are secreted into the blood by the endocrine system. Plasma concentrations of hormones must be carefully regulated for good health. Nitrogenous wastes (e.g., urea and creatinine) transported to the kidney for

excretion increase markedly with renal failure. Plasma contains 6–8 percent proteins. One critical group is the coagulation proteins and their inhibitors, synthesized primarily in the liver. When blood clotting is activated, fibrinogen circulating in the blood is converted to fibrin, which in turn helps to form a stable blood clot at the site of vascular disruption. Coagulation inhibitor proteins help to prevent abnormal coagulation (hypercoagulability) and to resolve clots after they are formed. When plasma is allowed to clot, fibrinogen converts to fibrin, trapping the cellular elements of blood. The resulting liquid, devoid of cells and fibrinogen, is called serum. Biochemical testing of plasma and serum is an important part of modern clinical diagnosis and treatment monitoring. High or low concentrations of glucose in the plasma or serum help to confirm serious disorders such as diabetes mellitus and hypoglycemia. Substances secreted into the plasma by cancers may indicate an occult malignancy; for instance, an increased concentration of prostate-specific antigen (PSA) in a middle-aged asymptomatic man may indicate undiagnosed prostate cancer. Serum is the portion of plasma remaining after coagulation of blood, during which process the plasma protein fibrinogen is converted to fibrin and remains behind in the clot. Antiserum, which is prepared from the blood of animals or humans that have been exposed to a disease and have developed specific antibodies, is used to protect persons against disease to which they have been exposed.

Interstitial fluid (or tissue fluid, or intercellular fluid) is a solution which bathes and surrounds the cells of multicellular animals. It is the main component of the extracellular fluid, which also includes plasma and transcellular fluid. Plasma and interstitial fluid are very similar. Plasma, the major component in blood, communicates freely with interstitial fluid through pores and intercellular clefts in capillary endothelium. Interstitial fluid consists of a water solvent containing amino acids, sugars, fatty acids, coenzymes, hormones, neurotransmitters, salts, as well as waste products from the cells. The composition of tissue fluid depends upon the exchanges between the cells in the tissue and the blood. This means that tissue fluid has a different composition in different tissues and in different areas of the body. Not all of the contents of the blood pass into the tissue, which means that tissue fluid and blood are not the same. Red blood cells, platelets and plasma proteins cannot pass through the walls of the capillaries. The resulting mixture that does pass through is essentially blood plasma without the plasma proteins. Tissue fluid also contains some types of white blood cell, which help combat infection. Lymph is considered a part of the interstitial fluid. The lymphatic system returns protein and excess interstitial fluid to the circulation.

Saliva is the thick, colourless, opalescent fluid that is constantly present in the mouth of humans and other vertebrates. It is

composed of water, mucus, proteins, mineral salts, and amylase. As saliva circulates in the mouth cavity it picks up food debris, bacterial cells, and white blood cells. One to two litres of fluid are excreted daily into the human mouth. Three major pairs of salivary glands and many smaller glands scattered in the surface tissue of the cheeks, lips, tongue, and palate contribute to the total amount of saliva. Small amounts of saliva are continually being secreted into the mouth, but the presence of food, or even the mere smell or thought of it, will rapidly increase saliva flow. The functions of saliva are numerous. Primarily, it lubricates and moistens the inside of the mouth to help with speech and to change food into a liquid or semisolid mass that can be tasted and swallowed more easily. Saliva helps to control the body's water balance; if water is lacking, the salivary glands become dehydrated, leaving the mouth dry, which causes a sensation of thirst and stimulates the need to drink. Saliva reduces tooth decay and infection by removing food debris, dead cells, bacteria, and white blood cells. It also contains small amounts of the digestive enzyme amylase, which chemically breaks down carbohydrates into simpler compounds.

6. Pearl divers can stay under water for more than four minutes without using SCUBA gear. From where is the oxygen obtained for the respiration process?

1 Their lungs
2 The water
3 The blood plasma
4 They have many red blood cells

Answer: 4 (Encyclopaedia Britannica/ Wikipedia)

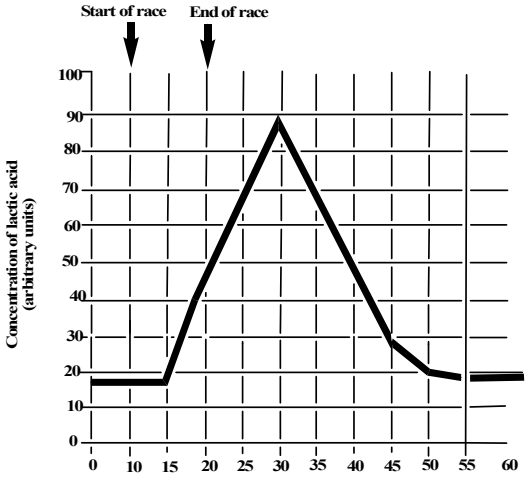
Continuous diving and holding one's breath for longer periods results in the body making more red blood cells to hold more oxygen. This is similar to altitude training, a practice by some endurance athletes of training at high altitude, usually over 2,500 m (8,000 ft) above sea level, for several weeks. At this altitude although the air still contains approximately 20.9% oxygen, the barometric pressure and thus the partial pressure of oxygen is reduced. The body adapts to the relative lack of oxygen by increasing the concentration of red blood cells and haemoglobin. Proponents claim that when such athletes return to sea level (where they are competing) they will still have a higher concentration of red blood cells for 10-14 days.

Before the beginning of the 20th century, the only means of obtaining pearls was by searching through oysters manually gathered and opened at random on the ocean floor or on lake or river bottoms. Free-divers were often forced to descend to depths of over 100 feet on a single breath, exposing them to the dangers of hostile creatures, waves, and drowning, often as a result of deep water blackout on resurfacing. Often, because of these dangers, divers

were slaves or of low social status (which is also true of many fisherfolk around the world). Because of the difficulty of diving and the unpredictable nature of natural pearl growth in oysters, pearls of the time were extremely rare and of varying quality. Today, pearl diving has largely been supplanted by cultured pearl farms, which use a process developed by Japanese entrepreneur Kokichi Mikimoto. Particles implanted in the oyster encourage the formation of pearls, and allow for more predictable production. Today's cultured pearl industry produces millions of high quality pearls every year.

Study the following information and answer questions 7 to 10.

The concentration of lactic acid in the blood of an athlete was measured at intervals before, during and after a long distance race which lasted 10 minutes.



7. For how long did the concentration of lactic acid continue to increase after the end of the race?

1 10 minutes
2 15 minutes
3 20 minutes
4 30 minutes

Answer: 1 (Encyclopaedia Britannica)
Also called α-hydroxypropionic acid, or 2-hydroxypropanoic acid, lactic acid is an organic compound (formula $CH_3CH(OH)COOH$) belonging to the family of carboxylic acids, present in certain plant juices, in the blood and muscles of animals, and in the soil. It is the commonest acidic constituent of fermented milk products such as sour milk, cheese, and buttermilk. In muscle cells functioning vigorously in the absence of adequate supplies of oxygen, pyruvate, derived from the breakdown of glucose for ATP generation (glycolysis) is reduced to lactate via a reaction catalyzed by lactate dehydrogenase.

8. Why didn't the concentration of lactic acid increase during the first 5 minutes of the race?

1 The athlete started slowly and gradually ran faster
2 The athlete inhaled deeply and no oxygen debt was built up
3 There was enough water in the blood to bread down the lactic acid
4 There was no lactic acid formed because enough

oxygen was available in the muscles

Answer: 4 (Wikipedia)

In animals, L-lactate is constantly produced from pyruvate via the enzyme lactate dehydrogenase (LDH) in a process of fermentation during normal metabolism and exercise. It does not increase in concentration until the rate of lactate production exceeds the rate of lactate removal which is governed by a number of factors including: monocarboxylate transporters, concentration and isoform of LDH and oxidative capacity of tissues. The concentration of blood lactate is usually 1-2 mmol/L at rest, but can rise to over 20 mmol/L during intense exertion.

9. How long after the race did the concentration of lactic acid take to reach the normal level again?

    1 20 minutes
    2 25 minutes
    3 30 minutes
    4 35 minutes

Answer: 4

The race ended after 20 minutes but the lactate concentration only reached the normal/original levels after 55 minutes.

10. What can the athlete do to prevent a build-up of lactic acid in the muscles?

    1 Drink more water during the race
    2 Train more often and use a training programme
    3 Change the diet
    4 Warm up before a race

Answer: 2 (Wikipedia)

During power-intensive exercises such as sprinting, when the rate of demand for energy is high, lactate is produced faster than the ability of the tissues to remove it and lactate concentration begins to rise. This is a beneficial process since the regeneration of NAD^+ ensures that energy production is maintained and exercise can continue. The increased lactate produced can be removed in a number of ways including (i) oxidation to pyruvate by well-oxygenated muscle cells which is then directly used to fuel the citric acid cycle and (ii) conversion to glucose via the Cori cycle in the liver through the process of gluconeogenesis.

To physically adapt, the athlete should undergo endurance training. This induces many physiological adaptations both centrally and peripherally mediated. Central cardiovascular adaptations include decreased heart rate, increased red blood cell count, increased blood plasma which reduces blood viscosity and increased cardiac output. Adaptations of the peripheral include an increase in the surface area that both the venous and arterial capillaries supply. This also allows for increased heat dissipation during strenuous exercise. The

muscles heighten their glycogen and fat storing capabilities in endurance athletes in order to increase the length in time in which they can perform work.

11. Human skin can get badly sunburnt, even in winter. Which rays cause the damage?

    1 Infrared rays
    2 Heat waves
    3 Ultraviolet rays
    4 Laser beams from the sun

Answer: 3 (Encyclopaedia Britannica)

Sunburn is acute cutaneous inflammation caused by overexposure to ultraviolet (UV) radiation of the so-called UVB wavelength band (290–320 nanometre; a nanometre is 10^{-9} metre), which originates from sunlight or artificial sources. Reactions to overexposure range in severity from mild redness and tenderness to intense pain, edema (swelling), and blistering; systemic symptoms include shock, chills, fever, and nausea. The visible manifestations of sunburn usually begin within 6–12 hours after the first ultraviolet exposure and peak within 24–28 hours, followed by a gradual easing of symptoms and light tanning or "peeling" (the sloughing off of the skin), depending on the severity of the burn.

12. Which part of a neuron is responsible for the regeneration of a damaged nerve?

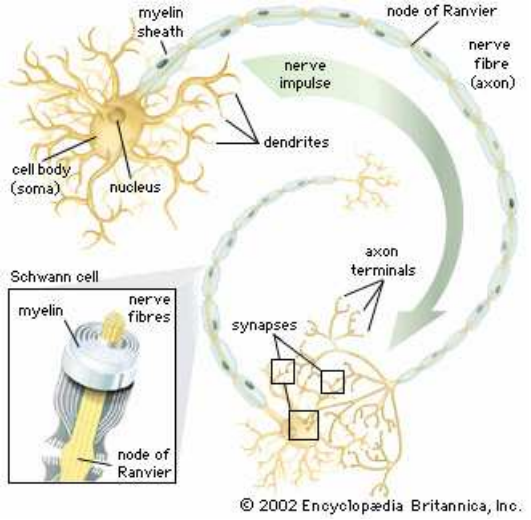
    1 Myelin sheath
    2 Axon
    3 Schwann cell
    4 Neurilemma

Answer: 4 (Encyclopaedia Britannica)

A neuron or nerve cell is the basic cell of the nervous system in vertebrates and most invertebrates from the level of the cnidarians (e.g., corals, jellyfish) upward. A typical neuron has a cell body containing a nucleus and two or more long fibres. Impulses are carried along one or more of these fibres, called dendrites, to the cell body; in higher nervous systems, only one fibre, the axon, carries the impulse away from the cell body. Bundles of fibres from neurons are held together by connective tissue and form nerves. Some nerves in large vertebrates are several feet long. A sensory neuron transmits impulses from a receptor, such as those in the eye or ear, to a more central location in the nervous system, such as the spinal cord or brain. A motor neuron transmits impulses from a central area of the nervous system to an effector, such as a muscle.

Myelin is the white, insulating sheath composed of fatty materials, protein, and water on the axon of many nerve fibres. The myelin sheath is deposited by Schwann cells in layers surrounding the nerve fibres of the central and peripheral nervous systems of many organisms. The sheath is interrupted at intervals by gaps called nodes of Ranvier; this structure speeds nerve conduction, as

impulses jump from node to node in a process known as saltatory conduction.

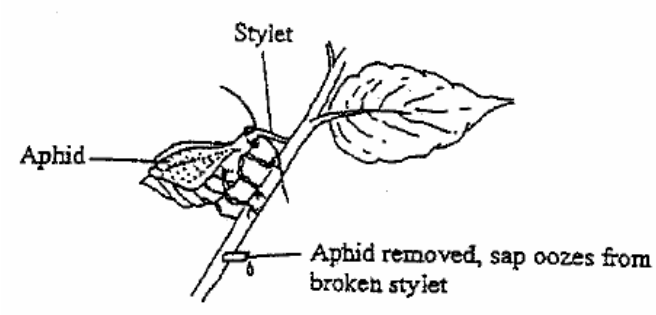


Named after the German physiologist Theodor Schwann, *Schwann cells* (also referred to as neurolemmocytes) are a variety of glial cell that mainly provide myelin insulation to axons in the peripheral nervous system of jawed vertebrates. The vertebrate nervous system relies on this myelin sheath for insulation and as a method of decreasing membrane capacitance in the axon, thus allowing for saltatory conduction to occur and for an increase in impulse speed, without an increase in axonal diameter. Non-myelinating Schwann cells are involved in maintenance of axons and are crucial for neuronal survival. Some group around smaller axons and form Remak bundles. Schwann cells are the peripheral nervous system's analogues of the central nervous system oligodendrocytes.

Neurolemma (also *neurilemma* and sheath of Schwann) is the outermost layer of nerve fibers in the peripheral nervous system. It is a nucleated cytoplasmic layer of Schwann cells that surrounds the myelin sheath of axons. Unlike the axon and the myelin sheath, the neurolemma does not degenerate after a nerve has been cut or crushed; the hollow tube formed by the neurolemma is instrumental in regenerating the nerve fiber. It is important to note that in CNS, axons are myelinated by oligodendrocytes, thus lack neurolemma.

Questions 13 to 15 refer to the information and table below.

Aphids are small insects which feed on plant sap. They have tubular mouth parts, called stylets, which are pushed through the surface of the plant's stem into the underlying tissues. Sap flows though the stylets into the aphids as shown in the diagram below. Aphids may be used to sample plant sap. If the stylet is cut near the aphid's head, the sap continues to flow out of the broken stylet.



The following table shows an analysis of the sap collected from the broken stylet.

SUBSTANCE	CONCENTRATION (in arbitrary units)
Sucrose	250
Potassium ions	80
Amino acids	40
Chloride ions	15
Phosphate ions	10
Magnesium ions	5
Sodium ions	2
ATP	0.5
Nitrate ions	0
Growth hormones	traces

13. From which plant tissue is the sample appearing in the table taken?

1 Xylem
2 Phloem
3 Epidermis
4 Cambium

Answer: 2 (Encyclopaedia Britannica)

The high sucrose and amino acid content of this fluid shows that this is not just water absorbed from the soil but that the plant has produced these solutes itself (through photosynthesis). *The phloem* (also called bast) are tissues in plants that conduct foods made in the leaves to all other parts of the plant. Phloem is composed of various specialized cells called sieve tubes, companion cells, phloem fibres, and phloem parenchyma cells. Primary phloem is formed by the apical meristems (zones of new cell production) of root and shoot tips; it may be either protophloem, the cells of which are matured before elongation (during growth) of the area in which it lies, or metaphloem, the cells of which mature after elongation. Sieve tubes of protophloem are unable to stretch with the elongating tissues and are torn and destroyed as the plant ages. The other cell types in the phloem may be converted to fibres. The later maturing metaphloem is not destroyed and may function during the rest of the plant's life in plants such as palms but is replaced by secondary phloem in plants that have a cambium.

The xylem is part of the plant vascular system that conveys water and dissolved minerals from the roots to the rest of the plant and may also furnish mechanical support. Xylem consists of specialized water-conducting tissues made up mostly of narrow, elongated, hollow cells. These cells may be of several types, including tracheids (the basic cell type), vessel members, fibres, and parenchyma. Xylem constitutes the major part of a mature woody stem or root; the wood of a tree is composed of xylem. Xylem formation begins when the actively dividing cells of growing root and shoot tips (apical meristems) give rise to primary xylem. As the growing part of the plant builds past the xylem thus formed, the vascular cambium produces secondary xylem tissues that cover the primary xylem. When this happens the primary xylem cells become dead and empty, losing their conducting function and forming a hard skeleton that serves only to support the plant. Thus, in the trunk and older branches of a large tree only the outer part of the wood (secondary xylem) serves in water conduction, while the inner part (heartwood)

is composed of dead but structurally strong primary xylem.

14. Which substance is manufactured by the plant itself?

1 Phosphate ions
2 Nitrate ions
3 Potassium ions
4 Amino acids

Answer: 4 (Encyclopaedia Britannica)

Plants, as autotrophic organisms, use light energy to photosynthesize sugars from CO_2 and water. They also synthesize amino acids and vitamins from carbon fixed in photosynthesis and from inorganic elements garnered from the environment. (Animals, as heterotrophic organisms, cannot synthesize many nutrients, including certain amino acids and vitamins, and so must take them from the environment.). Plants can make all of the amino acids required for protein synthesis, with either ammonia (NH_3) or nitrate (NO_3^-) as the nitrogen source. Some bacteria, and leguminous plants (*e.g.,* peas) that harbour such bacteria in their root nodules, are able to utilize nitrogen from the air to form ammonia and use the latter for amino-acid synthesis. Each of the 20 common amino acids is synthesized by a different pathway, the complexity of which reflects the chemical complexity of the amino acid formed.

15. Aphids are classified under which group of animals

1 Arachnida (spiders, mites and ticks)
2 Crustacea (crabs, crayfish)
3 Coleoptera (beetles, wood borers, dung beetles)
4 Insecta (insects)

Answer: 4 (Encyclopaedia Britannica)

Aphids, also known as greenfly or plant lice, are minute plant-feeding insects. Many, but far from all, aphids are monophagous (i.e. feeding only on 1 species of plant). Others, like *Myzus persicae* feed on hundreds of plant species across many families. Similarly to related families, aphids passively feed on sap of phloem vessels in plants. This sap being kept under high pressure, once a phloem vessel is punctured, it is forced into the food canal. As they feed, aphids often transmit plant viruses to their food plants. These viruses can sometimes kill the plants. Some species of ants "farm" aphids, protecting them on the plant they eat, and eating the honeydew that the aphids secrete; this is a mutualistic relationship. Aphid honeydew is rich in carbohydrates, of which the aphids ingest an excess, being phloem-feeders. Many aphids are host to endosymbiont bacteria, Buchnera, which live in specialized cells called bacteriocytes inside the aphid. These bacteria synthesize some essential amino acids that are absent in the phloem that the aphids eat.

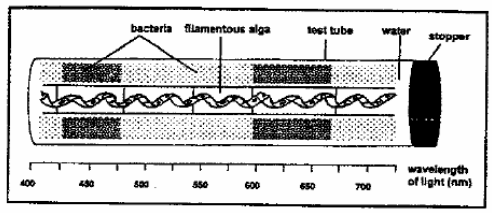
Read the following experimental setup carefully and answer questions 16 to 20.

Aim: An investigation was carried out to determine the effect of different wavelengths of light on the process of photosynthesis in a green alga

Setup: Mobile bacteria were placed in a large glass tube and allowed to use up all the available oxygen in the water. These bacteria were evenly distributed at the beginning of the investigation.

The green alga was then placed in the glass tube which was sealed with a stopper. The complete setup was then exposed to different wavelengths of light.

Results: The following diagram is made of the results.



16. Why do the bacteria move to certain areas of the wavelength of light?

1 The bacteria move to areas where there is more light
2 The bacteria move to areas where there is more oxygen
3 The bacteria move to areas where they can live more anaerobically (without oxygen)
4 The bacteria move to areas where there is more food

Answer: 2

The apparent clumping of the aerobic bacterial cells at two regions of different wavelengths can only suggest that there is more oxygen available in these regions.

17. Which is the most correct conclusion that can be made from these results?

1 Bacteria move towards certain wavelengths of light where they feel comfortable
2 Certain wavelengths of light are warmer than others and bacteria move accordingly
3 Photosynthesis takes place at certain wavelengths of light
4 Alga and bacteria live symbiotically, especially at certain wavelengths of light

Answer: 3 (Encyclopaedia Britannica)

The complex mechanism of photosynthesis includes a photochemical, or light-dependent, stage and an enzymatic, or dark, stage that involves chemical reactions. These stages can be distinguished by studying the rates of photosynthesis at various degrees of light saturation (*i.e.,* intensity) and at different temperatures. Over a range of moderate temperatures and at low to medium light intensities (relative to

the normal range of the plant species), the rate of photosynthesis increases as the intensity increases and is independent of temperature. As the light intensity increases to higher levels, however, the rate becomes increasingly dependent on temperature and less dependent on intensity; light "saturation" is achieved at a specific light intensity, and the rate then is dependent only on temperature if all other factors are constant. In the light-dependent range before saturation, therefore, the rate of photosynthesis is determined by the rates of photochemical steps. At high light intensities, some of the chemical reactions of the dark stage become rate-limiting. At light saturation, rate increases with temperature until a point is reached beyond which no further rate increase can occur. In many land plants, moreover, a process called photorespiration occurs at high light intensities and temperatures. Photorespiration competes with photosynthesis and limits further increases in the rate of photosynthesis, especially if the supply of water is limited. The quantum requirements of the individual light reactions of photosynthesis are defined as the number of light photons absorbed for the transfer of one electron. The quantum requirement for each light reaction has been found to be approximately one photon. The total number of quanta required, therefore, to transfer the four electrons that result in the formation of one molecule of oxygen via the two light reactions should be four times two, or eight. It appears, however, that additional light is absorbed and used to form ATP by a cyclic photophosphorylation pathway. The electron transfers of the light reactions provide the energy for the synthesis of two compounds vital to the dark reactions: NADPH and ATP.

18. In which organelle does photosynthesis take place?

    1 The chloroplasts of the bacteria
    2 The chloroplast of the algae
    3 The nucleus of the algae
    4 The pyrenoid of the algae

Answer: 2 (Encyclopaedia Britannica)

The process of plant photosynthesis takes place entirely within the chloroplasts. The chloroplast is enclosed in a double outer membrane, and its size approximates a spheroid about 2,500 nanometres thick and 5,000 nanometres long. Some single-celled algae have one chloroplast that occupies more than half the cell volume. Leaf cells of higher plants contain many chloroplasts, each approximately the size of the one in some algal cells. When thin sections of a chloroplast are examined under the electron microscope, several features are apparent. Chief among these are the intricate internal membranes (*i.e.,* the lamellae) and the stroma, a colourless matrix in which the lamellae are embedded. Also visible are starch granules, which appear as dense bodies. The stroma is basically a solution of enzymes and small molecules. The dark reactions occur in the stroma, the soluble

enzymes of which catalyze the conversion of carbon dioxide and minerals to carbohydrates and other organic compounds. The capacity for carbon fixation and reduction is lost if the outer membrane of the chloroplast is broken, allowing the stroma enzymes to leak out. A single lamella, which contains all the photosynthetic pigments, is approximately 10–15 nanometres thick. The lamellae exist in more-or-less flat sheets, a few of which extend through much of the length of the chloroplast. Examination of cross sections of lamellae under the electron microscope shows that their edges are joined to form closed hollow disks that are called thylakoids ("saclike"). The chloroplasts of most higher plants have regions, called grana, in which the thylakoids are very tightly stacked. When viewed by electron microscopy at an oblique angle, the grana appear as stacks of disks. When viewed in cross section, it is apparent that some thylakoids extend from one grana through the stroma into other grana. The thin aqueous spaces inside the thylakoids are believed to be connected with each other via these stroma thylakoids. These thylakoid spaces are isolated from the stroma spaces by the relatively impermeable lamellae. The light reactions occur exclusively in the thylakoids. The complex structural organization of lamellae is required for proper thylakoid function; intact thylakoids apparently are necessary for the formation of ATP.

19. Which difference between algae and bacteria is clearly observed during this experiment?

1 All bacteria are mobile and all algae are immobile
2 Algae have cell walls and bacteria have none
3 Algae reproduce by conjugation and bacteria by binary fission
4 Algae use CO_2 during the day and bacteria O_2 during the day

Answer: 4 (Encyclopaedia Britannica)
In the presence of light (daytime) algae will photosynthesise, using carbon dioxide to produce food and releasing water and oxygen as by-products. This oxygen is subsequently used by bacteria for cellular respiration.

20. Predict what will happen in the glass tube if the whole tube is exposed to light at 550 nm.

1 The algae will have a higher rate of photosynthesis
2 The bacteria will move towards the centre of the glass tube
3 The photosynthetic process in algae will stop and bacteria will spread out evenly

4 The photosynthetic process in algae will stop and bacteria will move as indicated on the diagram.

Answer: 2

Logical elimination of invalid/incorrect options is as follows:

From the experimental setup, it is evident that photosynthesis takes place at all the wavelengths depicted (400-750 nanometres). This is why there are bacterial cells scattered throughout the tube. However, there are more bacterial cells at around 400 and 625 nm, meaning that there is more oxygen hence higher photosynthesis rates there. This renders option 1 invalid. Exposing the entire tube to light of wavelength 550 nm will not stop photosynthesis, there would be no bacterial cells at 550 nm originally, if this was true. Thus options 3 and 4 are incorrect. The only answer is thus option 2.

21. What is the most important factor to limit algae from growing in swimming pools?

1 pH
2 Temperature
3 Chlorine level
4 Keep water in motion

Answer: 2 (Encyclopaedia Britannica)

All these answers are in fact correct! However, as those with swimming pools can tell, algal growth in prevalent in summer, despite treatment of water with sanitizers and acid and agitation of the water (with Creepy-Crawly for example). In general, algal abundance and diversity vary from one environment to the next, just as land plant abundance and diversity vary from tropical forests to deserts. Terrestrial vegetation (plants and algae) is influenced most by precipitation and temperature, whereas aquatic vegetation (primarily algae) is influenced most by light and nutrients. When nutrients are abundant, as in some polluted waters, algal cell numbers can become great enough to produce obvious patches of algae called “blooms” or “red tides,” usually linked to favourable growing conditions, including an abundance of nutrients.

Pools must be sanitized to prevent growth and spread of bacteria, viruses, algae and insect larvae that can cause disease. This is done using filters and chemical disinfectants such as chlorine (by using the commercial bleaching agent HTH, for example) , bromine or mineral sanitizers. A pool cover can keep debris out of a pool that is not in use. In cold climates, pools must be closed in winter to prevent them and their pipes from cracking due to ice.

22. Which product is least damaged by bacteria?

1 Cheese
2 Wine
3 Unused paint
4 Jam

Answer: 3 (Wikipedia/Encyclopaedia)

As decomposers, bacteria will degrade any dead organic matter, including food (this is why there are preservation methods such as canning and refrigeration). Paint is any liquid, liquifiable, or mastic composition consisting of a pigment suspended in a vehicle, or binder, which after application to a substrate in a thin layer is converted to an opaque solid film. Paint is used to protect, decorate (such as adding colour), or add functionality to an object or surface by covering it with a pigmented coating. An example of protection is to retard corrosion of metal. An example of decoration is to add festive trim to a room interior. An example of added functionality is to modify light reflection or heat radiation of a surface. Another example of functionality would be the use of colour to identify hazards or function of equipment and pipelines. The basic white pigments include zinc oxide, zinc sulfide, lithopone, and titanium dioxide. Most black pigments are composed of elemental carbon. Common red pigments include the minerals iron oxide, cadmium, and cuprous oxide and various synthetic organic pigments. Yellow and orange pigments include chromates, molybdates, and cadmium compounds. Blue and green pigments are either inorganic (synthetic ultramarines and iron blues) or organic (phthalocyanines).

23. How is it possible that algae can grow in caves which are visited by many tourists?

1 There is lots of oxygen and water
2 There is enough sunlight and water
3 There are high carbon dioxide levels (exhaled by humans) and lots of water
4 There are many electrical lights, carbon dioxide and water

Answer: 4 Encyclopaedia Britannica)

An alga is a member of a group of predominantly aquatic, photosynthetic organisms of the kingdom Protista. Algae range in size from the tiny flagellate *Micromonas* that is 1 micrometre (0.00004 inch) in diameter to giant kelps that reach 60 metres (200 feet) in length. Algae provide much of the Earth's oxygen, they are the food base for almost all aquatic life, they are a source of crude oil, and they provide foods and pharmaceutical and industrial products for humans. The algae have many types of life cycles. Their photosynthetic pigments are more varied than those of plants, and their cells have features not found among plants and animals. Some groups of algae are ancient, whereas other groups appear to have evolved more recently. The taxonomy of algae is subject to rapid change because new information is constantly being discovered. The study of algae is termed phycology, and one who studies algae is known as a phycologist.

As autotrophs, algae need light, carbon dioxide and water for growth. In artificially lit caves for tourism, algae will grow.

24. Which one of the following groups of fruit is not all citrus?

1 Navels and citrones
2 Lemons, limes and mandarins
3 Mineolas and grapefruit
4 Oranges, tangerines and tsammas

Answer: 4 (Encyclopaedia Britannica)

Citrus is a genus of plants belonging to the rue family (Rutaceae), and yielding pulpy fruits covered with fairly thick skins. Plants in this group include the lemon (*C. limon*), lime (*C. aurantifolia*), sweet orange (*C. sinensis*), sour orange (*C. aurantium*), tangerine (*C. reticulata*), grapefruit (*C. paradisi*), citron (*C. medica*), and shaddock (*C. maxima,* or *C. grandis;* pomelo).

The citron melon (*Citrullus lanatus*), or tsamma, is thought to be the original/ancestral variety of watermelon, a cucurbit. Its fruit has a hard white flesh, rendering it less likely to be eaten raw; more often it is "pickled" or used to make preserves. It is especially useful for the latter, because it has a high pectin content. The citron melon is native to Africa, probably the Kalahari desert, where it still grows abundantly. Its taxonomic classification is as follows: Kingdom: Plantae, Division: Magnoliophyta, Class: Magnoliopsida, Order: Cucurbitales, Family: Cucurbitaceae, Genus: *Citrullus,* Species: *C. lanatus*

25. Amoeba is classified as an animal because it….

1 is not green
2 has a nucleus
3 has no cell wall
4 has a cell membrane

Answer: 3 (Encyclopaedia Britannica)

Amoeba, also *spelled Ameba, plural Amoebas, or Amoebae,* is any of the microscopic unicellular protozoans of the rhizopodan order Amoebida. The well-known type species, *Amoeba proteus,* is found on decaying bottom vegetation of freshwater streams and ponds. There are numerous parasitic amoebas. Of six species found in the human alimentary tract, *Entamoeba histolytica* causes amoebic dysentery. Two related free-living genera of increasing biomedical importance are *Acanthamoeba* and *Naegleria,* strains of which have been recognized as disease-causing parasites in several vertebrates, including humans. Amoebas are identified by their ability to form temporary cytoplasmic extensions called pseudopodia, or false feet, by means of which they move about. This type of movement, called amoeboid movement, is considered to be the most primitive form of animal locomotion. Each amoeba contains a small mass of jellylike cytoplasm, which is differentiated into a thin outer plasma membrane, a layer of stiff,

clear ectoplasm just within the plasma membrane, and a central granular endoplasm. The endoplasm contains food vacuoles, a granular nucleus, and a clear contractile vacuole. The amoeba has no mouth or anus; food is taken in and material excreted at any point on the cell surface. During feeding, extensions of cytoplasm flow around food particles, surrounding them and forming a vacuole into which enzymes are secreted to digest the particles. Oxygen diffuses into the cell from the surrounding water, and metabolic wastes diffuse from the amoeba into the surrounding water. A contractile vacuole, which removes excess water from the amoeba, is absent in most marine and parasitic species. Reproduction is asexual (binary fission).

26. Sessile animals like Hydra are usually….

    1 hermaphroditic
    2 bilaterally symmetrical
    3 without cilia
    4 oviparous

Answer: 1 (Wikipedia)

In zoology, sessile animals are those which are not able to move about. They are usually permanently attached to a solid substrate of some kind, such as a rock, or the hull of a ship in the case of barnacles. Corals lay down their own substrate. Sessile animals typically have a motile phase in their development. Sponges have a motile larval stage, which becomes sessile at maturity. In contrast, many jellyfish develop as sessile polyps early in their life cycle. Many sessile animals, including sponges, corals, and hydra, are capable of asexual reproduction *in situ* by a process of budding.

27. Which animal does not have scales as skin covering?

    1 Birds
    2 Snakes
    3 Fish
    4 Insects

Answer: 4 (Encyclopaedia Britannica)

Scales provide protection from the environment and from predators. Fish scales are formed of bone from the deeper, or dermal, skin layer. The elasmobranchs (*e.g.,* sharks) have placoid scales; these are bony, spiny projections with an enamel-like covering. Ganoid scales, which are found on such fishes as gars and the bowfin, are similar to placoid scales but are covered with a peculiar enamel-like substance called ganoin. It is thought that true teeth developed from placoid scales. The advanced fish have either cycloid scales (*e.g.,* carp) or ctenoid scales (*e.g.,* perch; sunfish). These are the typical overlapping fish scales. Cycloid scales are large, thin, and round or oval in shape, and exhibit growth rings. Ctenoid scales resemble cycloid scales but have comb-like teeth on their overlapping edge. Horny scutes, or corneoscutes, derived from the upper, or epidermal, skin layer, appear in reptiles and

on the legs of birds. In crocodilians and some lizards, bony dermal scales (osteoderms) underlie the external scales. Bird feathers are developmentally modified epidermal scales. Modified epidermal tissue, mostly made up of keratin, forms the scaly surface found on some mammals (*e.g.,* rats; pangolins); however, although mammalian hair is also largely keratin, it is not a modified scale. The term scale is also applied to modified body coverings on certain insects, *e.g.,* moths.

Study the table below and answer questions 28 to 30.

The table below compares the percentage of food eaten which is used in respiration and growth in different animals.

Animal	**Type of feeder**	Percentage of food eaten which is:	
		Respired	**Used in Growth**
Caterpillar	Herbivore	17	23
Spider	Carnivore	57	27
Cow	Herbivore	39	1
Owl	Carnivore	82	1

28. Which animal uses more food for growth than in respiration?

    1 Caterpillar
    2 Spider
    3 Cow
    4 Owl

Answer: 1 (Encyclopaedia Britannica)

A caterpillar is the larva of a butterfly or moth (Lepidoptera). Caterpillars have cylindrical bodies consisting of 13 segments, with three pairs of true legs on the thorax and several pairs of short, fleshy pro-legs on the abdomen. The head has six small eyes (stemmata) on each side, short antennae, and strong jaws. The head bears a pair of very short antennae and on each side a cluster of minute simple eyes (stemmata). A short liplike labrum is in front of the mouth. Behind the labrum are paired jaws (mandibles) that are short, broad, and powerful to allow consumption of large amounts of plant material. Caterpillars are voracious feeders and many of them are considered pests in agriculture. Many moth species are better known in their caterpillar stages because of the damage they cause to fruits and other agricultural produce.

29. Why does the owl use so much more food in respiration than the other animals?

    1 It eats less frequently than the other animals and maximum energy is used for respiration
    2 The owl feeds in the night when more energy is needed to keep the bird warm
    3 The owl uses lots of energy for flying and does not use it for growth

4 The food stays in the alimentary canal for a longer period and it therefore gets more energy from it

Answer: 3 (Encyclopaedia Britannica)

Birds must be capable of high rates of gas exchange because their oxygen consumption at rest (for cellular respiration) is higher than that of all other vertebrates, including mammals, and it increases many times during flight. The flight of owls is a steady flapping on a straight path, ending in a short upward glide to the perch. Hunting, usually done from a perch, rarely involves extensive flight, requiring only a short burst of speed to surprise the prey on the ground. Short-eared owls flap slowly, the large area of the wings causing the light body to bob up and down; they also glide for brief periods with the wings held in a high V over the back.

30. What general conclusion can be made from the information in the table above?

1 Herbivores grow faster than carnivores
2 Carnivores use more food in respiration than in growth
3 Cold-blooded animals (ectotherms) grow faster than warm-blooded animals (endotherms)
4 Herbivores eat all the time

Answer: 2 (Encyclopaedia Britannica)

Being meat eaters, carnivores are at the top of the food chain and form the highest trophic level within ecosystems. As such, they are basic to maintaining the “balance of nature” within those systems. In areas of human settlement, this precarious balance has frequently been upset by the extermination of many carnivores formerly considered undesirable because of their predatory habits. Now, however, carnivores are recognized to be necessary elements in natural systems; they improve the stability of prey populations by keeping them within the carrying capacity of the food supply. As a result, the surviving animals are better fed and less subject to disease.

Carnivores necessarily form only a small portion of the animal kingdom, because each animal must eat a great many other animals of equivalent size in order to maintain itself over a lifetime. In addition to possessing the teeth and claws needed to kill their prey and then tear the flesh apart, carnivores have digestive enzymes that are able to break down muscle protein into amino acids, which can then diffuse through the walls of the small intestine. Therefore, carnivores have no need for any special development of the gut that allows for fermentation. Carnivores are also able to utilize animal fat. If their prey is small, they can chew and swallow bones, which serve as a source of calcium. Some carnivores, particularly cats (family *Felidae*), are obligate carnivores, meaning they cannot

obtain all the nutrients that they need from the plant kingdom and bacteria. In particular, obligate carnivores lack the enzyme needed to split carotene, obtained from plants, into vitamin A. Instead, these animals obtain vitamin A from the liver of their prey. Obligate carnivores are similarly unable to synthesize some essential very-long-chain, highly unsaturated fatty acids that other animals can make from shorter fatty acids found in plants.

31. Which animals echo-locate?

A. Whales
B Dolphins
C. Bats
D. Insects

1 A, B and C
2 Only C
3 B and C
4 C and D

Answer: 1 (Encyclopaedia Britannica)
Echolocation is a physiological process for locating distant or invisible objects (such as prey) by means of sound waves reflected back to the emitter (such as a bat) by the objects. Echolocation is used for orientation, obstacle avoidance, food procurement, and social interactions. Echolocation is known to be employed by most bats (all members of the suborder Microchiroptera and one genus, *Rousettus,* of the Megachiroptera); most, if not all, toothed whales and porpoises (Odontoceti), but apparently no baleen whales; a few shrews; and two kinds of birds, the oilbird (*Steatornis caripensis*) of northern South America and certain cave swiftlets (*Collocalia*) of Southeast Asia. Echolocation pulses consist of short bursts of sound at frequencies ranging from about 1,000 hertz in birds to at least 200,000 hertz in whales. Bats utilize frequencies from about 30,000 to about 120,000 hertz. The pulses are repeated at varying rates (often in a single individual, depending upon the situation) beginning at about one per second. The rate may reach several hundred per second (*e.g.,* in a bat close to its target).

32. If you were asked to euthanize a grasshopper, where would you put the cotton wool with chloroform?

1 At the ostia
2 At the sides of the thorax
3 At the rear end of the abdomen
4 At the front side at the mouth parts

Answer: 2 (Encyclopaedia Britannica)
A grasshopper is a jumping insect (order Orthoptera) that found in a variety of habitats. Grasshoppers occur in greatest numbers in lowland tropical forests, semiarid regions, and grasslands. They range in colour from green to olive or brown and may have yellow or red markings. Insects have segmented bodies, jointed legs, and external skeletons (exoskeletons). Insects

are distinguished from other arthropods by their body, which is divided into three major regions: (1) the head, which bears the mouthparts, eyes, and a pair of antennae, (2) the three-segmented thorax, which usually has three pairs of legs (hence "Hexapoda") in adults and usually one or two pairs of wings, and (3) the many-segmented abdomen, which contains the digestive, excretory, and reproductive organs. The respiratory system of insects consists of air-filled tubes or tracheae, which open at the surface of the thorax and abdomen through paired spiracles. The muscular valves of the spiracles, closed most of the time, open only to allow the uptake of oxygen and the escape of carbon dioxide. The tracheal tubes are continuous with the cuticle of the body surface. The tracheae are stiffened by spiral thickenings or threadlike ridges called taenidia, which branch repeatedly, becoming reduced in cross section and ending in fine thin-walled tracheoles less than one micron in diameter. The tracheoles insinuate themselves between cells, sometimes appearing to penetrate into them, and push deeply into the plasma membrane. Although movements of oxygen and carbon dioxide occur solely by gaseous diffusion in sedentary insects, the system is ventilated mechanically in active species. Pumping movements of the abdomen provide the force necessary to drive out streams of air at some spiracles and suck them in at others. The taenidia keep the tracheae distended, thus allowing free passage of air. In addition, the most active insects have large thin-walled dilatations of the tracheae called air sacs, which serve to increase the volume of air displaced during respiratory movements. Both lack of oxygen and accumulation of carbon dioxide provide stimuli to nerve centres that induce increased respiration during muscular activity.

33. Why are tapeworms not digested by the enzymes inside the host's body?

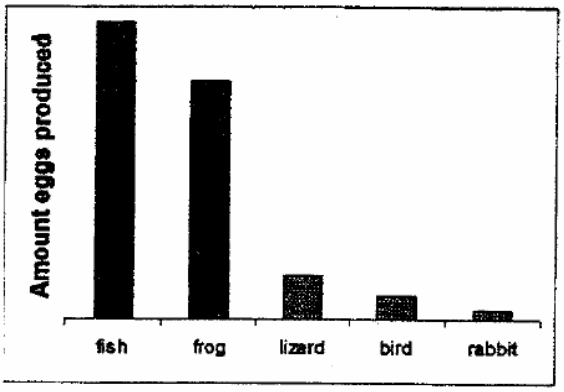
1 The epidermis is resistant to stomach acids
2 It secretes a chemical which neutralises digestive enzymes
3 The epidermis contains cellulose which is indigestible
4 The epidermis contains chitin similar to the exoskeleton of insects

Answer: 1 (Encyclopaedia Britannica)

Also called Cestode , a tapeworm is any member of the invertebrate class Cestoda (phylum Platyhelminthes), a group of parasitic flatworms containing about 3,000 species. Tapeworms, which occur worldwide and range in size from about 1 mm (0.04 inch) to more than 15 m (50 feet), are internal parasites, affecting certain invertebrates and the liver or digestive tracts of all types of vertebrates—including humans, domestic animals, and other food animals, such as fish. Some attack a single

host, others require one or two intermediate hosts as well as a final, or definitive, host during their life cycle. The disease caused by tapeworms is known as cestodiasis. Tapeworms are bilaterally symmetrical (*i.e.,* the right and left sides are similar). Some consist of one long segment; others have a definite head, followed by a series of identical segments called proglottids. The head, or scolex, bears suckers and often hooks, which are used for attachment to the host. The body covering is a tough cuticle, through which food is absorbed. There is neither a mouth nor a digestive tract.

Study the histogram showing the average number of offspring per season of the five vertebrate animal groups.



34. The main reason why the rabbit has so few offspring is….

    1 the rabbit has good parental care
    2 the rabbit is fertilized internally
    3 that it has the fewest predators
    4 that is has a safe nest to ensure the survival of all

Answer: 1 (Encyclopaedia Britannica)

The reproductive behaviour of *fishes* is remarkably diversified: they may be oviparous (lay eggs), ovoviparous (retain the eggs in the body until they hatch), or viviparous (have a direct tissue connection with the developing embryos and give birth to live young). All cartilaginous fishes—the elasmobranches (*e.g.,* sharks, rays, and skates)—employ internal fertilization and usually lay large, heavy-shelled eggs or give birth to live young. The most characteristic features of the more primitive bony fishes is the assemblage of polyandrous (many males) breeding aggregations in open water and the absence of parental care for the eggs. Many of the species in this group, such as herrings, make what appear to be completely chaotic migrations to their breeding areas. Actually, however, each of these huge spawning aggregations is made up of small, coordinated parties consisting of one female and one or more males.

Although true viviparity has been described in the African frog *Nectophrynoides*, most *amphibians* lay eggs. Some salamanders, however, retain the eggs within their body and give birth to live young. Most frogs and salamanders do not show brood care. The annual breeding of frogs usually takes place in freshwater. In the sexual embrace (amplexus) the male clasps the female from behind and extrudes sperm over the eggs as they are ejected by the female. The eggs,

laid in numbers varying from a few hundred to several thousand (depending on the species), then float off in clusters or sheets and may become attached to the stems of water plants; the eggs of some species sink. The tadpole hatches in a few days to a week or more and metamorphoses into a frog within two months to three years. During metamorphosis the lungs develop, limbs appear, the tail is absorbed, and the mouth becomes typically froglike. In some Oriental species the eggs are deposited on land and the young hatch as froglets, not tadpoles.

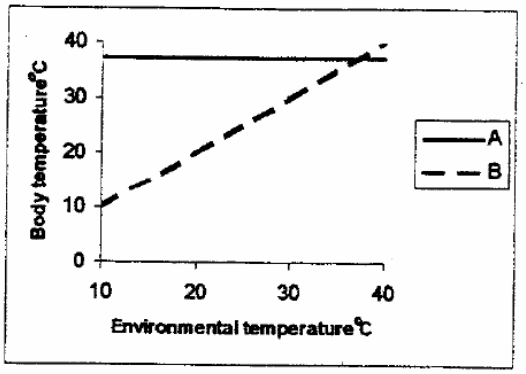
Most *rabbits* produce many offspring (kittens) each year, although scarcity of resources may cause this potential to be suppressed. A combination of factors allows the high rates of reproduction commonly associated with rabbits. Rabbits generally are able to breed at a young age, and many regularly conceive litters of up to seven young, often doing so four or five times a year. In addition, females (does) exhibit induced ovulation, their ovaries releasing eggs in response to copulation rather than according to a regular cycle. They can also undergo postpartum oestrus, conceiving immediately after a litter has been born. Newborn rabbits are naked, blind, and helpless at birth (altricial). Mothers are remarkably inattentive to their young and are almost absentee parents, commonly nursing their young only once per day and for just a few minutes. To overcome this lack of attention, the milk of rabbits is highly nutritious and among the richest of that of all mammals. The young grow rapidly, and most are weaned in about a month. Males (bucks) do not assist in rearing the kittens.

Most *lizards* reproduce by laying eggs. In some small species the number of eggs is rather uniform for each laying or clutch. Lizard eggs are usually leathery shelled and porous and can expand by absorption of moisture as the embryos grow. An exception occurs in the majority of egg-laying geckos, whose eggs have shells that harden soon after deposition and then show no further change in size or shape. Some lizards bear live young. In the family Scincidae this is true for about one-third of the species, many of which are tropical. Parental care among lizards tends to be minimal following egg deposition. Many species dig holes in which the eggs are placed; others bury them under leaf litter or utilize a cranny in a tree or cave. Juvenile lizards are essentially miniature adults; they do not go through any larval phase nor any stage of dependence upon adults.

Most *birds* build nests in which the eggs are laid. Nests vary widely: they may be a scrape in the sand, a deep burrow, a hole in a tree or rock, an open cup, a globular or retort-shaped mass with a side entrance tube, or an elaborately woven hanging structure. All birds incubate their eggs, except megapodes (mound builders), which depend on the heat generated by decaying vegetation or other external sources, and brood parasites such as cuckoos and cowbirds, which lay their eggs in the nests of other species. Murres and the king and emperor penguins build no nest but incubate

with the egg resting on top of the feet. Incubation takes from 11 to 80 days, depending at least in part on the size of the bird and the degree of development at hatching. The length of time that parents care for young birds varies widely. Young megapodes can fly shortly after hatching and are entirely independent of their parents; young royal albatrosses may spend more than eight months at the nest and in the area immediately around it before they can fly. The length of time needed to attain independence is related to size and condition at hatching. Ground-nesting birds tend to take less and hole-nesting birds more time than the average.

Study the graph showing the relationship between body temperature and environmental temperature of two animals.



35. Which deduction can be made from this graph?

1 That A is an endotherm and B is an ectotherm
2 That A is an ectotherm and B is an endotherm
3 That the body temperature of ectothermic animals increases during the day
4 That environmental temperature has no influence on endothermic animals

Answer: 1 (Encyclopaedia Britannica)

The body temperature of A stays constant despite the change in the temperature of the environment, whilst that of B increases as the environment warms up.

All animals thermoregulate. The internal environment of the body is under the influence of both external and internal conditions. Land animals thermoregulate in several ways. They do so behaviorally, by moving to a colder or warmer place, by exercising to generate body heat, or by panting or sweating to lose it. They also thermoregulate physiologically, by activating internal metabolic processes that warm or cool the blood. But these efforts have limits, and, as a result, external temperatures and climatic conditions are among the most important factors controlling the geographic distribution of animals.

Today's so-called warm-blooded animals are the mammals and birds; reptiles, amphibians, and most fishes are called cold-blooded. These two terms, however, are imprecise and misleading. Some “cold-blooded” lizards have higher normal body temperatures than do some mammals, for instance. Another pair of terms, *ectothermy* and *endothermy*, describes whether most of

an animal's heat is absorbed from the environment (“ecto-”) or generated by internal processes (“endo-”). A third pair of terms, *poikilothermy* and *homeothermy*, describes whether the body temperature tends to vary with that of the immediate environment or remains relatively constant.

Mammals and birds have a high metabolism and are considered endotherms, which produce body heat internally. They possess biological temperature sensors that control heat production and switch on heat-loss mechanisms such as perspiration. Today's reptiles and amphibians, on the other hand, are ectotherms that mostly gain heat energy from sunlight, a heated rock surface, or some other external source. The endothermic state is effective but metabolically expensive, as the body must produce heat continuously, which requires correspondingly high quantities of fuel in the form of food. On the other hand, endotherms can be more active and survive lower external temperatures. Ectotherms do not require as much fuel, but most cannot deal as well with cold surroundings.

36. Which one is not associated with bilateral symmetry?

1 Cephalisation
2 Effective locomotion
3 Triploblastic
4 Inability to react with equal speed to stimuli from all directions

Answer:

Symmetry refers to a correspondence of body parts, in size, shape, and relative position, on opposite sides of a dividing line or distributed around a central point or axis. With the exception of radial symmetry (*see* below), external form has little relation to internal anatomy, since animals of very different anatomical construction may have the same type of symmetry. Certain animals, particularly most sponges and the ameboid protozoans, lack symmetry, having either an irregular shape different for each individual or else one undergoing constant changes of form. The vast majority of animals, however, exhibit a definite symmetrical form. Four such patterns of symmetry occur among animals: spherical, radial, biradial, and bilateral.

In *spherical symmetry*, illustrated only by the protozoan groups Radiolaria and Heliozoia, the body has the shape of a sphere and the parts are arranged concentrically around or radiate from the centre of the sphere. Such an animal has no ends or sides, and any plane passing through the centre will divide the animal into equivalent halves. The spherical type of symmetry is possible only in minute animals of simple internal construction, since in spheres the interior mass is large relative to the surface area and becomes too large for efficient functioning with increase in size and complexity.

In *radial symmetry* the body has the general form of a short or long cylinder or bowl, with a central axis from which the body parts

radiate or along which they are arranged in regular fashion. The main axis is heteropolar—*i.e.,* with unlike ends, one of which bears the mouth and is termed the oral, or anterior, end, and the other of which, called the aboral, or posterior, end, forms the rear end of the animal and may bear the anus. The main axis is hence termed the oral-aboral, or anteroposterior, axis. Except in animals having an odd number of parts arranged in circular fashion (as in the five-armed starfishes), any plane passing through this axis will divide the animal into symmetrical halves. Animals having three, five, seven, etc., parts in a circle have symmetry that may be referred to, respectively, as three-rayed, five-rayed, seven-rayed, etc.; only certain planes through the axis will divide such animals into symmetrical halves. Radial symmetry is found in the coelenterates and echinoderms. In *biradial symmetry*, in addition to the anteroposterior axis, there are also two other axes or planes of symmetry at right angles to it and to each other: the sagittal, or median vertical-longitudinal, and transverse, or cross, axes. Such an animal therefore not only has two ends but also has two pairs of symmetrical sides. There are but two planes of symmetry in a biradial animal, one passing through the anteroposterior and sagittal axes and the other through the anteroposterior and transverse axes. Biradial symmetry occurs in the comb jellies. In *bilateral symmetry* there are the same three axes as in biradial symmetry but only one pair of symmetrical sides, the lateral sides, since the other two sides, called the dorsal (back) and ventral (belly) surfaces, are unlike. Thus, only one plane of symmetry will divide a bilateral animal into symmetrical halves, the median longitudinal, or sagittal, plane. Bilateral symmetry is characteristic of the vast majority of animals, including insects, fishes, amphibians, reptiles, birds, mammals, and most crustaceans. Bilateral symmetry permits streamlining, favors the formation of a central nerve center, contributes to cephalization, and promotes actively moving organisms. Bilateral symmetry is an aspect of both chordates and invertebrates.

37. Which organ detects depth/pressure in fish?

1 Swim bladder
2 Lateral line system
3 Brain
4 Gills

Answer: 2 (Encyclopaedia Britannica)

The lateral line system is a network of sensory receptors located along the head and sides of fishes and amphibians. The system serves to detect movements and pressure changes in the surrounding water. The individual receptor, called a lateral line organ, or neuromast, consists of a cluster of innervated hairs surrounded by a jellylike projection (cupula) that bends in response to water movements. The neuromasts of most bony fishes are set in a series of interconnected depressions, forming a

canal, with openings at intervals to the environment.

38. Which one of the following is not a water pollutant?

1 Insecticides and chemical sprays which accumulate in the food chain
2 Sewerage that contains intestinal bacteria
3 CFC gases which break up the ozone layer
4 Phosphate compounds which accelerate algae growth and thus deplete the oxygen level in water causing many fish to die

Answer: 3 (Encyclopaedia Britannica)

Water pollution involves the release into lakes, streams, rivers, and oceans of substances that become dissolved or suspended in the water or deposited upon the bottom and accumulate to the extent that they interfere with the functioning of aquatic ecosystems. It may also include the release of energy in the form of radioactivity or heat, as in the case of thermal pollution. Any body of water has the capacity to absorb, break down, or recycle introduced materials. Under normal circumstances, inorganic substances are widely dispersed and have little or no effect on life within the bodies of water into which they are released; organic materials are broken down by bacteria or other organisms and converted into a form in which they are useful to aquatic life. But, if the capacity of a body of water to dissolve, disperse, or recycle is exceeded, all additional substances or forms of energy become pollutants. Thus, thermal pollution, which is usually caused by the discharge of water that has been used as a coolant in fossil-fuelled or nuclear-power plants, can favour a diversity of aquatic life in waters that would otherwise be too cold. In a warmer body of water, however, the addition of heat changes its characteristics and may make it less suited to species that are considered desirable. Pollution may begin as water moves through the air, if the air is polluted. Soil erosion adds silt as a pollutant. The use of chemical fertilizers, pesticides, or other materials on watershed lands is an additional factor contributing to water pollution. The runoff from septic tanks and the outflow of manures from livestock feedlots along the watershed are sources of organic pollutants. Industries located along waterways downstream contribute a number of chemical pollutants, some of which are toxic if present in any concentration. Finally, cities and towns contribute their loads of sewage and other urban wastes. Thus, a community far upstream in a watershed may receive relatively clean water, whereas one farther downstream receives a partly diluted mixture of urban, industrial, and rural wastes. The cost of cleaning and purifying this water for community use may be high, and the process may be only partially effective. To add to the problem, the cities and towns in the lower, or downstream,

regions of the river basin contribute additional wastes that flow into estuaries, creating new pollution problems. The output of industries, agriculture, and urban communities generally exceeds the biologic capacities of aquatic systems, causing waters to become choked with an excess of organic substances and organisms to be poisoned by toxic materials. When organic matter exceeds the capacity of those microorganisms in water that break it down and recycle it, the excess of nutrients in such matter encourages rapid growth, or blooms, of algae. When they die, the remains of the dead algae add further to the organic wastes already in the water; eventually, the water becomes deficient in oxygen. Anaerobic organisms (those that do not require oxygen to live) then attack the organic wastes, releasing gases such as methane and hydrogen sulfide, which are harmful to the oxygen-requiring (aerobic) forms of life. The result is a foul-smelling, waste-filled body of water, a situation that has already occurred in such places as Lake Erie and the Baltic Sea and is a growing problem in freshwater lakes of Europe and North America. The process by which a lake or any other body of water changes from a clean, clear condition—with a relatively low concentration of dissolved nutrients and a balanced aquatic community—to a nutrient-rich, algae-filled body and thence to an oxygen-deficient, waste-filled condition is known as accelerated eutrophication.

A chlorofluorocarbon is any of several organic compounds composed of carbon, fluorine, chlorine, and hydrogen. Developed during the 1930s and manufactured under the trade name Freon, CFCs found wide application after World War II. These halogenated hydrocarbons, notably trichlorofluoromethane (CFC-11, or F-11) and dichlorodifluoromethane (CFC-12, or F-12), were used extensively as aerosol-spray propellants, refrigerants, solvents, and foam-blowing agents. They are well-suited for these and other applications because they are non-toxic and non-flammable and can be readily converted from a liquid to a gas and vice versa. Their commercial and industrial value notwithstanding, CFCs have been found to pose a serious environmental threat. Studies undertaken by various scientists during the 1970s revealed that CFCs released into the atmosphere accumulate in the stratosphere, where they have a deleterious effect on the ozone layer. Stratospheric ozone shields living organisms on Earth from the harmful effects of the Sun's ultraviolet radiation; even a relatively small decrease in the stratospheric ozone concentration can result in an increased incidence of skin cancer in humans and in genetic damage in many organisms. In the stratosphere the CFC molecules break down by the action of solar ultraviolet radiation and release their constituent chlorine atoms. These then react with the ozone molecules, resulting in their removal. Because of a growing concern over stratospheric ozone depletion and its attendant dangers, a ban was imposed on the use of CFCs in aerosol-spray dispensers.

Questions 39 to 42 refer to the table below which contains information about certain aspects of game animals and also the price of these animals.

Animal species	Sex ratio (number of female(s) to one male	Minimum number of animals in herd	Herd population growth (% per year)	Game auction price (per animal)
Impala	25	30	35%	R600
Kudu	10	15	20%	R1 800
Lion	3	5	50%	R20 000
Ostrich	1	10	50%	R1 000
Springbok	15	30	40%	R500
Blesbok	15	20	30%	R700
Warthog	10	15	20%	R600
Giraffe	3	2	15%	R11 000
Elephant	4	10	8%	R30 000

39. You seriously plan to establish a game farm and your aim is to manage a hunting business and not a tourist attraction. Which game will you buy first?

1 Elephant
2 Lion
3 Giraffe
4 Impala

Answer: 4

This is the logical choice, not only are impala cheaper and having a high reproduction rate but as herbivores they feed on grass and plants and thus need no maintenance.

Impala (*Aepyceros melampus*), is a swift-running antelope, family Bovidae (order Artiodactyla), that is found in large herds, usually near water, on the savannas and open woodlands of central and southern Africa. Impalas are noted for their grace and their ability to jump; when alarmed, they bound off in leaps up to 9 m (30 feet) in length and 3 m high. A lightly built animal, the impala stands 75–100 cm (29.5–39 inches) at the shoulder. It has a golden to reddish brown coat, white underparts, a vertical black stripe on each thigh, and a black tuft behind each hind hoof. The male has long, lyre-shaped horns.

40. At the first auction you decide to buy only one herd of animals. Which herd will be the cheapest?

1 Impala
2 Kudu
3 Springbok
4 Blesbok

Answer: 4

Mathematically, a herd of impala will set you back 30×R600 = R18 000. That of Kudus will cost 15×R1800 = R27 000, that of springbok will be 30×R500 = R15 000 whilst that of blesbok will require 20×R700 = R14 000.

A bleskbok is a sassaby, any of a few species of antelope belonging to the family Bovidae (order Artiodactyla) and inhabiting sub-Saharan grasslands, floodplains, and dense brush from western to eastern Africa

and southward to southern Africa. Modern classifications are not uniform, but generally two subgenera and three species are recognized: the subgenus *Beatragus,* consisting of a single species, *D. hunteri* (Hunter's hartebeest, or hirola), found in eastern Kenya and southwestern Somalia; and the subgenus *Damaliscus,* consisting of two species, *D. dorcas* (the bontebok [subspecies *D. dorcas dorcas*] and the blesbok [subspecies *D. dorcas phillipsi*]) and *D. lunatus* (topi), ranging widely from Senegal to Ethiopia and to South Africa. The sassabies stand shoulder-height about 90 to 120 cm (35 to 47 inches) and measure in body-and-head length from 130 to 200 cm (50 to 80 inches). The graceful lyre-shaped horns may extend as much as 70 cm (28 inches). The hair, generally iridescent and soft, ranges from grey to almost black or from red to rich brown and is often marked by contrasting white patches on the face, legs, or hips. The sassabies feed on grass.

41. Which herd (mentioned in question 40) will have the most siblings after one year?

    1 Impala
    2 Kudu
    3 Springbok
    4 Blesbok

Answer: 3

A herd of impala grows at 30% per year, which means in the first year there will be 30× 1.35 = 40 animals. Using the same reasoning, there will be 15×1.20 = 18 kudus, 30×1.40 = 42 springboks and 20×1.30 = 26 blesboks.

42. Calculate the value of a herd of Kudu after one year of breeding. Assume the selling price (hunting price) is equal to the auction price (bought).

    1 R5 400
    2 R27 000
    3 R32 400
    4 R90 000

Answer: 3

After one year of breeding, there will be 15×1.20 = 18 kudus. With the price staying the same at R1800 per animal, the total price will be R32 400.

A kudu is a handsome, slender antelope of the genus *Tragelaphus,* family Bovidae (order Artiodactyla). The greater kudu (*T. strepsiceros*) lives in small groups in hilly bush country or open woods of eastern and southern Africa. It stands about 1.3 m (51 inches) at the shoulder. It has a fringe on the throat and a crest of hair on the neck and back, and it is reddish brown to blue-gray, with a white mark between the eyes and narrow, vertical white stripes on the body. The male has long, divergent, corkscrewlike horns. Kudus browse on shrubs and tree leaves. Apart from mating periods, mature kudu live in segregated groups of males and females.

43. Which one of the following is a better nature conservation principle?

1 Foreign hunters shoot the biggest and best animals as trophies
2 Khoi-San are allowed to hunt the slow and weak animals in closed conservation areas
3 Sangomas collect certain plant roots, tubers and bark unregulated
4 To wipe out indigenous problematic animals like the jackal

Answer: 2 (Encyclopaedia Britannica)

Hunting the biggest and the best animals amounts to killing the ones that carry the best genes for survival and thus detrimental to the population of that species and contrary to natural selection. This thus makes option 2 the correct answer. Unregulated gathering of plants by sangomas will also lead to complete extermination of the plants. Killing of all jackals will also upset the ecosystem, these animals are not vermin, they fulfil an indispensable role in the wild as carnivores and scavengers.

Natural selection is the differential reproduction of alternative hereditary variants, determined by the fact that some variants increase the likelihood that the organisms having them will survive and reproduce more successfully than will organisms carrying alternative variants. Selection may occur as a result of differences in survival, in fertility, in rate of development, in mating success, or in any other aspect of the life cycle. All of these differences can be incorporated under the term differential reproduction because all result in natural selection to the extent that they affect the number of progeny an organism leaves. Natural selection moderates the disorganizing effects of these processes because it multiplies the incidence of beneficial mutations over the generations and eliminates harmful ones, since their carriers leave few or no descendants. Natural selection enhances the preservation of a group of organisms that are best adjusted to the physical and biological conditions of their environment and may also result in their improvement in some cases.

44. Why do many birds migrate annually from Europe to South Africa specifically?

1 It is warmer in South Africa
2 They cannot fly further south
3 They go where the winds take them
4 The SA Highveld has lots of grasslands and insects

Answer: 1 (Encyclopaedia Britannica)

Migration is most evident among birds. Most species, because of their high metabolic

rate, require a rich, abundant supply of food at frequent intervals. Such a situation does not always prevail throughout the year in any given region. Birds have thus evolved a highly efficient means for travelling swiftly over long distances with great economy of energy. The populations of many northern and eastern European species of birds have pronounced migratory tendencies; the populations of Western Europe, on the other hand, are more sedentary. Some birds are nomadic in winter; others spend the colder months in the south-western part of the continent or in the Mediterranean region. Many migrant populations migrate to Africa south of the Sahara. Geographical conditions determine several main routes. The Alps are an important barrier to migratory birds. About 150 species travel westward and south-westward; others travel south-eastward. Insectivorous (insect-eating) species, such as warblers, flycatchers, and wagtails, are highly migratory and spend the winter in the tropics, chiefly in Africa. They migrate to Sierra Leone on the west coast, Tanzania on the east coast, and all the way southward to the tip of the continent. Most of these migrants use different routes to cross the Mediterranean, chiefly in the western portion, although some migrate only southeastward. Golden orioles (*Oriolus oriolus*) and red-backed shrikes (*Lanius collurio*) go to East Africa by way of Greece and Egypt. Swallows—particularly barn swallows (*Hirundo rustica*) and house martins (*Delichon urbica*)—and swifts (*Apus apus*) pass the winter in Africa south of 20° N latitude, particularly in South Africa, in the Congo River region, and in some coastal areas of West Africa. Wading birds (shorebirds) also are typical migrants, most of them nesting in tundra of the Arctic region and wintering along the seacoasts from western Europe to South Africa.

45. Why do black herons fold their wings over their heads like an umbrella?

1 It protects them from the hot sun
2 It protects them when it rains
3 It leads the prey into the shade because they usually hide in the shady areas
4 It camouflages itself and the nest in this way

Answer: 3 (Wikipedia)

The Black Heron, *Egretta ardesiaca* is an African heron. It is a medium-sized (42.5–66 cm in height), black plumaged heron with yellow legs and feet. It is found south of the Sahara Desert, including Madagascar, and prefers shallow open, waters, such as the edges of fresh water lakes and ponds. It may also be found in marshes, river edges, rice fields, and seasonally flooded grasslands. The black heron has an interesting hunting method, called canopy feeding - it uses its wings like an umbrella, and uses the shade it creates to attract fish.

Some black herons feed solitarily, while others feed in groups of up to 50 individuals, 200 being the highest number reported. The black heron feeds by day but especially prefers the time around sunset. It roosts communally at night, and coastal flocks roost at high tide. The primary food of the black heron is small fish, but it will also eat aquatic insects and crustaceans.

46. Brazilian scientists recently discovered a caffeine-free coffee plant. After 8 years of research where several recessive characteristics were crossed, the plant's unique feature was discovered. This is proof that….

    1 plants have great genetic diversity in gene banks
    2 ages ago, coffee was caffeine free
    3 any research will always be successful
    4 caffeine is harmful to humans

Answer: 1 (Encyclopaedia Britannica)

Details of this research were published in the Scientific magazine/journal *Nature,* in Volume 429, on 24 JUNE 2004. The plants were found to be lacking the enzyme caffeine synthase which converts theobromine to caffeine, and high levels of theobromine were detected in them.

Coffee is the beverage brewed from the roasted and ground seeds of the tropical evergreen coffee plant of African origin. It is consumed either hot or cold by about one-third of the people in the world, in amounts larger than those of any other drink. Its popularity can be attributed to its invigorating effect, which is produced by caffeine, an alkaloid stimulant present in green coffee in amounts between 0.8 and 1.5 percent for the Arabica varieties and 1.6 to 2.5 percent for Robusta. Two species of the coffee plant, *Coffea arabica* and *C. canephora,* supply almost all of the world's consumption. Arabica coffee, which is divided between Brazilians and milds, is considered to brew a more flavourful and aromatic beverage than Robusta, the main variety of *C. canephora.* Arabicas are grown in Central and South America, the Caribbean, and Indonesia, while Robustas are grown mainly in Africa. Because of some undesirable effects of caffeine, many attempts have been made to decaffeinate coffee, with the industrial process of solvent extraction being the commercial route. Genetic engineering attempts have thus far failed to provide plants whose seeds give coffee of the same quality, taste and aroma.

47. Recessive characteristics are features which….

    1 develop as the organism adapts to the environment
    2 can never be eliminated and often appear in a next generation

3 are carried on the sex chromosomes

4 can only be separated from dominant genes though meiosis

Answer: 4 (Encyclopaedia Britannica)

Recessiveness is the failure of one of a pair of genes (alleles) present in an individual to express itself in an observable manner because of the greater influence, or dominance, of its opposite-acting partner. Both alleles affect the same inherited characteristic, but the presence of the recessive gene cannot be determined by observation of the organism; *i.e.*, although present in the organism's genotype, the recessive trait is not evident in its phenotype. The term recessive is applied both to the organism having the alleles of a gene pair in the recessive condition and to the allele whose effect can be masked by another allele of the same gene.

Dominance is greater influence by one of a pair of genes (alleles) that affect the same inherited character. If an individual pea plant with the alleles *T* and *t* (*T* = tallness, *t* = shortness) is the same height as a *TT* individual, the *T* allele (and the trait of tallness) is said to be completely dominant; if the *Tt* individual is shorter than the *TT* but still taller than the *tt* individual, *T* is said to be partially or incompletely dominant; *i.e.,* it has a greater influence than *t* but does not completely mask the presence of *t*, which is said to be recessive.

Also called allelomorph, an allele is any one of two or more genes that may occur alternatively at a given site (locus) on a chromosome. Alleles may occur in pairs, or there may be multiple alleles affecting the expression (phenotype) of a particular trait. If the paired alleles are the same, the organism is said to be homozygous for that trait; if they are different, the organism is heterozygous. A dominant allele will override the traits of a recessive allele in a heterozygous pairing. In some traits, however, alleles may be co-dominant—i.e., neither acts as dominant or recessive. An example is the human ABO blood system; persons with type AB blood have one allele for A and one for B. (Persons with neither are type O.). Most traits are determined by more than two alleles. Multiple forms of the allele may exist, though only two will attach to the designated gene site during meiosis. Also, some traits are controlled by two or more gene sites. Both possibilities multiply the number of alleles involved. All genetic traits are the result of the interactions of alleles. Mutation, crossing over, and environmental conditions selectively change the frequency of phenotypes (and thus their alleles) within a population.

48. What is the biggest disadvantage of genetically manipulated cotton plants?

1 They are more resistant to insects; fewer insecticides are sold

2 The quality of cotton linters is very high; clothes are more expensive because cheap cloth disappears

3 Cotton growers must replant plantations; previous product doesn't sell

4 less high quality cotton is imported; more import companies go bankrupt

Answer: 3 (Wikipedia/Encyclopaedia Britannica)

Transgenic plants possess a gene or genes that have been transferred from a different species. Although DNA of another species can be integrated in a plant genome by natural processes, the term "transgenic plants" refers to plants created in a laboratory using recombinant DNA technology. The aim is to design plants with specific characteristics by artificial insertion of genes from other species or sometimes entirely different kingdoms.

Cotton is attacked by several hundred species of insects, including such harmful species as the boll weevil, pink bollworm, cotton leafworm, cotton fleahopper, cotton aphid, rapid plant bug, conchuela, southern green stinkbug, spider mites (red spiders), grasshoppers, thrips, and tarnished plant bugs. Limited control of damage by insect pests can be achieved by proper timing of planting and other cultural practices or by selective breeding of varieties having some resistance to insect damage. Chemical insecticides, which were first introduced in the early 1900s, require careful and selective use because of ecological considerations but appear to be the most effective and efficient means of control.

Cotton plants are also subject to diseases caused by various pathogenic fungi, bacteria, and viruses and to damage by nematodes (parasitic worms) and physiological disturbances also classified as diseases. Because young seedlings are especially sensitive to attack by a complex of disease organisms, treatment of seeds before planting is common. Some varieties have been bred that are resistant to a bacterial disease called angular leaf spot. Soil fumigation moderately succeeded in combating such fungus diseases as fusarium wilt, verticillium wilt, and Texas root rot, which are restricted to certain conditions of soil, rainfall, and general climate. The breeding of resistant varieties, however, has been more effective. Genetically modified (GM) cotton contains the *Bacillus thuringiensis* (a bacterium) genes that encode toxins which have specific activities against species of the orders Lepidoptera (Moths and Butterflies), Diptera (Flies and Mosquitoes) and Coleoptera (Beetles). However, like many GM crops, the seeds of the plants are not viable for re-cultivation and new GM seed must be purchased at the beginning of every planting season.

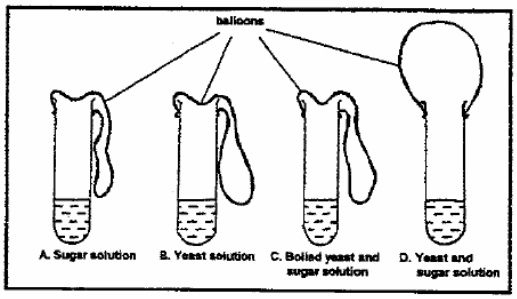
49. Which chromosome determines that a boy is born instead of a girl?

1 The X-chromosome of the father
2 The Y-chromosome of the mother
3 The X-chromosome of the mother
4 The Y-chromosome of the father

Answer: 4 (Encyclopaedia Britannica)

Sex chromosomes are either of a pair of chromosomes that determine whether an individual is male or female. The sex chromosomes of human beings and other mammals are designated by scientists as X and Y. In humans the sex chromosomes comprise one pair of the total of 23 pairs of chromosomes. The other 22 pairs of chromosomes are called autosomes. Individuals having two X chromosomes (XX) are female; individuals having one X chromosome and one Y chromosome (XY) are male. The X chromosome resembles a large autosomal chromosome with a long and a short arm. The Y chromosome has one long arm and a very short second arm. This path to maleness or femaleness originates at the moment of meiosis, when a cell divides to produce gametes, or sex cells having half the normal number of chromosomes. During meiosis the male XY sex-chromosome pair separates and passes on an X or a Y to separate gametes; the result is that one-half of the gametes (sperm) that are formed contains the X chromosome and the other half contains the Y chromosome. The female has two X chromosomes, and all female egg cells normally carry a single X. The eggs fertilized by X-bearing sperm become females (XX), whereas those fertilized by Y-bearing sperm become males (XY).

The diagram below shows the results of an experiment concerning anaerobic respiration (fermentation). Carbon dioxide is given off.



50. What is important during the planning stage and execution of the experiment?

1 It is not necessary to take temperature readings
2 The same amount of yeast, sugar and water should be used in each test tube
3 The size of the test tube and the size of the balloon is important
4 The experiment in all the test tubes should start at the same time

Answer: 2 (Encyclopaedia Britannica)

This experiment also proves that yeast cells are living, which is why the test tube in which the contents were first boiled, failed to

produce carbon dioxide. In conducting experiments, normally only one variable (the one under experimentation) is allowed, everything else must be kept the same; in this case temperature, the size of test tubes and the amounts of sugar, water and yeast used.

Baker's yeast is composed of living cells of the yeast strain *Saccharomyces cerevisiae*. It is a fungus commonly used to leaven bread. Bakers' yeast performs its leavening function by fermenting sugars such as glucose, fructose, maltose, and sucrose. It cannot use lactose, the predominant sugar of milk, or certain other carbohydrates. The principal products of fermentation are carbon dioxide, the leavening agent, and ethanol, an important component of the aroma of freshly baked bread. In the process of fermentation (generally known as glycolysis), which involves the activity of several enzymes, glucose is broken down into fructose 1,6-diphosphate, containing a phosphoryl group (originating from ATP) at each end. This molecule is then split into two smaller fragments (dihydroxyacetone phosphate and glyceraldehyde 3-phosphate) that are interconvertible. Subsequent steps convert these three carbon fragments into phosphoenol pyruvate which in turn is converted to pyruvate with concomitant production of ATP. The net yield is two molecules of ATP for each six-carbon sugar. In certain bacteria (e.g., so-called lactic acid bacteria) or in muscle cells functioning vigorously in the absence of adequate supplies of oxygen, pyruvate is then reduced to lactate via a reaction catalyzed by lactate dehydrogenase. Alternatively, in organisms such as yeast, pyruvate is first decarboxylated to form acetaldehyde and carbon dioxide in a reaction catalyzed by pyruvate decarboxylase. Acetaldehyde is then reduced to ethanol with alcohol dehydrogenase acting as the catalyst.