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QUESTIONS AND SOLUTIONS: BIOLOGY

1. A bacterial cell reproduces by mitosis at intervals of 20 seconds. Starting with a single bacterium in a dish, how many bacterial cells would be in the dish after one minute?

   A. 16
   B. 4
   C. 8
   D. 6

Answer: C

There are sixty seconds in a minute. In twenty seconds, there will be two bacterial cells. These will each divide in another twenty seconds to give 4 bacterial cells. After another twenty seconds, each of these will have divided once to give a total of 8 cells. The simple mathematical sequence for this twenty second replication is thus
2^n: n = 0, 1, 2, …

2. Forensic investigators would best make meaning out of the following

   A. Finger prints
   B. Blood pathogens
   C. Sweat
   D. Scratch marks

Answer: A (Encyclopaedia Britannica)

A fingerprint is an impression made by the papillary ridges on the ends of the fingers and thumbs. Fingerprints afford an infallible means of personal identification, because the ridge arrangement on every finger of every human being is unique and does not alter with growth or age. Fingerprints serve to reveal an individual's true identity despite personal denial, assumed names, or changes in personal appearance resulting from age, disease, plastic surgery, or accident. The practice of utilizing fingerprints as a means of identification, referred to as dactyloscopy, is an indispensable aid to modern law enforcement. Each ridge of the epidermis (outer skin) is dotted with sweat pores for its entire length and is anchored to the dermis (inner skin) by a double row of peg-like protuberances, or papillae. Injuries such as superficial burns, abrasions, or cuts do not affect the ridge structure or alter the dermal papillae, and the original pattern is duplicated in any new skin that grows. An injury that destroys the dermal papillae, however, will permanently obliterate the ridges. Any ridged area of the hand or foot may be used as identification. However, finger impressions are preferred to those from other parts of the body because they can be taken with a minimum of time and effort, and the ridges in such impressions form patterns (distinctive outlines or shapes) that can be readily sorted into groups for ease in filing.

Fingerprint patterns. From top left to bottom right: loop, double loop, central pocket loop, plain whorl, plain arch, and tented arch.

3. Which one of the following diseases is transmitted by an invertebrate vector?

A. Tuberculosis
B. Malaria
C. Measles
D. Rabies

Answer: B (Encyclopaedia Britannica)

Tuberculosis is an infectious disease that is caused by the tubercle bacillus, *Mycobacterium tuberculosis*. In most forms of the disease, the bacillus spreads slowly and widely in the lungs, causing the formation of hard nodules (tubercles) or large, cheese-like masses that break down the respiratory tissues and form cavities in the lungs. Blood vessels also can be eroded by the advancing disease, causing the infected person to cough up bright red blood. The tubercle bacillus is a small, rod-shaped bacterium that is extremely hardy; it can survive for months in a state of dryness and can also resist the action of mild disinfectants. Infection spreads primarily by the respiratory route directly from an infected person who discharges live bacilli into the air. Minute droplets ejected by sneezing, coughing, and even talking can contain hundreds of tubercle bacilli that may be inhaled by a healthy person. There the bacilli become trapped in the tissues of the body, are surrounded by immune cells, and finally are sealed up in hard, nodular tubercles. A tubercle usually consists of a centre of dead cells and tissues, cheese-like (caseous) in appearance, in which can be found many bacilli. This centre is surrounded by radially arranged phagocytic (scavenger) cells and a periphery containing connective tissue cells. The tubercle thus forms as a result of the body's defensive reaction to the bacilli. Individual tubercles are microscopic in size, but most of the visible manifestations of tuberculosis, from barely visible nodules to large tuberculous masses, are conglomerations of tubercles. In otherwise healthy children and adults, the primary infection often heals without causing symptoms. The bacilli are quickly sequestered in the tissues, and the infected person acquires a lifelong immunity to the disease. A skin test taken at any later time may reveal the earlier infection and the immunity, and a small scar in the lung may be visible by X-ray. In this condition, sometimes called latent tuberculosis, the affected person is not contagious. In some cases, however, sometimes after periods of time that can reach 40 years or more, the original tubercles break down, releasing viable bacilli into the bloodstream. From the blood the bacilli create new tissue infections

elsewhere in the body, most commonly in the upper portion of one or both lungs. This causes a condition known as pulmonary tuberculosis, a highly infectious stage of the disease. In some cases the infection may break into the pleural space between the lung and the chest wall, causing a pleural effusion, or collection of fluid outside the lung. Particularly among infants, the elderly, and immuno-compromised adults (organ transplant recipients or AIDS patients, for example), the primary infection may spread through the body, causing miliary tuberculosis, a highly fatal form if not adequately treated. In fact, once the bacilli enter the bloodstream, they can travel to almost any organ of the body, including the lymph nodes, bones and joints, skin, intestines, genital organs, kidneys, and bladder. An infection of the meninges that cover the brain causes tuberculous meningitis; before the advent of specific drugs, this disease was always fatal, though most affected people now recover.

Malaria is a serious, relapsing infection in humans, characterized by periodic attacks of chills and fever, anemia, splenomegaly (enlargement of the spleen), and often fatal complications. It is caused by one-celled parasites of the genus *Plasmodium* that are transmitted to humans by the bite of *Anopheles* mosquitoes. Malaria can occur in temperate regions, but it is most common in the tropics and subtropics. In many parts of sub-Saharan Africa, entire populations are infected more or less constantly. Malaria is also common in Central America, the northern half of South America, and in South and Southeast Asia. The disease also occurs in countries bordering on the Mediterranean, in the Middle East, and in East Asia. In Europe, North America, and the developed countries of East Asia, malaria is still encountered in travelers arriving or returning from affected tropical zones. Annual cases of malaria worldwide are estimated at 250 million, with more than one million deaths resulting—most of them young children in Africa. Malaria is actually four diseases caused by four related protozoan (single-celled) parasites: *Plasmodium falciparum*, *P. vivax*, *P. ovale*, and *P. malariae*. The most common is *P. vivax*; the deadliest is *P. falciparum*. The parasites are spread by the bite of infected female *Anopheles* mosquitoes, which feed on human blood in order to nourish their own eggs. While taking its meal (usually between dusk and dawn), an infected mosquito injects immature forms of the parasite, called sporozoites, into the person's bloodstream. The sporozoites are carried by the blood to the liver, where they mature into forms known as schizonts. Over the next one to two weeks each schizont multiplies into thousands of other forms known as merozoites. The merozoites break out of the liver and reenter the bloodstream, where they invade red blood cells, grow and divide further, and destroy the blood cells in the process. The interval between invasion of a blood cell and rupture of that cell by the next generation of merozoites is about 48 hours for *P. falciparum*, *P. vivax*, and *P.*

ovale; in *P. malariae* the cycle is 72 hours long. Most merozoites reproduce asexually—that is, by making identical copies of themselves rather than by mixing the genetic material of their parents. A few, however, develop into a sexual stage known as a gametocyte. These will mate only when they enter the gut of another mosquito that bites the infected person. Mating between gametocytes produces embroyonic forms called ookinetes; these embed themselves in the mosquito's gut, where they mature after 9 to 14 days into oocysts, which in turn break open and release thousands of sporozoites that migrate to the insect's salivary glands, ready to infect the next person in the cycle. Typically, victims who are bitten by malaria-carrying mosquitoes experience no symptoms until 10 to 28 days after infection. The first clinical signs may be any combination of chills, fever, headache, muscle ache, nausea, vomiting, diarrhea, and abdominal cramps. Chills and fever occur in periodic attacks; these last 4 to 10 hours and consist first of a stage of shaking and chills, then a stage of fever and severe headache, and finally a stage of profuse sweating during which the temperature drops back to normal. Between attacks the temperature may be normal or below normal. The classic attack cycles, recurring at intervals of 48 hours (in so-called tertian malaria) or 72 hours (quartan malaria), coincide with the synchronized release of each new generation of merozoites into the bloodstream. Often, however, a victim may be infected with different species of parasites at the same time or may have different generations of the same species being released out of synchrony—in which case the classic two- or three-day pattern may be replaced by more frequent rigours of chills, fever, and sweating. The parasites continue to multiply until the body's immune system suppresses the infection—unless the victim is treated with appropriate drugs or dies in the interim. Besides attacks, persons with malaria commonly have anemia (owing to the destruction of red blood cells by the parasites), enlargement of the spleen (the organ responsible for ridding the body of degenerate red blood cells), and general weakness and debility. Infections due to *P. falciparum* are by far the most dangerous. Victims of this “malignant tertian” form of the disease may deteriorate rapidly from mild symptoms to coma and death unless they are diagnosed and treated promptly and properly. The greater virulence of *P. falciparum* is associated with its tendency to infect a large proportion of the red blood cells; patients infected with that species will exhibit ten times the number of parasites per cubic millimetre of blood than patients infected with the other three malaria species. In addition, red blood cells infected with *P. falciparum* have a special tendency to adhere to the walls of the tiniest blood vessels, or capillaries. This results in obstruction of the blood flow in various organs, but the consequences are gravest when capillaries in the brain are affected, as they often are. It is this latter complication—known as cerebral malaria and manifested

by confusion, convulsions, and coma—that frequently kills victims of *P. falciparum* malaria. Several strains of *P. falciparum* have developed that are resistant to some of the drugs used to treat or prevent malaria.

Also called rubeola, measles is a contagious viral disease marked by fever, cough, conjunctivitis, and a characteristic rash. Measles is commonest in children but may appear in older persons who have escaped it earlier in life. Infants are immune up to four or five months of age if the mother has had the disease. Immunity to measles following an attack is usually lifelong. Measles is so highly communicable that the slightest contact with an active case may infect a susceptible person. After an incubation period of about 10 days, the patient develops fever, redness and watering of the eyes, profuse nasal discharge, and congestion of the mucous membranes of the nose and throat—symptoms often mistaken for those of a severe cold. This period of invasion lasts for 48 to 96 hours. The fever increases with appearance of a blotchy rash, and the temperature may rise as high as 40 °C (about 105 °F) when the rash reaches its maximum. Twenty-four to 36 hours before the rash develops, there appear in the mucous membranes of the mouth typical maculae, called Koplik spots—bluish-white specks surrounded by bright red areas about $^{1}/_{32}$ inch (0.75 mm) in diameter. After a day or two the rash becomes a deeper red and gradually fades, the temperature drops rapidly, and the catarrhal symptoms disappear. No drug is effective against measles; the only treatment required is control of fever, rest in bed, protection of the eyes, care of the bowels, and sometimes steam inhalations to relieve irritation of the bronchial tree. When no complications occur, the illness lasts 10 days. Uncomplicated measles is seldom fatal; deaths attributed to measles usually result from secondary bronchopneumonia caused by bacterial organisms entering the inflamed bronchial tree. On the other hand, complications of measles are frequent and include a superimposed bacterial ear infection or pneumonia or a primary measles lung infection. Encephalitis is a rare occurrence. Measles virus can invade various organ systems and cause hepatitis, appendicitis, and gangrene of the extremities. A large percentage of cases of severe measles are associated with inadequate intake of vitamin A, and there is evidence that treatment with vitamin A may reduce measles complications. Mortality caused by measles declined steadily in the 20th century as the health of children and infants improved and effective treatment of complications became possible through the use of sulfonamide and antibiotic drugs. The widespread use of measles vaccine, beginning in the late 1960s, raised hopes for the eventual eradication of the disease; but, contrary to expectations, the incidence of measles remains high worldwide. The main problem is that the vaccine is not given to infants before the age of nine months, when the disease is most serious in the less-

developed countries. Another problem is that the measles vaccine is a live vaccine, and it rapidly becomes inert if exposed to warm temperatures; 10 minutes in sunlight is sufficient to kill it. This sensitivity is a great hindrance to its use in tropical areas. Research is currently directed toward development of a more stable vaccine. In developed countries, a measles vaccine is commonly given at 12 to 15 months of age as part of a combined measles-mumps-rubella (MMR) vaccine.

Also called hydrophobia or lyssa, rabies is an acute, ordinarily fatal, viral disease of the central nervous system that is usually spread among domestic dogs and wild carnivorous animals by a bite. All warm-blooded animals, including humans, are susceptible to rabies infection. The virus, a rhabdovirus, is often present in the salivary glands of rabid animals and is excreted in the saliva; thus, the bite of the infected animal introduces the virus into a fresh wound. Under favourable conditions, the virus propagates along nerve tissue from the wound to the brain and becomes established in the central nervous system. After a time it spreads via nerves to the salivary glands, where it frequently produces a foaming at the mouth. The disease develops most often between four and six weeks after infection, but the incubation period may vary from 10 days to eight months. Rabies virus travels quickly in a bitten animal (e.g., raccoons, skunks, bats, foxes, dogs, and cats, among other smaller animals) from the bite to the central nervous system. The disease often begins with excitation of the central nervous system expressed as irritability and viciousness. A rabid animal is most dangerous during the early stages of the disease because it appears to be healthy and may seem friendly but will bite at the slightest provocation. Wild animals that appear to be tame and that approach people or human habitations in the daytime should be suspected of having rabies. Infected dogs usually show a short excitation phase that is characterized by restlessness, nervousness, irritability, and viciousness and is followed by depression and paralysis. After a few days they are unable to bite any more because the muscles of the throat are paralyzed; they seek only a quiet place to hide and die from the rapid spread of paralysis. Sudden death without recognizable signs of illness is also not uncommon. Dogs that develop the predominantly excited type of rabies invariably die of the infection, usually within three to five days after the onset of symptoms. Those that develop the paralytic type of rabies without any evidence of excitation or viciousness may recover on rare occasions. Paralysis of the “voice” muscles in rabid dogs may produce a characteristic change in the sound of the bark. Rabies in humans is similar to that in animals. Symptoms include depression, headache, nausea, seizures, anorexia, muscle stiffness, and increased production of saliva. Abnormal sensations, such as itching, around the site of exposure are a

common early symptom. The muscles of the throat become paralyzed so that the person cannot swallow or drink, and this leads to a dread of water (hydrophobia). The mental state of a person infected with rabies varies from maniacal excitement to dull apathy—the term rabies means “madness”—but soon the person falls into a coma and usually dies in less than one week owing to cardiac or respiratory failure. Sometimes rabies is characterized by paralysis without any evidence of excitation of the nervous system. In such cases the course of the disease may be prolonged to a week or more. There is no cure for rabies. The incubation period (the time that elapses between the bite and the first symptom) is usually one to three months but in rare cases has been as long as several years. This provides a chance to interrupt the otherwise inevitable progress of the infection. The bite should be washed immediately because much, if not all, of the virus can be thus removed. The bitten patient should then receive a dose of antirabies serum. Serum is derived from horses or humans that have been immunized with attenuated rabies virus; it provides the patient with already prepared antibodies against the rabies antigen. The treatment is effective if given within 24 hours after exposure but has little, if any, value if given three or more days after infection by rabies. Active immunization with rabies vaccine should also be initiated to allow the patient's body to make its own antibody. The safest and most effective vaccines are human diploid cell vaccine (HDCV), purified chick embryo cell culture (PCEC), and rabies vaccine adsorbed (RVA). With older vaccines, at least 16 injections were required, whereas with HDCV, PCEC, or RVA, 5 are usually sufficient. Persons at risk of rabies by virtue of occupation (e.g., veterinarians) or travel to endemic areas should receive rabies vaccine as a form of preexposure prophylaxis.

4. A boy with blood group A can donate blood to all his classmates with blood group(s)

   A. B
   B. AB and A
   C. O
   D. AB only

Answer: B (Encyclopaedia Britannica)

The human ABO blood groups were discovered by Austrian-born American biologist Karl Landsteiner in 1901. Landsteiner found that there are substances in the blood, antigens and antibodies, that induce clumping of red cells when red cells of one type are added to those of a second type. He recognized three groups—A, B, and O—based on their reactions to each other. A fourth group, AB, was identified a year later by another research team. Red cells of the A group clump with donor blood of the B group; those of the B group clump with blood of the A group; those of the AB group clump with those of the A or the B group because AB cells contain both A and

B antigens; and those of the O group do not generally clump with any group, because they do not contain either A or B antigens. The application of knowledge of the ABO system in blood transfusion practice is of enormous importance, since mistakes can have fatal consequences.

Blood group AB individuals have both A and B antigens on the surface of their red blood cells (RBCs), and their blood serum does not contain any antibodies against either A or B antigen. Therefore, an individual with type AB blood can receive blood from any group (with AB being preferable), but can donate blood only to another group AB individual.

Blood group A individuals have the A antigen on the surface of their RBCs, and blood serum containing IgM antibodies against the B antigen. Therefore, a group A individual can receive blood only from individuals of groups A or O (with A being preferable), and can donate blood to individuals of groups A or AB.

Blood group B individuals have the B antigen on the surface of their RBCs, and blood serum containing IgM antibodies against the A antigen. Therefore, a group B individual can receive blood only from individuals of groups B or O (with B being preferable), and can donate blood to individuals of groups B or AB.

Blood group O (or blood group zero in some countries) individuals do not have either A or B antigens on the surface of their RBCs, but their blood serum contains IgM anti-A antibodies and anti-B antibodies against the A and B blood group antigens. Therefore, a group O individual can receive blood only from a group O individual, but can donate blood to individuals of any ABO blood group (i.e., A, B, O or AB). If anyone needs a blood transfusion in a dire emergency, and if the time taken to process the recipient's blood would cause a detrimental delay, O Negative blood can be issued. Blood group O is the most common blood type throughout the world, particularly among peoples of South and Central America. Type B is prevalent in Asia, especially in northern India. Type A also is common all over the world; the highest frequency is among the Blackfoot Indians of Montana and in the Sami people of northern Scandinavia. The ABO antigens are developed well before birth and remain throughout life. Children acquire ABO antibodies passively from their mother before birth, but by three months infants are making their own—it is believed the stimulus for such antibody formation is from contact with ABO-like antigenic substances in nature. Erythroblastosis fetalis (hemolytic disease of the newborn) is a type of anemia in which the red blood cells of the fetus are destroyed by the maternal immune system because of a blood group incompatibility between the fetus and its mother, particularly in matings where the mother is type O and the father type A.

5. What would be the most likely vitamin deficiency of a patient having bleeding gums?

A. C
B. K
C. A
D. D

Answer: A (Encyclopaedia Brtitannica)

Vitamin C, also known as ascorbic acid, functions as a water-soluble antioxidant and as a cofactor in various enzyme systems, such as those involved in the synthesis of connective tissue components and neurotransmitters. Symptoms of scurvy, a disease caused by vitamin C deficiency, include pinpoint hemorrhages (petechiae) under the skin, bleeding gums, joint pain, and impaired wound healing. Although rare in developed countries, scurvy is seen occasionally in people consuming restricted diets, particularly those containing few fruits and vegetables, or in infants fed boiled cow's milk and no source of vitamin C. Scurvy can be prevented with relatively small quantities of vitamin C (10 milligrams [mg] per day), although recommended intakes, which aim to provide sufficient antioxidant protection, are closer to 100 mg per day. Disease states, environmental toxins, drugs, and other stresses can increase an individual's vitamin C needs. Smokers, for example, may require an additional 35 mg of the vitamin daily to maintain vitamin C levels comparable to non-smokers.

Vitamin K is necessary for the formation of prothrombin and other blood-clotting factors in the liver, and it also plays a role in bone metabolism. A form of the vitamin is produced by bacteria in the colon and can be utilized to some degree. Vitamin K deficiency causes impaired clotting of the blood and internal bleeding, even without injury. Due to poor transport of vitamin K across the placenta, newborn infants in developed countries are routinely given the vitamin intramuscularly or orally within six hours of birth to protect against a condition known as hemorrhagic disease of the newborn. Vitamin K deficiency is rare in adults, except in syndromes with poor fat absorption, in liver disease, or during treatment with certain anticoagulant drugs, which interfere with vitamin K metabolism. Bleeding due to vitamin K deficiency may be seen in patients whose gut bacteria have been killed by antibiotics.

Vitamin A deficiency is the leading cause of preventable blindness in children and is a major problem in the developing world, especially in Africa and Southeast Asia; in the poorest countries hundreds of thousands of children become blind each year due to a deficiency of the vitamin. Even a mild deficiency can impair immune function, thereby reducing resistance to disease. Night blindness is an early sign of vitamin A deficiency, followed by abnormal dryness of the eye and ultimately scarring of the cornea, a condition known as xerophthalmia. Other symptoms include dry skin, hardening of epithelial cells elsewhere in the body (such as mucous membranes), and impaired growth and development. In many areas where vitamin A deficiency is endemic, the incidence is being reduced by giving

children a single large dose of vitamin A every six months. A genetically modified form of rice containing beta-carotene, a precursor of vitamin A, has the potential to reduce greatly the incidence of vitamin A deficiency, but the use of this so-called golden rice is controversial.

Vitamin D (also known as vitamin D hormone) is synthesized in the body in a series of steps, starting in the skin by the action of sunlight's ultraviolet rays on a precursor compound; thus, without adequate food sources of vitamin D, a deficiency of the vitamin can occur when exposure to sunlight is limited. Lack of vitamin D in children causes rickets, a disease characterized by inadequate mineralization of bone, growth retardation, and skeletal deformities such as bowed legs. The adult form of rickets, known as osteomalacia, results in weak muscles as well as weak bones. Inadequate vitamin D may also contribute to the thinning of bones seen in osteoporosis. Individuals with limited sun exposure (including women who completely cover their bodies for religious reasons), elderly or homebound persons, and those with dark skin, particularly those who live in northern latitudes, are at risk of vitamin D deficiency. Vitamin D is found in very few foods naturally; thus fortification of milk and other foods (e.g., margarine, cereals, and breads) with the vitamin has helped protect those populations in which sun exposure is inadequate. Supplemental vitamin D also may help protect against bone fractures in the elderly, who make and activate vitamin D less efficiently even if exposed to sunlight.

6. Which one of the following is under the control of the parasympathetic nervous system?

   A. Speeding up the thinking process
   B. Tension in musculature
   C. Relaxation of the blood vessels
   D. Decreased blood flow to the gut

Answer: D (Encyclopaedia Britannica)

The parasympathetic nervous system primarily modulates visceral organs such as glands. Responses are never activated en masse as in the fight-or-flight sympathetic response. While providing important control of many tissues, the parasympathetic system, unlike the sympathetic system, is not crucial for the maintenance of life. The parasympathetic nervous system is organized in a manner similar to the sympathetic nervous system. Its motor component consists of preganglionic and postganglionic neurons. Both pre- and postganglionic neurons secrete acetylcholine as a neurotransmitter, but, like sympathetic ganglion cells, they also contain other neuroactive chemical agents that function as co-transmitters. Parasympathetic nerve fibres regulate the iris and lens of the eye. Various secretory glands located in the head are under parasympathetic control.

These include the lacrimal gland, which supplies tears to the cornea of the eye; salivary glands (sublingual, submandibular, and parotid glands), which produce saliva; and nasal mucous glands, which secrete mucus throughout the nasal air passages. The parasympathetic preganglionic neurons that regulate these functions originate in the reticular formation of the medulla oblongata. Preganglionic parasympathetic fibres of the 10th cranial (vagus) nerve arise from two different sites in the medulla oblongata. Neurons that slow heart rate arise from a part of the ventral medulla called the nucleus ambiguus, while those that control functions of the gastrointestinal tract arise from the dorsal vagal nucleus. After exiting the medulla in the vagus nerve and traveling to their respective organs, the fibres synapse on ganglion cells embedded in the organs themselves. The vagus nerve also contains visceral afferent fibres that carry sensory information from organs of the neck (larynx, pharynx, and trachea), chest (heart and lungs), and gastrointestinal tract into a visceral sensory nucleus located in the medulla called the solitary tract nucleus. The parasympathetic system activates digestive processes while the sympathetic system inhibits them. The sympathetic system inhibits digestive processes by two mechanisms: (1) contraction of circular smooth muscle sphincters located in the distal portion of the stomach (pyloric sphincter), small intestine (ileo-cecal sphincter), and rectum (internal anal sphincter), which act as valves to prevent the oral-to-anal passage (as well as reverse passage) of digestive products; and (2) inhibition of motor neurons throughout the length of the gut. In contrast, the parasympathetic system provides messages only to myenteric motor neurons.

7. Osmosis will continue to take place between two solutions until they become

   A. Hypertonic
   B. Hypotonic
   C. Isotonic
   D. Diluted

Answer: C (Wikipedia)

Osmosis is the spontaneous net movement of water through a semi-permeable membrane from a region of low solute concentration to a solution with a high solute concentration, up a solute concentration gradient. It is a physical process in which a solvent moves, without input of energy, across a semi permeable membrane (permeable to the solvent, but not the solute) separating two solutions of different concentrations. Osmosis releases energy, and can be made to do work, as when a growing tree-root splits a stone. Net movement of solvent is from the less-concentrated (*hypotonic*) to the more-concentrated (*hypertonic*) solution, which tends to reduce the difference in concentrations. This effect can be countered by increasing the pressure of the hypertonic solution, with respect to the hypotonic. The

osmotic pressure is defined to be the pressure required to maintain an equilibrium, with no net movement of solvent. Osmotic pressure is a colligative property, meaning that the property depends on the molar concentration of the solute but not on its identity. Osmosis is the result of diffusion across a semi-permeable membrane. It is important in biological systems as many biological membranes are semi-permeable. In general, these membranes are impermeable to organic solutes with large molecules, such as polysaccharides, while permeable to water and small, uncharged solutes.

8. A tree with severely damaged bark is likely to die from deprivation of

   A. Water
   B. Organic food
   C. Oxygen
   D. Mineral salts

Answer: B (Encyclopaedia Britannica)

Bark, in woody plants, are tissues external to the vascular cambium (the growth layer of the vascular cylinder); the term bark is also employed more popularly to refer to all tissues outside the wood. The inner soft bark, or bast, is produced by the vascular cambium; it consists of secondary phloem tissue whose innermost layer conveys food from the leaves to the rest of the plant. The outer bark, which is mostly dead tissue, is the product of the cork cambium (phellogen). Layered outer bark, containing cork and old, dead phloem, is known as rhytidome. The dead cork cells are lined with suberin, a fatty substance that makes them highly impermeable to gases and water. Gas exchange between the inner tissues of bark-covered roots and stems and their surroundings takes place through spongy areas (lenticels) in the cork. Bark is usually thinner than the woody part of the stem or root. Both inner bark (secondary phloem) and wood (secondary xylem) are generated by the vascular cambium layer of cells: bark toward the outside where the oldest layers may slough off, and wood toward the inside where it accumulates as dead tissue.

9. Which of the following animals use echolocation for movement and detection of objects in its path?

   A. Dolphins and bats
   B. Dolphins and seals
   C. Seals and birds
   D. Bats and birds

Answer: A (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).

10. Proteases do not break down carbohydrates and carbohydrases do not break down proteins. Why is this so?

    A. Enzymes are pH sensitive
    B. No protein digesting enzymes occur in the mouth
    C. No carbohydrate digesting enzymes occur in the stomach
    D. Enzymes are substrate specific

Answer: D (Encyclopaedia Britannica)

An enzyme will interact with only one type of substance or group of substances, called the substrate, to catalyze a certain kind of reaction. Because of this specificity, enzymes often have been named by adding the suffix “-ase” to the substrate's name (as in urease, which catalyzes the breakdown of urea). Not all enzymes have been named in this manner, however, and to ease the confusion surrounding enzyme nomenclature, a classification system has been developed based on the type of reaction the enzyme catalyzes. There are six principal categories and their reactions: (1) oxidoreductases, which are involved in electron transfer; (2) transferases, which transfer a chemical group from one substance to another; (3) hydrolases, which cleave the substrate by uptake of a water molecule (hydrolysis); (4) lyases, which form double bonds by adding or removing a chemical group; (5) isomerases, which transfer a group within a molecule to form an isomer; and (6) ligases, or synthetases, which couple the formation of various chemical bonds to the breakdown of a pyrophosphate bond in adenosine triphosphate or a similar nucleotide. Proteases and carbohydrases fall under hydrolases, a class of more than 200 enzymes that catalyze the hydrolysis of several types of compounds. Esterases include lipases, which break ester bonds (between a carboxylic acid and an alcohol) in lipids, and phosphatases, which act analogously upon phosphates; a narrower category comprises the nucleases, which are phosphatases that hydrolyze nucleic acids. Glycosidases sever bonds between sugar molecules in carbohydrates. Peptidases hydrolyze peptide bonds (between the carboxylic acid group of one

amino acid and the amino group of another) within protein molecules. Specific hydrolases also catalyze reactions that break ether (C-O) bonds; carbon–nitrogen (C-N) bonds other than peptide bonds; acid anhydride bonds; carbon–carbon (C-C) bonds; or phosphorus–nitrogen (P-N) bonds.

11. Which one of the following is true about growth responses in plants?

    A. Roots are positively geotropic and negatively hydrotropic
    B. Shoots are negatively phototropic and positively geotropic
    C. Shoots are positively phototropic and negatively geotropic
    D. Roots are negatively geotropic and positively phototropic

Answer: C (Encyclopaedia Brittanica)

Tropism is a respose or orientation of a plant or certain lower animals to a stimulus that acts with greater intensity from one direction than another. It may be achieved by active movement or by structural alteration. Forms of tropism include phototropism (response to light), geotropism (response to gravity), chemotropism (response to particular substances), hydrotropism (response to water), thigmotropism (response to mechanical stimulation), traumatotropism (response to wound lesion), and galvanotropism, or electrotropism (response to electric current). Most tropic movements are orthotropic; *i.e.,* they are directed toward the source of the stimulus. Plagiotropic movements are oblique to the direction of stimulus. Diatropic movements are at right angles to the direction of stimulus.

12. Identify the correct combination of characteristics for a good absorption surface in the human body

    A. Thin walled, large surface area, dense blood capillary network
    B. Thin walled, small surface area, dense capillary network
    C. Thick walled, large surface area, dense blood capillary network
    D. Thin walled, large surface area, sparse blood capillary network

Answer: A (Encyclopaedia Britannica)

The best example of this absorption surface is the small intestine. It is a long, narrow, folded or coiled tube extending from the stomach to the large intestine; it is the region where most digestion and absorption of food takes place. It is about 6.7 to 7.6 metres (22 to 25 feet) long, highly convoluted, and contained in the central and lower abdominal cavity. A thin membranous material, the mesentery, supports and somewhat suspends the intestines. The

mesentery contains areas of fat that help retain heat in the organs, as well as an extensive web of blood vessels. Nerves lead to the small intestine from two divisions of the autonomic nervous system: parasympathetic nerves initiate muscular contractions that move food along the tract (peristalsis), and sympathetic nerves suppress intestinal movements.

13. All of the following positively contribute to the conservation of animal species except one

    A. Protection of habitats
    B. Regulation of trophy hunting
    C. Environmental legislation
    D. Inbreeding within species

Answer: D (Encyclopaedia Britannica)
Inbreeding may be defined as mating of individuals more closely related than the average of the population. It increases the homozygosity and decreases the heterozygosity of the inbred animals. The so-called inbreeding coefficient is a measure of the loss of heterozygosity due to inbreeding, and it is expressed as a fraction, or percentage, of the amount of heterozygosity present when inbreeding started. After one generation of mating between full sibs or mating of sire with daughter or dam with son, the heterozygosity of the offspring is reduced by 25 percent (or the inbreeding coefficient is 25 percent). In the mating of half-sibs or double first cousins the inbreeding coefficient is 12.5 percent. Mating of single first cousins gives an inbreeding coefficient of 6.25 percent, and that of half first cousins 3.12 percent. Mating between full sibs in two successive generations decreases the heterozygosity by 37.5 percent, and in three generations by 50 percent. So-called inbred lines are produced by continuous consanguineous matings in several generations; genetic variation decreases within each line and increases between separate lines. Inbreeding increases the homozygosity of unfavourable as well as favourable genes. As a result there is a segregation of various kinds of congenital defects and, more important, a general decline in fertility and viability of the inbred animals.

14. Which one of the following is not a classification group or taxon?

    A. Species
    B. Family
    C. Population
    D. Class

Answer: C (Wikipedia)
Scientific classification or biological classification is a method by which biologists group and categorize species of organisms. Scientific classification also can be called scientific taxonomy, but should be distinguished from folk taxonomy, which lacks scientific basis. Modern classification has its root in the work of Carolus Linnaeus, who grouped species according to shared

physical characteristics. These groupings have since been revised to improve consistency with the Darwinian principle of common descent. Molecular systematics, which uses DNA sequences as data, has driven many recent revisions and is likely to continue to do so. Scientific classification belongs to the science of taxonomy or biological systematics. There are 7 main taxonomic ranks: kingdom, phylum/division, class, order, family, genus, species. There are slightly different ranks for zoology and different ranks for botany. As an example, the classification of a human being is:
Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Primates
Family: Hominidae
Genus: *Homo*
Species: *H. sapiens*

That of an apple is:
Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Rosales
Family: Rosaceae
Subfamily: Maloideae
Genus: *Malus*
Species: *M. domestica*

15. Which one of the following is not an adaptation against water loss?

    A. Hairy leaves
    B. Stomata on the under surface of leaves
    C. Tolerance of a narrow temperature range
    D. Tough exoskeletons of insects

Answer: C (Wikipedia)
Land animals and plants have adapted to their relatively dry environments and those in areas where water is scarce, even more so. Drought tolerance refers to the degree to which a plant is adapted to arid or drought conditions. *Desiccation tolerance* is an extreme degree of drought tolerance. Plants naturally adapted to dry conditions are called *xerophytes*. Drought tolerant plants typically make use of either C4 carbon fixation or crassulacean acid metabolism (CAM) to fix carbon during photosynthesis. Both are improvements over the more common but more basal C3 pathway in that they are more energy efficient. CAM is particularly good for arid conditions because carbon dioxide can be taken up at night, allowing the stomata to stay closed during the heat of day and thus reducing water loss. Many adaptations for dry conditions are structural, including the following: (i) adaptations of the stomata to reduce water loss, such as reduced numbers or waxy surfaces; (ii) water storage in succulent above-ground parts or water-filled tubers; (iii) adaptations in the root system to increase water absorption and (iv) trichomes (small hairs) on the leaves to absorb atmospheric water. The exoskeletons of arthropods (i.e. insects, spiders, myriapods and crustaceans) contain rigid and resistant

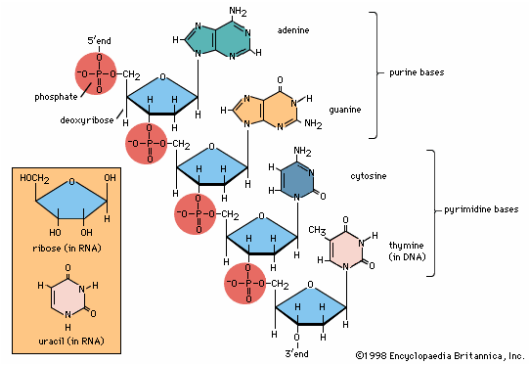
components that fulfil a set of functional roles including protection, excretion, sensing, support, feeding and (for terrestrial organisms) acting as a barrier against desiccation. Some mammals are also extraordinarily adapted to habitats. An example is the Kangaroo rat, found in arid and semi-arid areas of Canada, the United States and Mexico that retain some grass or other vegetation. They have very efficient kidneys. The kangaroo rat has a longer loop of Henle in the nephrons which permits a greater magnitude of countercurrent multiplication and thus a larger medullary vertical osmotic gradient. As a result, these rodents can produce urine that is concentrated up to an osmolarity of almost 6,000 mosm/liter, which is five times more concentrated than maximally concentrated human urine at 1,200 mosm/liter. Because of this tremendous concentration ability, kangaroo rats never have to drink; the H_2O produced metabolically within their cells during oxidation of foodstuff (food plus O_2 yields CO_2 + H_2O + energy) is sufficient for their body. Kangaroo rats lose so little water that they can recover 90% of the loss by using metabolic water gaining the remaining 10% from the small amount of water in their diet. Kangaroo rats lose water mainly by evaporation during gas exchange and gain water mainly from cellular metabolism.

16. The pyrimidine bases of DNA are

A. Guanine and Cytosine
B. Adenine and Guanine
C. Adenine and Thymine
D. Cytosine and Thymine

Answer: D (Encyclopaedia Britannica)

The nucleotide of DNA consists of a deoxyribose sugar molecule to which is attached a phosphate group and one of four nitrogenous bases: two purines (adenine and guanine) and two pyrimidines (cytosine and thymine). The nucleotides are joined together by covalent bonds between the phosphate of one nucleotide and the sugar of the next, forming a phosphate-sugar backbone from which the nitrogenous bases protrude. One strand is held to another by hydrogen bonds between the bases; the sequencing of this bonding is specific—i.e., adenine bonds only with thymine, and cytosine only with guanine. The nitrogenous bases in RNA are adenine, guanine, cytosine, and uracil.



17. The tendency of living organisms to maintain their internal environment constant within narrow limits is referred to as….

A. Equilibrium

B. Physiology
C. Homeostasis
D. Osmotic potential

Answer: C (Encyclopaedia Britannica)
Homeostasis is a self-regulating process by which biological systems tend to maintain stability while adjusting to conditions that are optimal for survival. If homeostasis is successful, life continues; if unsuccessful, disaster or death ensues. The stability attained is actually a dynamic equilibrium, in which continuous change occurs yet relatively uniform conditions prevail. The control of body temperature in humans is a good example of homeostasis in a biological system. In humans, normal body temperature fluctuates around the value of 98.6° F, but various factors can affect this value, including exposure, hormones, metabolic rate, and disease, leading to excessively high or low temperatures. The body's temperature regulation is thought to be controlled by a region in the brain called the hypothalamus. Feedback about body temperature is carried through the bloodstream to the brain and results in compensatory adjustments in the breathing rate, the level of blood sugar, and the metabolic rate. Heat loss in humans is aided by reduction of activity, by perspiration, and by heat-exchange mechanisms that permit larger amounts of blood to circulate near the skin surface. Heat loss is reduced by insulation, decreased circulation to the skin, and cultural modification such as the use of clothing, shelter, and external heat sources. The range between high and low body temperature levels constitutes the homeostatic plateau—the “normal” range that sustains life. As either of the two extremes is approached, corrective action (through negative feedback) returns the system to the normal range.

18. A patient whose gall bladder is surgically removed is most likely to encounter problems with….

A. Production of acids
B. Excretion of urea
C. Breakdown of fats
D. Absorption of mineral salts

Answer: C (Encyclopaedia Britannica)
The bile acids and their salts are detergents that emulsify fats in the gut during digestion. They are synthesized from cholesterol in the liver by a series of reactions that introduce a hydroxyl group into ring B and ring C and shorten the acyl side chain of ring D to seven carbons with the terminal carbon changed to a carboxyl group. The resulting molecule, cholic acid—as well as chenodeoxycholic acid (a close relative lacking the OH on ring C)—are usually found in the form of their salts, in which the amino acids taurine and glycine are chemically linked to the side-chain carboxyl group. These detergents are secreted from the liver into the gall bladder, where they are stored before being released through the bile duct into the small intestine. After performing an emulsifying action that is

essential in fat digestion, they are reabsorbed in the lower small intestine, returned through the blood to the liver, and reused. This cyclic process, called the enterohepatic circulation, handles 20 to 30 grams of bile acids per day in human beings. The small fraction that escapes this circulation is lost in the faeces. This is the major excretory route for cholesterol (though a smaller fraction is lost through the normal sloughing of dead skin cells).

19. An unknown food sample can be tested for the presence of starch and proteins by using

A. Benedict's solution and ethanol and filter paper
B. Iodine solution and Benedict's solution
C. Millon's reagent and Benedict's solution
D. Iodine solution and Millon's reagent

Answer: D (Wikipedia)

The Iodine test is used to test for the presence of starch. Iodine solution — iodine dissolved in an aqueous solution of potassium iodide — reacts with starch producing a deep blue-black color. This reaction is the result of the formation of polyiodide chains from the reaction of starch and iodine. The amylose, or straight chain portion of starch, forms helices where iodine molecules assemble, forming a dark blue/black colour. The amylopectin, or branched portion of starch, forms much shorter helices and iodine molecules are unable to assemble, leading the colour to be of an orange/yellow hue. As starch is broken down or hydrolyzed into smaller carbohydrate units, the blue-black colour is not produced. Therefore, this test can determine completion of hydrolysis when a colour change does not occur. Iodine solution will also react with glycogen, although the colour produced is browner and much less intense.

Millon's reagent is mercuric nitrate and nitric acid as used in the Millon reaction- the reaction of phenolic compounds (e.g., tyrosine in protein) with $Hg(NO_3)_2$ in HNO_3 (and a trace of HNO_2) to give a red colour.

Benedict's reagent (also called Benedict's solution or Benedict's test) is a chemical reagent named after an American chemist, Stanley Rossiter Benedict. Benedict's reagent is used as a test for the presence of reducing sugars such as glucose, fructose, galactose, lactose and maltose, or more generally for the presence of aldehydes (except aromatic ones). It can be prepared from sodium carbonate, sodium citrate and copper(II) sulfate. It is often used in place of Fehling's solution. Benedict's reagent contains blue copper(II) ions (Cu^{2+}) which are reduced to copper(I) (Cu^{+}). These are precipitated as red copper(I) oxide which is insoluble in water.

Fehling's solution is a solution used to differentiate between water soluble aldehyde and ketone functional groups. The substance to be tested is heated together

with Fehling's solution; a red precipitate indicates the presence of an aldehyde. Ketones (except alpha hydroxy ketones) do not react. An example for its use is to screen for glucose in urine, thus detecting diabetes. It was developed by German chemist Hermann von Fehling.

20. Athletes who do their training at high altitudes usually do well during running competitions. The best explanation for this is that their….

    A. Leg muscles relax and contract easily
    B. Bodies are very resistant to water loss
    C. Lung capacity is large
    D. Blood oxygen-carrying capacity is large.

Answer: D (Wikipedia)

Altitude training traditionally called training at an altitude camp, or now commonly using altitude simulation tents or mask based hypoxicator systems is the 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 hemoglobin. 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. Some athletes live permanently at high altitude, only returning to sea level to compete, but their training may suffer due to less available oxygen for workouts. A larger concentration of red blood cells allows more oxygen to be supplied to the muscles allowing higher performance. Increases in red blood cell mass are stimulated by an increase in erythropoietin (EPO). The body naturally produces EPO to regulate red blood cell mass and should not be confused with synthetic EPO. Synthetic EPO injections and blood doping are illegal in athletic competition because they cause an increase in red blood cells beyond the individual athlete's natural limits. This increase, unlike the increase caused by altitude training, can be dangerous to an athlete's health as the blood may become too thick and cause heart failure. The natural secretion of EPO by the human kidneys can be increased by altitude training, but the body has limits on the amount of natural EPO that it will secrete, thus avoiding the harmful side effects of the illegal doping.

21. Why is it important to keep newly born babies in warm clothing? Because they….

    A. are very susceptible to diseases and the clothing serves as a barrier to germs

B. are most used to confinement and not used to openness

C. have a large surface area to volume ratio and lose a lot of heat

D. have a small surface area to volume ratio and lose a lot of heat

Answer: C (Wikipedia)

The ratio between the surface area and volume of cells and organisms has an enormous impact on their biology. For example, many aquatic microorganisms have increased surface area to increase their drag in the water. This reduces their rate of sink and allows them to remain near the surface with less energy expenditure. If you have 3 cubes: one 2 cm each side, one 1 cm each side and one 0.5 cm each side...the SA/Vol ratio will double every single time i.e.: 2 cm cube would be 3:1 (surface area of a cube is length x breadth and there are 6 sides thus 2x2x6 = 24 cm^2. Its volume is length x breadth x height = 2x2x2 = 8); the 1 cm cube would be 6:1 and the 0.5 cm cube would be 12:1 This practically shows that every single time, the surface area doubles. Humans cannot rely on diffusion for their whole body. However, animals such as flatworms and leeches can, as they have less volume. An increased surface area to volume ratio also means increased exposure to the environment. The many tentacles of jellyfish and anemones are the result of increased surface area for the acquisition of food. Greater surface area allows more of the surrounding water to be sifted for food. Individual organs in animals are often based on the principle of greater surface area. The lung is an organ with numerous internal branching that increases the surface area through which oxygen is passed into the blood and carbon dioxide is released from the blood. The intestine has a finely wrinkled internal surface, increasing the area through which nutrients are absorbed by the body. This is done to increase the surface area in which diffusion of oxygen and carbon dioxide in the lungs and diffusion of nutrients in villi of the small intestine can occur. Cells can get around having a low surface area to volume ratio by being long and thin (nerve cells) or convoluted (microvilli). Increased surface area can also lead to biological problems. More contact with the environment through the surface of a cell or an organ (relative to its volume) increases loss of water and dissolved substances. High surface area to volume ratios also present problems of temperature control in unfavourable environments.

22. Where best would you grow a garden fern?

A. Open, windy place

B. Sunny, dry place

C. Dry, shady place

D. Moist, shady place

Answer: D (Wikipedia)

The ferns are extremely diverse in habitat, form, and reproductive methods. In size alone they range from minute filmy plants only 2 to 3 millimetres (0.08 to 0.12 inch) tall to huge tree ferns 10 to 25 metres (30 to 80 feet) in height. Some are twining vines; others float on the surface of ponds. The majority of ferns inhabit warm, damp areas of the Earth. Growing profusely in tropical areas, ferns diminish in number with increasingly higher latitudes and decreasing supplies of moisture. Few are found in dry, cold places. There are four particular types of habitats that ferns are found in: moist, shady forests; crevices in rock faces, especially when sheltered from the full sun; acid wetlands including bogs and swamps; and tropical trees, where many species are epiphytes.

23. Moodley severely damaged his tongue and lost the ability to taste and recognise sweetness. Which part of his tongue was damaged?

    A. The anterior free end
    B. The middle part
    C. The posterior edge close to the throat
    D. The sides

Answer: A (Encyclopaedia Britannica)

The mammalian tongue consists of a mass of interwoven, striated muscles interspaced with glands and fat and covered with mucous membrane. In humans the front tips and margins of the tongue usually touch the teeth, aiding in swallowing and speech. The top surface, or dorsum, contains numerous projections of the mucous membrane called papillae. They contain taste buds sensitive to food flavours and serous glands that secrete some of the fluid in saliva, a substance that moistens the oral cavity and helps lubricate food particles. The base, or upper rear portion, of the tongue has no papillae, but aggregated lymphatic tissue (lingual tonsils) and serous and mucus-secreting glands are present. The inferior, or under, surface leads from the tip of the tongue to the floor of the mouth; its mucous membrane is smooth, devoid of papillae, and purple in colour from the many blood vessels present. The root, the remainder of the underside that lies on the mouth's floor, contains bundles of nerves, arteries, and muscles that branch to the other tongue regions. Nerves from the tongue receive chemical stimulation from food in solution that gives the sensation of taste. There are four fundamental taste sensations, which derive from receptors that have specific topographical distribution: salt and sweet at the tip of the tongue, bitter at the base, and acid or sour along the borders. The total flavour of a food comes from the combination of taste, smell, touch, texture or consistency, and temperature sensations. Small taste buds situated on the tongue's top surface transmit these flavour sensations to the nervous system. Among the disorders to which the tongue is subject are cancer, leukoplakia (white patches), fungus infection, congenital defects, and a

variety of symptoms caused by disease elsewhere in the body. Surgical removal of this organ makes speech and swallowing difficult.

24. Both plant and animal cells possess….

A. Cell walls
B. Nuclei
C. Plastids
D. Large vacuoles

Answer: B (Encyclopaedia Britannica)

A cell is enclosed by the plasma membrane (plant, bacterial and fungal cells have cell walls in addition), which forms a selective barrier allowing nutrients to enter and waste products to leave. The interior is organized into many specialized compartments, or organelles, each surrounded by a separate membrane. One major organelle, the nucleus, contains the genetic information necessary for cell growth and reproduction. Each cell contains only one nucleus; other types of organelles are present in multiple copies in the cellular contents, or cytoplasm. The mitochondria are responsible for the energy transactions necessary for cell survival. The lysosomes digest unwanted materials within the cell. The endoplasmic reticulum and the Golgi apparatus play an important role in the internal organization of the cell by synthesizing selected molecules and then processing, sorting, and directing them to their proper locations. (Plant cells, in addition to all the above organelles, contain chloroplasts, which are responsible for photosynthesis, whereby the energy of sunlight is used to convert molecules of carbon dioxide [CO_2] and water [H_2O] into carbohydrates.) Between all of these organelles is the space in the cytoplasm called the cytosol, which is organized around a framework of fibrous molecules constituting the cytoskeleton. The cytosol contains more than 10,000 different kinds of molecules involved in cellular biosynthesis.

25. Which one of the following is a wrong deduction from the dental formula

$$\frac{2\ 1\ 2\ 3}{2\ 1\ 2\ 3}$$

A. There are 32 teeth altogether
B. There are four incisors in the upper jaw
C. There are four premolars in the lower jaw
D. There are three molars in the lower jaw

Answer: D (Wikipedia)

All mammals except the monotremes, the edentates, the pangolins, and the cetaceans have up to four distinct types of teeth, with a maximum number for each. These are the incisor *(cutting)*, the canine, the premolar, and the molar *(grinding)*. Mammals that have distinct types of teeth are heterodont; others are homodont. The number of teeth

of each type is written as a dental formula for one side of the mouth, with the upper and lower teeth shown on separate rows. The number of teeth in a mouth is twice that listed as there are two sides. In each set, the first number indicates incisors, the second, canines, the third, premolars, and the last, molars. For example, the formula 2.1.2.3 for upper teeth indicates 2 incisors, 1 canine, 2 premolars, and 3 molars on one side of the upper mouth.

26. Why are arteries thicker walled than veins?

A. Arteries carry oxygenated blood
B. Arteries branch to form arterioles
C. Arteries carry blood under pressure
D. Arteries convey blood to all organs

Answer: C (Encyclopaedia Britannica)

In human physiology, an artery is any of the vessels that, with one exception, carry oxygenated blood and nourishment from the heart to the tissues of the body. The exception, the pulmonary artery, carries oxygen-depleted blood to the lungs for oxygenation and removal of excess carbon dioxide. Arteries are muscular and elastic tubes that must transport blood under a high pressure exerted by the pumping action of the heart. The pulse, which can be felt over an artery lying near the surface of the skin, results from the alternate expansion and contraction of the arterial wall as the beating heart forces blood into the arterial system via the aorta. Large arteries branch off from the aorta and in turn give rise to smaller arteries until the level of the smallest arteries, or arterioles, is reached. The threadlike arterioles carry blood to networks of microscopic vessels called capillaries, which supply nourishment and oxygen to the tissues and carry away carbon dioxide and other products of metabolism by way of the veins. The largest artery is the aorta, which arises from the left ventricle of the heart. The aorta arches briefly upward before continuing downward close to the backbone; the arteries that supply blood to the head, neck, and arms arise from this arch and travel upward. As it descends along the backbone, the aorta gives rise to other major arteries that supply the internal organs of the thorax. After descending to the abdomen, the aorta divides into two terminal branches, each of which supplies blood to one leg. Each artery, no matter what its size, has walls with three layers, or coats. The innermost layer, or tunica intima, consists of a lining, a fine network of connective tissue, and a layer of elastic fibres bound together in a membrane pierced with many openings. The tunica media, or middle coat, is made up principally of smooth (involuntary) muscle cells and elastic fibres arranged in roughly spiral layers. The outermost coat, or tunica adventitia, is a tough layer consisting mainly of collagen fibres that act as a supportive element. The large arteries differ structurally

from the medium-sized arteries in that they have a much thicker tunica media and a somewhat thicker tunica adventitia.

27. Which one of the following practices in a zoo is ethical?

A. Allowing lions to feed on live antelopes
B. Allowing courtship between different species of civets
C. Putting to death by euthanasia a severely injured parrot
D. Dissection and display of the alimentary canal of a live rat for a group of grade 12 learners

Answer: C

Allowing lions to feed on live antelopes is cruel; one cannot cage animals to be killed by their natural predators. Allowing courtship between different species of civets might lead to cross-breeding which results in hybrid offspring having characteristics of both parents. Whilst this is not reprehensible (cross-breeding does occur in nature, e.g. a mule is a cross between a donkey and a horse) allowing caged animals to do so is questionable. Dissection of animals such as mice is done routinely for educational purposes in schools, universities and research laboratories. However, doing it in a zoo where most of the visitors are not science students, will cause revulsion.

28. The biological study of insects is known as

A. Insectivore
B. Anthropology
C. Ichthyology
D. Entomology

Answer: D

Insectivore is a common name applied to any of 450 or so species of mammals—comprising hedgehogs, golden moles, “true” moles, “true” shrews, the moonrat, gymnures, solenodons, and tenrecs—that subsist primarily on insects, other arthropods, and earthworms.

Anthropology, “the science of humanity,” which studies human beings in aspects ranging from the biology and evolutionary history of *Homo sapiens* to the features of society and culture that decisively distinguish humans from other animal species. Because of the diverse subject matter it encompasses, anthropology has become, especially since the middle of the 20th century, a collection of more specialized fields. Physical anthropology is the branch that concentrates on the biology and evolution of humanity. The branches that study the social and cultural constructions of human groups are variously recognized as belonging to cultural anthropology (or ethnology), social anthropology, linguistic anthropology, and psychological anthropology. Archaeology as the method of investigation of prehistoric cultures, has been an integral part of

anthropology since it became a self-conscious discipline in the latter half of the 19th century.

Ichthyology is the scientific study of fishes, including, as is usual with a science that is concerned with a large group of organisms, a number of specialized sub-disciplines: *e.g.,* taxonomy, anatomy (or morphology), behavioral science (ethology), ecology, and physiology. Because of the great importance of fishes as human food, economic ichthyology is a significant segment of the field.

Entomology is a branch of zoology dealing with the scientific study of insects. The Greek word *entomon,* meaning "notched," refers to the segmented body plan of the insect. The zoological categories of genetics, taxonomy, morphology, physiology, behaviour, and ecology are included in this field of study. Also included are the applied aspects of economic entomology, which encompasses the harmful and beneficial impact of insects on humans and their activities.

29. Suppose that in the sweet pea "T" is the gene for tallness and "t" is the gene for shortness. In a genetic cross between two plants, one heterozygous and the other homozygous tall, which one of the following would be true about the offspring?

    A. They are all phenotypically similar

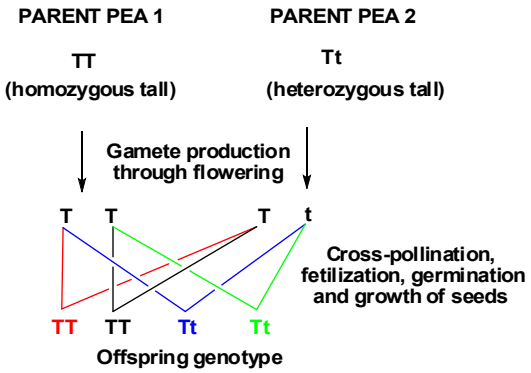
    B. They all have similar genotypes

    C. Three are tall and one is short

    D. One is tall and three are short

Answer: A

The cross over is best depicted as follows:



Since "T" is dominant, the offspring will all be tall even though half of them are heterozygous short.

30. Which one of the following plant tissues and functions are not correctly matched?

Tissue	Function
A. Epidermis	Protection
B. Xylem	Transport of water and minerals
C. Meristem	Growth
D. Parenchyma	Translocation of organic food

Answer: D (Wikipedia)

Parenchyma is the most common ground tissue. It forms, for example, the cortex and pith of stems, the cortex of roots, the mesophyll of leaves, the pulp of fruits, and the endosperm of seeds. Parenchyma cells are still meristematic, which means that they are capable of cell division even after maturation. They have thin but flexible cell walls, and are generally cube-shaped and loosely packed. They have large central vacuoles, which allows the cells to store nutrients and water. Parenchyma cells have a variety of functions: (1) In leaves, they form the mesophyll and are responsible for photosynthesis and the exchange of gases; (2) Storage; (3) Secretion (e.g. epithelial cells lining the inside of resin ducts); (4) Healing and (5) Other specialized functions. The form of parenchyma cells varies with their function. The epidermal parenchyma cells of a leaf are barrel shaped and have no chloroplasts. This tissue serves as a barrier wall and protects the internal tissues from injury. In the spongy mesophyll of a leaf, parenchyma cells are spherical and loosely arranged with large intercellular spaces. These cells, with the epidermal guard cells of the stomata, form a system of air spaces and chambers that regulate the exchange of gases. Translocation of organic food (from leaves, the sites of photosynthesis, to the rest of the plant) is done by the phloem.

31. Why would it be impossible to drown and kill a cockroach by holding its head down under water?

A. Cockroaches have lived for many centuries and are tolerant of many dangers
B. Cockroaches can survive without oxygen for many hours
C. Cockroaches take in air through holes situated elsewhere away from the head
D. Cockroaches have no blood and respire anaerobically

Answer: C (Wikipedia)

Cockroaches, like all insects, breathe through a system of tubes called tracheae. The tracheae of insects are attached to the spiracles, excluding the head. Thus, all insects, including cockroaches, can breathe without a head. The valves open when the CO_2 level in the insect rises to a high level; then the CO_2 diffuses out of the tracheae to the outside and fresh O_2 diffuses in. The tracheal system brings the air directly to cells because they branch continually like a tree until their finest divisions tracheoles are associated with each cell, allowing gaseous oxygen to dissolve in the cytoplasm lying across the fine cuticle lining of the tracheole. CO_2 diffuses out of the cell into the tracheole. Insects do not have lungs and thus do not actively breathe in the vertebrate lung manner. However, in some very large insects the diffusion process may not be sufficient to provide oxygen at the necessary rate and body musculature may contract rhythmically to forcibly move air out and in

the spiracles and one can actually call this breathing.

32. Mycorrhiza can be described as the association of pine roots and ….

A. Bacteria
B. Fungi
C. Ferns
D. Algae

Answer: B (Encyclopaedia Britannica)

Mycorrhiza, also spelled *Mycorhiza,* is an intimate association between the branched, tubular filaments (hyphae) of a fungus (kingdom Fungi) and the roots of higher plants. The association is usually of mutual benefit (symbiotic): a delicate balance between host plant and symbiont results in enhanced nutritional support for each member. The establishment and growth of certain plants (*e.g.,* citrus, orchids, pines) is dependent on mycorrhiza; other plants survive but do not flourish without their fungal symbionts. The two main types of mycorrhiza are endotrophic, in which the fungus invades the hosts' roots (*e.g.,* orchids), and ectotrophic, in which the fungus forms a mantle around the smaller roots (*e.g.,* pines). Exploitation of these natural associations can benefit forestry, horticulture, and other plant industries.

33. How best can the population of elephants in the Kruger Park be determined?

A. Mark-release-recapture method
B. Quadrats methods
C. Direct counting through game drives
D. Direct counting through aerial survey

Answer: D

The Kruger Park with an area of 7,523 square miles (19,485 square km, almost as big as the State of Israel!), is about 200 miles (320 km) long and 25 to 50 miles (40 to 80 km) wide. Thus, marking, releasing and recapturing all elephants in the park would be an unnecessary, labour intensive and very expensive exercise given the sheer size of the park. The area has a generally flat terrain with low ranges of hills traversed by nearly 5,000 miles of paved and gravel roads, but direct counting through game drives is not feasible too because in addition to the above reason, the animals move about. The quadrats method is also not feasible for the same reasons. A quadrat is a measured and marked square, used in field biology to isolate a sample area for the purpose of counting the population of different species within that area. By sampling many quadrats, biologists can create data sets for statistical analysis. This leaves direct counting by aerial survey as the only feasible option and indeed this is widely used.

34. Tabulated below are the tests and results from three food samples

Tests	Results
Iodine solution to food X	Blue-black
Millon's/Biuret test on food Y	Colourless
Benedict's/Fehlings test on food Z	Orange-red precipitate

What was contained in foods X, Y and Z?

Food X	Food Y	Food Z
A. Starch	Proteins	Fat
B. Starch	Proteins	Starch
C. Fat	Starch	Proteins
D. Starch	No proteins	Glucose

Answer: D

A blue-black colour during an iodine test on food X indicates the presence of starch. The Biuret and Millon tests detect the presence of proteins. In the Biuret test, peptide bonds react with Cu(II) ions to give a violet colour. The Millon test hinges on the reaction of phenolic compounds (e.g., tyrosine in protein) with $Hg(NO_3)_2$ in HNO_3 (and a trace of HNO_2) to give a red colour. No colour change in both cases means there are no proteins in food Y. Benedict's reagent is used as a test for the presence of reducing sugars such as glucose, fructose, galactose, lactose and maltose, or more generally for the presence of aldehydes. Benedict's reagent contains blue copper(II) ions (Cu^{2+}) which are reduced to copper(I) (Cu^{+}). These are precipitated as red copper(I) oxide which is insoluble in water. Fehling's solution is also used to test for aldoses (a.k.a. reducing sugars). Also based on Cu(II) chemistry, a red precipitate indicates the presence of an aldehyde.

35. Cellular respiration involves the substances below

(i) Oxygen
(ii) Carbon dioxide
(iii) Energy
(iv) Water
(v) Carbohydrates

Which one of the following equations correctly represents the substances in cellular respiration?

A. (ii) +(iii) = (i) +(iv) + (v)
B. (v) +(iv) = (i) +(ii) + (iii)
C. (iii) +(v) = (i) +(ii) + (iv)
D. (v) +(i) = (ii) +(iii) + (iv)

Answer: D (Encyclopaedia Britannica)

Cellular respiration is the process by which organisms combine oxygen with foodstuff molecules, diverting the chemical energy in these substances into life-sustaining processes and discarding, as waste products, carbon dioxide and water. Organisms that do not depend on oxygen degrade foodstuffs in a process called fermentation. One objective of the degradation of foodstuffs is to transduce the energy contained in chemical bonds into the energy-rich compound adenosine triphosphate (ATP). In eukaryotic cells the

enzymes that catalyze the individual steps involved in respiration and energy conservation are located in highly organized rod-shaped compartments of the cell called mitochondria. In micro-organisms the enzymes occur as components of the cell membrane. A liver cell has about 1,000 mitochondria; large egg cells of some vertebrates have up to 200,000. For the most part, the major foodstuffs (carbohydrates, fats, and proteins) are made available for the energy-yielding process by degradation to a two-carbon fragment (acetyl group) that, when combined as acetyl coenzyme A, provides the fuel for an important sequence of metabolic reactions called the tricarboxylic acid cycle (TCA cycle or the Krebs/ citric acid cycle cycle). Each pair of hydrogen atoms removed from a participant in the TCA cycle provides a pair of electrons that—through the action of a series of iron-containing hemoproteins, the cytochromes—eventually reduces one atom of oxygen to form water. In 1951 it was discovered that the transfer of one pair of electrons to oxygen results in the formation of three molecules of ATP. This process, called oxidative phosphorylation, or respiratory-chain phosphorylation, is the major mechanism by which the large amounts of energy in foodstuffs are conserved and made available to the cell. The series of steps by which electrons flow to oxygen permits a gradual lowering of the energy of the electrons.

36. The temporary blindness which follows movement from the bright sunny outside to a dim lighted room is associated with

A. Changes in the shape of the eye lens
B. Changes in the ciliary muscle and body
C. Changes in the suspensory ligaments
D. Changes in the diameter of the pupil

Answer: D (Encyclopaedia Britannica)

Flash blindness is caused by bleaching (oversaturation) of the retinal pigment. As the pigment returns to normal, so too does sight. In daylight the eye's pupil constricts, thus reducing the amount of light entering after a flash. At night, the dark-adapted pupil is wide open so flash blindness has a greater effect and lasts for a longer time. The pupil is the opening within the iris through which light passes before reaching the lens and being focused onto the retina. The size of the opening is governed by the muscles of the iris, which rapidly constrict the pupil when exposed to bright light and expand (dilate) the pupil in dim light. Parasympathetic nerve fibres from the third (oculomotor) cranial nerve innervate the muscle that causes constriction of the pupil, whereas sympathetic nerve fibres control dilation. The pupillary aperture also narrows when focusing on close objects and dilates for more distant viewing.

37. DNA replication is needed for….

A. Mitosis only
B. Meiosis only
C. Mitosis and meiosis
D. Either mitosis or meiosis depending on the type of cell

Answer: C (Encyclopaedia Britannica)

The process of *meiosis* is characteristic of organisms that reproduce sexually. Such species have in the nucleus of each cell a diploid (double) set of chromosomes, consisting of two haploid sets (one inherited from each parent). These haploid sets are homologous—*i.e.,* they contain the same kinds of genes, but not necessarily in the same form. In humans, for example, each set of homologous chromosomes contains a gene for blood type, but one set may have the gene for blood type A and the other set the gene for blood type B. Prior to meiosis, each of the chromosomes in the diploid germ cell has replicated and thus consists of a joined pair of duplicate chromatids. Meiosis begins with the contraction of the chromosomes in the nucleus of the diploid cell. Homologous paternal and maternal chromosomes pair up along the midline of the cell. Each pair of chromosomes—called a tetrad, or a bivalent—consists of four chromatids. At this point, the homologous chromosomes exchange genetic material by the process of crossing over. The homologous pairs then separate, each pair being pulled to opposite ends of the cell, which then pinches in half to form two daughter cells. Each daughter cell of this first meiotic division contains a haploid set of chromosomes. The chromosomes at this point still consist of duplicate chromatids. In the second meiotic division, each haploid daughter cell divides. There is no further reduction in chromosome number during this division, as it involves the separation of each chromatid pair into two chromosomes, which are pulled to the opposite ends of the daughter cells. Each daughter cell then divides in half, thereby producing a total of four different haploid gametes. When two gametes unite during fertilization, each contributes its haploid set of chromosomes to the new individual, restoring the diploid number.

During *mitosis*, one cell gives rise to two genetically identical daughter cells. Strictly applied, the term mitosis is used to describe the duplication and distribution of chromosomes, the structures that carry the genetic information. A brief treatment of mitosis follows. Prior to the onset of mitosis, the chromosomes have replicated and the proteins that will form the mitotic spindle have been synthesized. Mitosis begins at prophase with the thickening and coiling of the chromosomes. The nucleolus, a rounded structure, shrinks and disappears. The end of prophase is marked by the beginning of the organization of a group of fibres to form a spindle and the disintegration of the nuclear membrane. The chromosomes, each of which is a double structure

consisting of duplicate chromatids, line up along the midline of the cell at metaphase. In anaphase each chromatid pair separates into two identical chromosomes that are pulled to opposite ends of the cell by the spindle fibres. During telophase, the chromosomes begin to decondense, the spindle breaks down, and the nuclear membranes and nucleoli re-form. The cytoplasm of the mother cell divides to form two daughter cells, each containing the same number and kind of chromosomes as the mother cell. The stage, or phase, after the completion of mitosis is called interphase. Mitosis is absolutely essential to life because it provides new cells for growth and for replacement of worn-out cells. Mitosis may take minutes or hours, depending upon the kind of cells and species of organisms. It is influenced by time of day, temperature, and chemicals.

38. The table below lists a number of diseases and their causative agents. Choose the one disease for which antibiotic treatment would be appropriate.

Disease	**Causative Agent**
influenza	virus
food poisoning	bacterium
ringworm	fungus
malaria	protozoan

A. influenza
B. food poisoning
C. ringworm
D. malaria

Answer: B, but also C and D (Wikipedia)
An antibiotic is a chemotherapeutic agent that inhibits or abolishes the growth of micro-organisms, such as bacteria, fungi, or protozoans. The term originally referred to any agent with biological activity against living organisms; however, "antibiotic" now is used to refer to substances with anti-bacterial, anti-fungal, or anti-parasitic activity. The first antibiotic compounds used in modern medicine were produced and isolated from living organisms, such as the penicillin class produced by fungi in the genus *Penicillium*, or streptomycin from bacteria of the genus *Streptomyces*. With advances in organic chemistry many antibiotics are now also obtained by chemical synthesis, such as the sulfa drugs. Many antibiotics are relatively small molecules with a molecular weight less than 2000 Da.

39. The principles of genetics and evolution are employed in animal and plant breeding in which natural selection is then replaced by ….

A. artificial selection
B. deliberate selection
C. isolation
D. natural breeding

Answer: A (Encyclopaedia Britannica)
Artificial selection is the selective breeding of plants and animals by humans. It differs

from natural selection in that heritable variations in a species are manipulated by humans through controlled breeding. The breeder attempts to isolate and propagate those genotypes that are responsible for a plant or animal's desired qualities in a suitable environment. These qualities are economically or aesthetically desirable to humans, rather than useful to the organism in its natural environment.

40. The giraffe is a mammal and it has …. cervical (neck) vertebrae.

A. 14
B. 21
C. 7
D. none of the above

Answer: C (Encyclopaedia Britannica)

Giraffes (*Giraffa camelopardalis*) have only seven neck (cervical) vertebrae, but they are elongated. Thick-walled arteries in the neck have extra valves to counteract gravity when the head is up; when the giraffe lowers its head to the ground, special vessels at the base of the brain control blood pressure. The gait of the giraffe is a pace (both legs on one side move together). In a gallop it pushes off with the hind legs and the front legs come down almost together, but no two hooves touch the ground at the same time. The neck flexes so that balance is maintained. Speeds of 50 km (31 miles) per hour can be maintained for several kilometres, but 60 km (37 miles) per hour can be attained over short distances.

41. The first living photosynthetic organisms on earth were

A. proto-cells
B. green plants
C. cyanobacteria (blue-green algae)
D. gymnosperms

Answer: C (Wikipedia)

The biochemical capacity to use water as the source for electrons in photosynthesis evolved once, in a common ancestor of extant cyanobacteria. The geological record indicates that this transforming event took place early in our planet's history, at least 2450-2320 million years ago (Ma), and possibly much earlier. Geobiological interpretation of Archean (>2500 Ma) sedimentary rocks remains a challenge; available evidence indicates that life existed 3500 Ma, but the question of when oxygenic photosynthesis evolved continues to engender debate and research. A clear paleontological window on cyanobacterial evolution opened about 2000 Ma, revealing an already-diverse biota of blue-greens. Cyanobacteria remained principal primary producers throughout the Proterozoic Eon (2500-543 Ma), in part because the redox structure of the oceans favored photautotrophs capable of nitrogen fixation. Green algae joined blue-greens as major primary producers on continental shelves near the end of the Proterozoic, but only with the Mesozoic (251-65 Ma) radiations of

dinoflagellates, coccolithophorids, and diatoms did primary production in marine shelf waters take modern form. Cyanobacteria remain critical to marine ecosystems as primary producers in oceanic gyres, as agents of biological nitrogen fixation, and, in modified form, as the plastids of marine algae.

42. Parasitic fungi obtain their nutrients (food) from ….

A. living host tissue
B. the mycelium
C. bacteria
D. dead organic matter

Answer: A (Encyclopaedia Britannica)
In contrast with the saprobic fungi, which feed on dead organic matter, parasitic fungi attack living organisms, penetrate their outer defenses, invade them, and obtain nourishment from living cytoplasm, causing disease and sometimes the death of the host. Most pathogenic (disease-causing) fungi are parasites of plants, but several are known to cause diseases of humans and lower animals. Most parasites enter the host through a natural opening, such as a stomate (microscopic air pore) in a leaf, a lenticel (small opening through bark) in a stem, a broken plant hair or a hair socket in a fruit, or a wound in the plant or animal epidermis (skin). Such wounds may be insect punctures or accidentally inflicted scratches, cuts, or bruises. Among the most common and widespread diseases of plants caused by fungi are the various downy mildews (*e.g.,* of grape, onion, tobacco), the powdery mildews (*e.g.,* of grape, cherry, apple, peach, rose, lilac), the smuts (*e.g.,* of corn, wheat, onion), the rusts (*e.g.,* of wheat, oats, beans, asparagus, snapdragon, hollyhock), apple scab, brown rot of stone fruits, and various leaf spots, blights, and wilts. These diseases cause great damage annually throughout the world.

43. Which is not true regarding the mammals?

A. They include groups that lay eggs
B. They include several sub-classes including the pouch animals
C. Produce mother's milk from the mammary glands
D. Are ectothermic (cold-blooded)

Answer: D (Encyclopaedia Britannica)
A mammal is any member of the group of vertebrate animals in which the young are nourished with milk from special mammary glands of the mother. In addition to these characteristic milk glands, mammals are distinguished by several other unique features. Hair is a typical mammalian feature, although in many whales it has disappeared except in the fetal stage. The mammalian lower jaw is hinged directly to the skull, instead of through a separate bone (the quadrate) as in all other vertebrates. A

chain of three tiny bones transmits sound waves across the middle ear. A muscular diaphragm separates the heart and the lungs from the abdominal cavity. Only the left aortic arch persists. (In birds the right aortic arch persists; in reptiles, amphibians, and fishes both arches are retained.) Mature red blood cells (erythrocytes) in all mammals lack a nucleus; all other vertebrates have nucleated red blood cells. Except for the monotremes (an egg-laying order of mammals comprising echidnas and the duck-billed platypus), all mammals are viviparous—they bear live young. In the placental mammals (including humans), the young are carried within the mother's womb, reaching a relatively advanced stage of development before birth. In the marsupials (kangaroos, opossums, and allies), the newborn are incompletely developed at birth and continue to develop outside the womb, attaching themselves to the female's body in the area of her mammary glands. Some marsupials have a pouch-like structure or fold, the marsupium, that shelters the suckling young.

44. The marsupials such as the kangaroos are ….

A. placental mammals
B. lay eggs and are therefore kinds of reptiles
C. known as pouch animals
D. know as cold-blooded mammals

Answer: C (Encyclopaedia Britannica)

Marsupials, of which there are more than 250 species, belong to the infraclass Metatheria (sometimes called Marsupialia), a mammalian group characterized by premature birth and continued development of the newborn while attached to the nipples on the lower belly of the mother. The pouch, or marsupium, from which the group takes its name, is a flap of skin covering the nipples. Although prominent in many species, it is not a universal feature—in some species the nipples are fully exposed or are bounded by mere remnants of a pouch. The young remain firmly attached to the milk-giving teats for a period corresponding roughly to the latter part of development of the foetus in the womb of a placental mammal (eutherian). A placenta is the vascular (supplied with blood vessels) organ in most mammals that unites the foetus to the uterus of the mother. It mediates the metabolic exchanges of the developing individual through an intimate association of embryonic tissues and of certain uterine tissues, serving the functions of nutrition, respiration, and excretion. Marsupials and monotremes do not have a placenta.

45. Setae (chaetae) are:

A. hairs or bristles of the annelids used in locomotion
B. excretory organs in annelids
C. locomotory organs found in flatworms

D. digestive organs in the annelids

Answer: A (Encyclopaedia Britannica)

Annelids have a thin, horny cuticle pierced by pores through which epidermal glands secrete mucus. In some marine annelids, glands are also present that secrete materials constituting a parchmentlike or calcareous tube within which the worm dwells. Earthworms and leeches secrete cocoons from a specialized epidermis in a region of the body known as the clitellum. A major feature of all annelids except leeches is the possession of bristles, or chaetae, of which there are many varieties. The bulk of each chaeta is secreted by a single cell, though the surrounding lateral cells may contribute materials that bring about its hardening. Setae help earthworms attach to the surface and prevent backsliding during peristaltic motion. These hairs are what make it difficult to pull a worm straight from the ground.

46. Which of the following are examples of vestigial structures?

A. your tailbone
B. nipples on male mammals
C. sixth fingers found on some humans
D. your kneecap

Answer: A (Wikipedia)

Vestigial structures are those that have their original function in a species through evolution. In humans, examples are the vermiform appendix,. the coccyx, or tailbone (a remnant of a lost tail); the plica semilunaris on the inside corner of the eye (a remnant of the nictitating membrane); and, muscles in the ear and other parts of the body.

47. The widespread use of …. To control insect pests has lead to the evolution of resistance to this chemical by many species.

A. ARVs
B. DNA
C. DDT
D. Antibiotics

Answer: C (Encyclopaedia Britannica)

DDT is the abbreviation of *dichlorodiphenyltrichloroethane, also called 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane* a synthetic insecticide belonging to the family of organic halogen compounds, highly toxic toward a wide variety of insects as a contact poison that apparently exerts its effect by disorganizing the nervous system. DDT, prepared by the reaction of chloral with chlorobenzene in the presence of sulfuric acid, was first made in 1874; its insecticidal properties were discovered in 1939 by a Swiss chemist, Paul Hermann Müller. During and after World War II, DDT was found to be effective against lice, fleas, and mosquitoes (the carriers of typhus, of plague, and of malaria and yellow fever,

respectively) as well as the Colorado potato beetle, the gypsy moth, and other insects that attack valuable crops. Many species of insects rapidly develop populations resistant to DDT; the high stability of the compound leads to its accumulation in insects that constitute the diet of other animals, with toxic effects on them, especially certain birds and fishes. These two disadvantages had severely decreased the value of DDT as an insecticide by the 1960s, and severe restrictions were imposed on its use in the United States in 1972. Pure DDT is a colourless, crystalline solid that melts at 109° C (228° F); the commercial product, which is usually 65 to 80 percent active compound, along with related substances, is an amorphous powder that has a lower melting point. DDT is applied as a dust or by spraying its aqueous suspension.

48. What term refers to the mass of threads that forms the body of most fungi?

A. hyphae
B. mycelium
C. sporangia
D. basidium

Answer: B (Encyclopaedia Britannica)
A typical fungus consists of a mass of branched, tubular filaments enclosed by a rigid cell wall. The filaments, called hyphae (singular hypha), branch repeatedly into a complicated, radially-expanding network called the mycelium, which makes up the thallus, or undifferentiated body, of the typical fungus. Some fungi, notably the yeasts, do not form a mycelium but grow as individual cells that multiply by budding or, in certain species, by fission. The mycelium grows by utilizing nutrients from the environment and, upon reaching a certain stage of maturity, forms—either directly or in special fruiting bodies—reproductive cells called spores. The spores are released and dispersed by a wide variety of passive or active mechanisms; upon reaching a suitable substrate, the spores germinate and develop hyphae that grow, branch repeatedly, and become the mycelium of the new individual. Fungal growth is mainly confined to the tips of the hyphae.

49. If you put an unripe banana in a bag with an apple, it will quickly ripen because of the hormone …. produced by the apple.

A. cytokinin
B. gibberellin
C. abscisic acid
D. ethylene

Answer: D (Encyclopaedia Britannica)
Growth in plants is regulated by a variety of plant hormones, including auxins, gibberellins, cytokinins, and growth inhibitors, primarily abscisic acid and ethylene. The distribution of *auxins*, which promote the lengthwise growth of plants, is correlated with the distribution of the growth regions of the plant. In addition to promoting

normal growth in plant length, auxins influence the growth of stems toward the light (phototropism) and against the force of gravity (geotropism). The phototropic response occurs because greater quantities of auxin are distributed to the side away from the light than to the side toward it; the geotropic response occurs because more auxin accumulates along the lower side of the coleoptile than along the upper side. The downward growth of roots is also associated with a greater quantity of auxin in their lower halves.

Gibberellins are named after the fungus *Gibberella fujikuroi,* which produces excessive growth and poor yield in rice plants. One gibberellin is gibberellic acid (GA_3), which is present in higher plants as well as in fungi; many related compounds have structural variations that correlate with marked differences in effectiveness. Gibberellins, abundant in seeds, are also formed in young leaves and in roots; they move upward from the roots in the xylem (woody tissue) and thus do not show the movement characteristic of auxins. Evidence suggests that gibberellins promote the growth of main stems, especially when applied to the whole plant.

Cytokinins are compounds derived from a nitrogen-containing compound (adenine). One cytokinin is 6-furfurylaminopurine (kinetin); other compounds derived from adenine with effects similar to those of kinetin, and certain compounds derived from another nitrogen-containing compound, urea, are conveniently referred to as cytokinins, although not all are natural products. Cytokinins are synthesized in roots, from which, like the gibberellins, they move upward in the xylem and pass into the leaves and the fruit. Required for normal growth and differentiation, cytokinins act, in conjunction with auxins, to promote cell division and to retard senescence, which, at least in its early stages, is an organized phase of metabolism and not just a breakdown of tissue. An example of senescence is the yellowing of isolated leaves, which occurs as proteins are broken down and chlorophyll is destroyed. Cytokinins, which prevent yellowing by stabilizing the content of protein and chlorophyll in the leaf and the structure of chloroplasts, are used commercially in the storage of green vegetables.

Growth inhibitors of various types have been identified in plants. The best characterized one is *abscisic acid*, which is chemically related to the cytokinins. It is probably universally distributed in higher plants and has a variety of actions; for example, it promotes abscission (leaf fall), the development of dormancy in buds, and the formation of potato tubers. The mode of action of abscisic acid has not yet been clarified but is thought to involve the direct inhibition of the synthesis of RNA and protein.

Another growth inhibitor is *ethylene*, which is a natural product of plants, formed possibly from linolenic acid (a fatty acid) or from methionine (an amino acid). Ethylene promotes abscission in senescent leaves,

perhaps by facilitating the destruction of auxin. Its effects extend beyond that of inhibiting growth; in fruit, for example, ethylene is regarded as a ripening hormone. Involved in its action in fruit is another factor, perhaps auxin or another growth-regulating hormone, which influences the ethylene sensitivity of the tissues.

50. Roots turn downward in a process known as?

A. reverse phototropism
B. taxis
C. apical dominance
D. gravitropism

Answer: D

Refer to Question 11 for a detailed explanation on tropism.

51. Which of the following is an advantage of social groupings of animals?

A. increased ability to detect, repel or confuse predators
B. increased hunting efficiency
C. increased likelihood of finding mates
D. touch, maintains social bonds

Answer: All Correct (Encyclopaedia Britannica)

By social behaviour animals gain: (1) food and other resources, (2) reproductive advantages, and (3) shelter and space. They are enabled to avoid (4) physical and other small hazards, (5) competitors, and (6) predators or other large dangers. The first and third of these gains are reactions to desirable things of small (1) and medium to large size (3) respectively; the fourth and sixth are reactions to undesirable things of these sizes. The value of being social in getting food is obvious in the case of hunting bands. Cooperative hunting has been found among wolves and African hunting dogs, hyenas, lions, killer whales, porpoises, cormorants, white pelicans, pairs of eagles and of ravens, tuna when chasing small fish, army ants, primitive and modern men, and many other animals. Animals that hunt cooperatively can trap, chase, and tear apart prey that would otherwise be too fast, strong, or large for them. It was noted that sex is a way of combining desirable genes from different lines, genes that otherwise might slowly or never get together. In many lines of animals, parental behaviour is clearly useful in protecting or teaching the young. This normally requires the adult to have fewer young. The careful parent loses in time and energy and number of offspring but comes to prevail in evolution if it has more descendants than does a careless parent that lets its young die. Social behaviour is often used in habitat selection and shelter selection, even to the extent of making it possible for the animal to improve the environment it finds. Cooperative building of structures is well known in humans, prairie dogs, rats (whose tunnel

systems rival the catacombs in complexity), beavers, certain weaver finches, wasps, bees, termites, and many others; symbiotic use of structures occurs in many animals. Social behaviour can also help animals avoid small hazards. This includes avoiding heat or cold and wet or dry situations as well as preening or grooming to keep off dirt, parasites, and other small environmental hazards. A goose cleaving the air for its companions at the front of a V-shaped flock, a parent bird brooding its young or sheltering it from the Sun, a group of creepers roosting together to help each other survive the cold winter night, and a group of baboons grooming each other to pick off ticks furnish other examples. Dangers from competition are avoided by agonistic behaviour. The five basic types of agonistic behaviour are aggressive display (threat), submissive display (appeasement), attack, avoidance, and fighting. The final reason for social behaviour, and one of the most important, is to avoid predators or other large dangers. Just as animals can sometimes overcome large prey by grouping to attack it, so they can sometimes overcome large predators by grouping to defend against them. Cooperative and spirited attacks upon predators occur in most animals that protect their young and are a regular phenomenon in gull and tern colonies, in baboon troupes, in bees and wasps, and many others. “Mobbing” is a similar phenomenon in which the attack is not carried all the way to the predator but so harasses it that it departs or at least is prevented from getting its prey. The massed effect of many mobbing birds is more intimidating to a predator than is mobbing by one or two birds. Grouping also helps against predators because a predator is distracted by the “confusion effect” of so many shapes, sounds, or smells. Another advantage of the group or flock is that many eyes can see a predator more quickly than can one pair of eyes.

52. When a male rat defeats another male and takes his harem, the new male often kills any current litters. What principle does this behaviour represent?

A. altruism
B. kin selection
C. operant conditioning
D. parental investment

Answer: D (Wikipedia)

Infanticide based on sexual competition has the general theme of the killer (often male) becoming the new sexual partner of the victim's parent which would otherwise be unavailable to it. This represents a gain in fitness by the killer, and a loss in fitness by the parent of the offspring killed. This is a form of sexual conflict and is a type of evolutionary struggle between the two sexes, in which the victim sex may have its own counter-adaptations which reduce the success of this practice. When a male tries to take over a group, there is a violent struggle with the existing male. If successful

in overthrowing the previous male, infants of the females are then killed. This infanticidal period is limited to the window just after the group is taken over. This behaviour not only reduces intraspecific competition between the incumbent's offspring and those of other males and increases the parental investment afforded to their own young, but also allows females to become sexually receptive sooner. This is because females of many mammals, do not ovulate during the period in which they produce milk. It then becomes easier to see how this behaviour could have evolved. If a male kills a female's young, they stop lactating and are able to become pregnant again. As males are in a constant struggle to protect their group, those that express infanticidal behaviour will contribute a larger portion to future gene pools. The behaviour has been observed in many species, including monkeys, rats and lions.

Parental investment means any investment by the parent in an individual offspring that increases the offspring's chance of surviving (and hence reproductive success) at the cost of the parent's ability to invest in other offspring.

In the science of ethology (the study of behaviour), and more generally in the study of social evolution, *altruism* refers to behaviour by an individual that increases the fitness of another individual while decreasing the fitness of the actor (potential self-sacrifice).

Kin selection means the evolution of characteristics which favour the survival of close relatives of the affected individual, by processes which do not require any discontinuities in the population breeding structure. Parental care is, therefore, a form of altruism readily explained by kin selection. Kin selection extends beyond the relationship between parents and their offspring. It facilitates the development of altruistic behaviour when the energy invested, or the risk incurred, by an individual is compensated in excess by the benefits ensuing to relatives. Adult zebras, for instance, will turn toward an attacking predator to protect the young in the herd rather than fleeing to protect themselves. Operant conditioning is the use of consequences to modify the occurrence and form of behaviour.

Operant conditioning is distinguished from Pavlovian conditioning in that operant conditioning deals with the modification of "voluntary behaviour" through the use of consequences, while Pavlovian conditioning deals with the conditioning of behaviour so that it occurs under new antedecent conditions.

53. Why do many animals defend territories?

A. to monopolise the resources within the territory
B. to avoid predation
C. to secure over-wintering sites
D. to avoid each other

Answer: A (Wikipedia)

The term territory refers to any geographical area that an animal of a particular species consistently defends against conspecifics (and, occasionally, animals of other species). Animals that defend territories in this way are referred to as capricornius. The most obvious examples of the "classic" territory are birds and fish. Animals like these defend territories that contain their nest site and sufficient food resources for themselves and their young. Defence rarely takes the form of overt fights: more usually there is a highly noticeable display, which may be visual (as in the red breast of the robin), auditory (as in much bird song, or the calls of gibbons) or olfactory, through the deposit of scent marks. Many territorial mammals use scent-marking to signal the boundaries of their territories; the marks may be deposited by urination, by defecation, or by rubbing parts of the bodies that bear specialised scent glands against the substrate. For example, dogs and other canids scent-mark by urination and defecation, while cats scent-mark by rubbing their faces and flanks against objects. Territoriality is only shown by a minority of species. More commonly, an individual or a group of animals will have an area that it habitually uses but does not necessarily defend; this is called its home range. The home ranges of different groups often overlap, and in the overlap areas the groups will tend to avoid each other rather than seeking to expel each other. Within the home range there may be a core area that no other individual group uses, but again this is as a result of avoidance rather than defence. Behavioural ecologists have argued that food distribution determines whether a species will be territorial or not. Territoriality is only expected to emerge where there is a focused resource that provides enough for the individual or group, within a boundary that is small enough to be defended without the expenditure of too much effort.

54. If a population is above carrying capacity, what must happen?

A. It must immediately crash
B. It can remain stable indefinitely
C. If the species is territorial, it can continue to increase
D. It must eventually decline

Answer: D (Encyclopaedia Britannica)

Carrying capacity is the average population density or population size of a species below which its numbers tend to increase and above which its numbers tend to decrease because of shortages of resources. The carrying capacity is different for each species in a habitat because of that species' particular food, shelter, and social requirements.

55. Which of the following is an example of commensal relationship?

A. orchids growing on tree limbs
B. flowering plants and their pollinators
C. lupines and blue butterflies
D. monarch and viceroy butterflies

Answer: A (Wikipedia)

Commensalism is a term employed in ecology to describe a relationship between two living organisms where one benefits and the other is not significantly harmed or helped. It is derived from the English word *commensal*, meaning the sharing of food, and used of human social interaction. The word derives from the Latin *com mensa*, meaning *sharing a table*. Commensalism can be in several forms, for example: (i) Phoresy: One animal attaching to another animal for transportation only. This concerns mainly arthropods, examples of which are mites on insects (such as beetles, flies, or bees), pseudoscorpions on mammals and millipedes on birds. Phoresy can be either obligate or facultative (induced by environmental conditions); (ii) Inquilinism: Using a second organism for housing. Examples are epiphytic plants (such as many orchids) which grow on trees, or birds that live in holes in trees; (iii) Metabiosis: A more indirect dependency, in which the second organism uses something the first created, however after the death of the first. An example is the hermit crabs that use gastropod shells to protect their bodies.

56. Why do scientists think that human-induced global warming will be more harmful to plants and animals than were past, natural climate fluctuations?

A. because temperature will change fast
B. because the temperature changes will be larger
C. because species now are less adaptable than species in the past
D. because ecosystems are now more complicated than they used to be

Answer: B (Encyclopaedia Britannica)

Global warming is an increase in global average surface temperature resulting from an increase in the amount of carbon dioxide, methane, and certain other trace gases in the atmosphere. These gases are known collectively as greenhouse gases because they contribute to a warming of the Earth's surface and lower atmosphere, a phenomenon called the greenhouse effect. In part because the emission of carbon dioxide is related to the essential use of carbon-based energy sources, the issue of global warming incorporates a broad scientific and political debate about its significance and consequences. Increasing global temperature will cause sea level to rise, and is expected to increase the intensity of extreme weather events and to change the amount and pattern of

precipitation. Other effects of global warming include changes in agricultural yields, trade routes, glacier retreat, species extinctions and increases in the ranges of disease vectors. Concerned about such projections and their potentially severe consequences for human populations and the environment, nations around the world in the late 1980s and early 1990s focused their attention on developing policies to control greenhouse gases. One step was to organize the scientific community to provide information on a periodic basis to policy makers. Toward this end the World Meteorological Organization and the United Nations Environment Programme formed the Intergovernmental Panel on Climate Change (IPCC) in 1988. The IPCC has produced several major assessments for policy makers. In February 2007 the panel released a summary from its first working group on the science of climate change in anticipation of the release of its fourth assessment report later in the year. The IPCC largely reaffirmed the conclusions of its earlier reports, indicating that it is now 90 percent certain that most of the warming observed over the previous half century could be attributed to greenhouse gas emissions produced by human activities (i.e., primarily industrial processes and transportation). In 2001 the panel had concluded that the previous 100 years had seen an increase in global average surface temperature of 0.6 °C (1.1 °F), with an error range of 0.2 °C (0.4 °F). The 2001 report predicted that the average surface temperature would increase by 1.4 to 5.8 °C (2.5 to 10.4 °F) by 2100, according to the best estimate values over a range of scenarios for greenhouse gas emissions. Revised estimates from the fourth assessment report in 2007 forecast a 1.8–4.0 °C (3.2–7.2 °F) rise in average surface temperature over the same period.

57. The reservoir for carbon is….

A. coal, oil and natural gas
B. plants
C. CO_2 in the atmosphere
D. methane (CH_4) in the atmosphere

Answer: C (Wikipedia)

The carbon cycle is the biogeochemical cycle by which carbon is exchanged between the biosphere, geosphere, hydrosphere, and atmosphere of the Earth. The cycle is usually thought of as four major reservoirs of carbon interconnected by pathways of exchange. The reservoirs are the atmosphere, the terrestrial biosphere (which usually includes freshwater systems and non-living organic material, such as soil carbon), the oceans (which includes dissolved inorganic carbon and living and non-living marine biota), and the sediments (which includes fossil fuels). The annual movements of carbon, the carbon exchanges between reservoirs, occur because of various chemical, physical, geological, and biological processes. The ocean contains the largest active pool of

carbon near the surface of the Earth, but the deep ocean part of this pool does not rapidly exchange with the atmosphere. The global carbon budget is the balance of the exchanges (incomes and losses) of carbon between the carbon reservoirs or between one specific loop (e.g., atmosphere - biosphere) of the carbon cycle. An examination of the carbon budget of a pool or reservoir can provide information about whether the pool or reservoir is functioning as a source or sink for carbon dioxide. Carbon exists in the Earth's atmosphere primarily as the gas carbon dioxide (CO_2). Although it is a very small part of the atmosphere overall (approximately 0.04% on a molar basis, though rising), it plays an important role in supporting life. Other gases containing carbon in the atmosphere are methane and chlorofluorocarbons (the latter is entirely anthropogenic). The overall atmospheric concentration of these greenhouse gases has been increasing in recent decades, contributing to global warming. Carbon is taken from the atmosphere in several ways:

(i) When the sun is shining, plants perform photosynthesis to convert carbon dioxide into carbohydrates, releasing oxygen in the process. This process is most prolific in relatively new forests where tree growth is still rapid; (ii) At the surface of the oceans towards the poles, seawater becomes cooler and more carbonic acid is formed as CO_2 becomes more soluble. This is coupled to the ocean's thermohaline circulation which transports dense surface water into the ocean's interior. Carbon can be released back into the atmosphere in many different ways:

(i) Through the respiration performed by plants and animals. This is an exothermic reaction and it involves the breaking down of glucose (or other organic molecules) into carbon dioxide and water; (ii) Through the decay of animal and plant matter. Fungi and bacteria break down the carbon compounds in dead animals and plants and convert the carbon to carbon dioxide if oxygen is present, or methane if not; (iii) Through combustion of organic material which oxidizes the carbon it contains, producing carbon dioxide (and other things, like water vapor); (iv) Burning fossil fuels such as coal, petroleum products, and natural gas releases carbon that has been stored in the geosphere for millions of years; (v) Production of cement: carbon dioxide is released when limestone (calcium carbonate) is heated to produce lime (calcium oxide), a component of cement; (vi) At the surface of the oceans where the water becomes warmer, dissolved carbon dioxide is released back into the atmosphere; (vii) Volcanic eruptions and metamorphism release gases into the atmosphere. Volcanic gases are primarily water vapor, carbon dioxide and sulfur dioxide. The carbon dioxide released is roughly equal to the amount removed by silicate weathering; so the two processes, which are the chemical reverse of each other, sum to roughly zero, and do not affect

the level of atmospheric carbon dioxide on time scales of less than about 100,000 yr.

58. The biological process whereby carbon is returned to its reservoir is:

A. photosynthesis
B. glycolysis
C. cellular respiration
D. nitrification

Answer: C

See the answer to question 57 above for a detailed discussion.

59. Which continent has the highest rate of human population growth?

A. Asia
B. Africa
C. North America
D. South America

Answer: B (Wikipedia/Britannica)

Globally, the growth rate of the human population has been steadily declining (i.e., population is growing more slowly than in the recent past, although the last 50 years have seen a rapid increase in population due to medical advances and massive increase in agricultural productivity made by the Green Revolution. The actual annual growth in the number of humans is in decline, from 87 million per annum in the late 1980s, down to 75 million per annum in 2006. Growth remains high in the Middle East, South Asia, Southeast Asia, Latin America, and primarily in Sub-Saharan Africa. In some countries there is negative population growth (i.e., net decrease in population over time), especially in Central and Eastern Europe (mainly due to low fertility rates) and Southern Africa (due to the high number of HIV-related deaths). Within the next decade, Japan and some countries in Western Europe are also expected to encounter negative population growth due to sub-replacement fertility rates. The greatest population growth rates were reached in Latin America and in Asia during the mid- to late 1960s. Since then, these regions have experienced variable but sometimes substantial fertility declines along with continuing mortality declines, resulting in usually moderate and occasionally large declines in population growth. The most dramatic declines have been those of the People's Republic of China, where the growth rate was estimated to have declined from well over 2 percent per year in the 1960s to about half that in the 1980s, following official adoption of a concerted policy to delay marriage and limit childbearing within marriage. The predominance of the Chinese population in East Asia means that this region has experienced the most dramatic declines in population growth of any of the developing regions. Over the same period population growth rates have declined only modestly—and in some cases have actually risen—in other developing regions. In South Asia the rate has declined only from 2.4 to 2.0 percent; in Latin America, from about 2.7 to

about 2.3 percent. Meanwhile, in Africa population growth has accelerated from 2.6 percent to more than 3 percent over the same period, following belated significant declines in mortality not accompanied by similar reductions in fertility.

60. Abnormal …. counts are used to determine the progress of HIV/AIDS

A. white blood cell
B. red blood cell
C. haemoglobin
D. blood platelets

Answer: A (Encyclopaedia Britannica)

The main cellular target of HIV is a special class of white blood cells critical to the immune system known as helper T lymphocytes, or helper T cells. Helper T cells are also called CD4+ T cells because they have on their surfaces a protein called CD4. Helper T cells play a central role in normal immune responses by producing factors that activate virtually all the other immune system cells. These include B lymphocytes, which produce antibodies needed to fight infection; cytotoxic T lymphocytes, which kill cells infected with a virus; and macrophages and other effector cells, which attack invading pathogens. AIDS results from the loss of most of the helper T cells in the body. The human immunodeficiency virus (HIV) destroys a special class of white blood cells called T4.HIV is a retrovirus, one of a unique family of viruses that consist of genetic material in the form of RNA (instead of DNA) surrounded by a lipoprotein envelope. HIV cannot replicate on its own and instead relies on the mechanisms of the host cell to produce new viral particles. HIV infects helper T cells by means of a protein embedded in its envelope called gp120. Once the virus has infected a T cell, HIV copies its RNA into a double-stranded DNA copy by means of the viral enzyme reverse transcriptase; this process is called reverse transcription because it violates the usual way in which genetic information is transcribed. Because reverse transcriptase lacks the “proofreading” function that most DNA synthesizing enzymes have, many mutations arise as the virus replicates, further hindering the ability of the immune system to combat the virus. These mutations allow the virus to evolve very rapidly, approximately one million times faster than the human genome evolves. This rapid evolution allows the virus to escape from antiviral immune responses and antiretroviral drugs. The next step in the virus life cycle is the integration of the viral genome into the host cell DNA. Integration occurs at essentially any accessible site in the host genome and results in the permanent acquisition of viral genes by the host cell. Under appropriate conditions these genes are transcribed into viral RNA molecules. Some viral RNA molecules are incorporated into new virus particles, while others are used as messenger RNA for the production of new viral proteins. Viral proteins assemble at the plasma membrane

together with the genomic viral RNA to form a virus particle that buds from the surface of the infected cell, taking with it some of the host cell membrane that serves as the viral envelope. Embedded in this envelope are the gp120/gp41 complexes that allow attachment of the helper T cells in the next round of infection. Most infected cells die quickly (in about one day). The number of helper T cells that are lost through direct infection or other mechanisms exceeds the number of new cells produced by the immune system, eventually resulting in a decline in the number of helper T cells. Physicians follow the course of the disease by determining the number of helper T cells (CD4+ cells) in the blood. This measurement, called the CD4 count, provides a good indication of the status of the immune system. Physicians also measure the amount of virus in the bloodstream—i.e., the viral load—which provides an indication of how fast the virus is replicating and destroying helper T cells. Because of the high rate at which the genetic material of HIV mutates, the virus in each infected individual is slightly different. Genetic variants of HIV have been categorized into several major subtypes, or clades, which have different geographical distributions. Variation occurs throughout the genome but is especially pronounced in the gene encoding the gp120 protein. By constantly changing the structure of its predominant surface protein, the virus can avoid recognition by antibodies produced by the immune system.

61. Examples of crustaceans are:

A. a crayfish and a crab
B. an octopus and a crab
C. a snail and a crab
D. all of the above

Answer: A (Encyclopaedia Britannica)

A crustacean is any member of the subphylum Crustacea (phylum Arthropoda), a group of invertebrate animals consisting of some 39,000 species distributed worldwide. Crabs, lobsters, shrimps, crayfish and wood lice are among the best-known crustaceans, but the group also includes an enormous variety of other forms without popular names. Crustaceans are generally aquatic and differ from other arthropods in having two pairs of appendages (antennules and antennae) in front of the mouth and paired appendages near the mouth that function as jaws. Because there are many exceptions to the basic features, however, a satisfactory inclusive definition of all the Crustacea is extraordinarily hard to frame. Crustaceans include such arthropods as crabs, lobsters, shrimps, barnacles, and many other forms. For a number of crustacean species, reactions to food chemicals or other substances have been used to locate the body regions that bear chemoreceptors. The list is impressive. Distance chemoreceptors are borne on the antennae and the smaller antennules, specialized structures (esthetascs) on the tips of the antennules being particularly sensitive. Contact

chemoreceptors are borne chiefly on the tips of the walking legs, the mouthparts, antennules, tail flap (telson), walls of the gill chambers, and, in some species, on the general body surface.

A gastropod is any member of the class Gastropoda, the largest group of the phylum Mollusca, consisting of about 65,000 species. Gastropod, which means "belly-footed," refers to the broad tapered foot on which these animals glide. The class comprises the snails, which have a shell into which the animal can withdraw, and the slugs—snails whose shells have been reduced to an internal fragment or completely lost in the course of evolution. Gastropods are among the few groups of animals to have successfully radiated in the ocean, fresh waters, and on land. Because of the challenges presented by these diverse habitats, gastropods are very difficult to characterize. A few are used as food, a very few transmit animal diseases (only a fraction of these have been found to carry the agents of human and animal disease), and the shells of some are used as ornaments or in making jewellery. The main role of gastropods is as scavengers, feeding on dead plant or animal matter, or as predators. *Octopuses, or Octopi,* in general, are eight-armed cephalopod (octopod) mollusk of the order Octopoda; the true octopuses are members of the genus *Octopus,* a large group of widely distributed, shallow-water cephalopods. (*See* cephalopod.) Octopuses vary greatly in size; the smallest, *O. arborescens,* is about 5 cm (2 inches) long, while the largest species may grow to 5.4 m (18 feet) in length and have an armspan of almost 9 m (30 feet). The typical octopus has a saccular body: the head is only slightly demarcated from the body and has large, complex eyes and eight contractile arms. Each arm bears two rows of fleshy suckers that are capable of great holding power. The arms are joined at their bases by a web of tissue known as the skirt, at the centre of which lies the mouth. The latter organ has a pair of sharp, horny beaks and a filelike organ, the radula, for drilling shells and rasping away flesh. The octopus takes water into its mantle and expels the water after respiration through a short funnel called a siphon. Most octopuses move by crawling along the bottom with their suckers, though when alarmed they may shoot swiftly backward by ejecting a jet of water from the siphon. When endangered, they eject an inky substance, which is used as a screen; the substance produced by some species paralyzes the sensory organs of the attacker. The best-known octopus is the common octopus, *O. vulgaris,* a medium-sized species that is widely distributed in tropical and temperate seas throughout the world. This species is thought to be the most intelligent of all invertebrate animals. *O. vulgaris* also has highly developed pigment-bearing cells and can change its skin colours to an astonishing degree with great rapidity.

62. What is the difference between solitary and sedentary?

A. solitary animals do not move; sedentary animals move slowly if at all
B. solitary animals live alone; sedentary animals live together
C. solitary animals live alone, sedentary animals move slowly, if at all
D. solitary animals move slowly; sedentary animals live on their own

Answer: C

The term sedentary in biology applies to organisms and species that are not migratory but rather remain at a single location (permanently fixed or otherwise). Examples in zoology include such sessile organisms as barnacles, corals and mussels. A solitary (Latin *solus*, meaning *alone*) person, animal or object is one which is not usually in the companionship of others of its type. Some animals live a mostly solitary life, only looking for others in mating season, e.g. feral cats and bears.

63. What is the difference between a predator and a scavenger?

A. a predator feeds only on plants; a scavenger feeds only on animals
B. a predator eats both plants and animals; a scavenger feeds only on plants
C. a predator eats only dead organisms; a scavenger is an active hunter of flesh
D. a predator is an active hunter of flesh; a scavenger feeds on dead or dying organisms;

Answer: D (Wikipedia)

In ecology, predation describes a biological interaction where a predator organism feeds on another living organism or organisms known as prey. A true predator is one which kills and eats another organism. Whereas other types of predator all harm their prey in some way, this form results in their instant death. Some predators kill large prey and dismember or chew it prior to eating it, such as a jaguar, while others may eat their (usually much smaller) prey whole, as does a bottlenose dolphin or any snake. In some cases the prey organism may die in the mouth or digestive system of the predator. Baleen whales, for example, eat millions of microscopic plankton at once, the prey being broken down well after entering the whale. Seed predation is another form of true predation, as seeds represent potential organisms. Predators of this classification need not eat prey entirely, for example some predators cannot digest bones, while others can. Some may merely eat only part of an organism, as in grazing below, but still consistently cause its direct death. Scavengers are animals that consume already dead animals (carrion). Scavengers play an important role in the ecosystem by

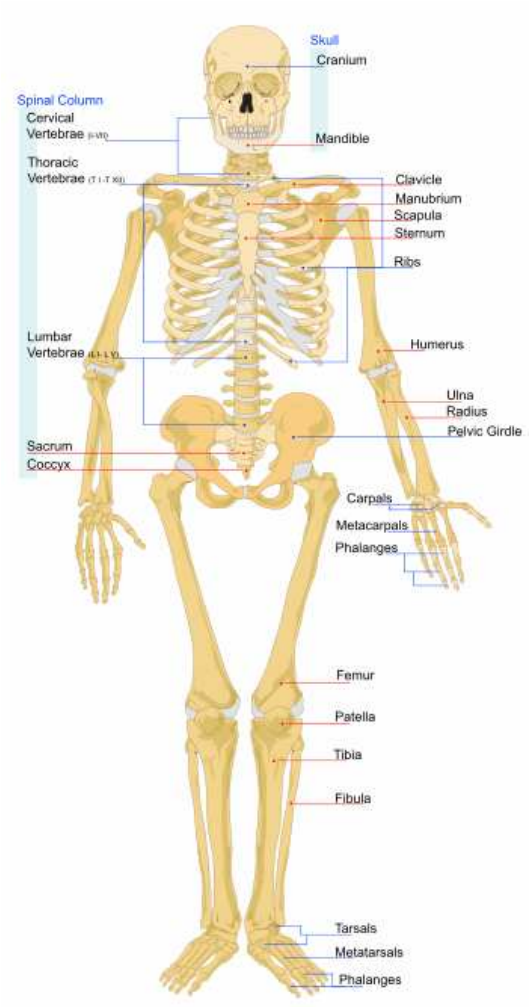
contributing to the decomposition of dead animal remains. Decomposers complete this process, by consuming the remains left by scavengers. Well known scavengers include vultures, burying beetles, blowflies, yellowjackets, and raccoons. Many large carnivores that hunt regularly--such as hyenas and lions--will scavenge if given the chance. Animals which consume faeces, such as dung beetles, are also referred to as scavengers. Animals which primarily consume dead plants (litter) are referred to as detritivores.

64. With regard to the human skeleton, the skeleton can be divided into axial and ….. skeletons which are both composed of numerous bones.

A. central
B. appendicular
C. cartilage
D. synovial

Answer: B (Wikipedia)

The human skeleton consists of both fused and individual bones supported and supplemented by ligaments, tendons, muscles and cartilage. It serves as a scaffold which supports organs, anchors muscles, and protects organs such as the brain, lungs and heart. The longest and heaviest bone in the body is the femur, and the smallest is the stapes bone in the middle ear. In an adult, the skeleton comprises around 20% of the total body weight. Fused bones include those of the pelvis and the cranium. Not all bones are interconnected directly: There are 6 bones in the middle ear called the ossicles (three on each side) that articulate only with each other. The hyoid bone, which is located in the neck and serves as the point of attachment for the tongue, does not articulate with any other bones in the body, being supported by muscles and ligaments.



The human skeleton can be divided into the axial skeleton and the appendicular skeleton. The axial skeleton consists of the 80 bones in the head and trunk of the human body. It is composed of five parts;

the human skull, the ossicles of the inner ear, the hyoid bone of the throat, the chest, and the vertebral column. The appendicular skeleton consists of 126 bones in the human body which make motion possible and protects the organs of digestion, excretion, and reproduction. The word appendicular means referring to an appendage or anything attached to a major part of the body, such as the upper and lower extremities.

65. In the mammalian eye the receptor cells, cones and rods are located in the ….. on which light rays are brought into focus.

A. retina
B. lens
C. cornea
D. cochlea

Answer: A (Wikipedia)

The structure of the mammalian eye owes itself completely to the task of focusing light onto the retina. This light causes chemical changes in the photosensitive cells of the retina, the products of which trigger nerve impulses which travel to the brain. The retina contains two forms of photosensitive cells important to vision—rods and cones. Though structurally and metabolically similar, their function is quite different. Rod cells are highly sensitive to light allowing them to respond in dim light and dark conditions, however, they cannot detect colour. These are the cells which allow humans and other animals to see by moonlight, or with very little available light (as in a dark room). This is why the darker conditions become, the less colour objects seem to have. Cone cells, conversely, need high light intensities to respond and have high visual acuity. Different cone cells respond to different wavelengths of light, which allows an organism to see colour. The differences are useful; apart from enabling sight in both dim and light conditions, humans have given them further application. The fovea, directly behind the lens, consists of mostly densely-packed cone cells. This gives humans a highly detailed central vision, allowing reading, bird watching, or any other task which primarily requires staring at things. Its requirement for high intensity light does cause problems for astronomers, as they cannot see dim stars, or other celestial objects, using central vision because the light from these is not enough to stimulate cone cells. Because cone cells are all that exist directly in the fovea, astronomers have to look at stars through the "corner of their eyes" (averted vision) where rods also exist, and where the light *is* sufficient to stimulate cells, allowing an individual to observe faint objects.

66. Behaviour that is disadvantageous for the individual performing it, but helpful to another individual is said to be ….

A. reciprocal
B. learning

C. socialization
D. altruistic

Answer: D

Refer to Question 52 for a detailed explanation.

67. External fertilization is found in ….

A. aquatic organisms and some terrestrial organisms such as frogs
B. aquatic organisms only
C. organisms with an organ to introduce sperm into the female's body
D. in terrestrial animals only

Answer: A (Wikipedia)

External fertilization is a form of fertilization in which a sperm cell is united with an egg cell external to the body of the female. Thus, the fertilization is said to occur "externally". This is distinct from internal fertilization where the union of the egg and sperm occur inside the female after insemination through copulation. In sexual reproduction, there must be some way of getting the sperm to the egg. Since sperm are designed to be motile in a watery environment, aquatic animals can make use of the water in which they live. In many aquatic animals such as coral or Hydra, eggs and sperm are simultaneously shed into the water, and the sperm swim through the water to fertilize the egg in a process known as broadcast fertilization. In many fish species, including salmon, the female will deposit unfertilized eggs in the substrate and the male will swim by and fertilize them. Many land plants make use of external fertilization as well. For example, bees and butterflies brush against pollen when gathering nectar from flowers and spread them to another flower of the same species, pollinating that plant.

68. The progressive sequence of changes which a species goes through from fertilization in one generation to fertilization in the next is known as

A. the evolutionary cycle
B. the lactation period
C. the life cycle
D. the generational cycle

Answer: D (Wikipedia)

A generation has traditionally been defined as "the average interval of time between the birth of parents and the birth of their offspring." This places a generation at around 20 years in span and this matches the generations up to and including America's Baby Boomers. However, while in the past this has served sociologists well in analysing generations, it is irrelevant today. More relevantly, a generation is the time span from birth to sexual maturity.

69. Some animals have a larva in the course of their development which develops into the adult by ….

A. metamorphosis
B. fertilization
C. differentiation
D. growth

Answer: A (Encyclopaedia Britannica)

Metamorphosis is the striking change of form or structure in an individual after hatching or birth. Hormones called moulting and juvenile hormones, which are not species specific, apparently regulate the changes. These physical changes as well as those involving growth and differentiation are accompanied by alterations of the organism's physiology, biochemistry, and behaviour. The immature forms, or larvae, are adapted to environments and modes of life that differ from those of the adult forms. These differences may be of significance in assuring that larvae and adults of the same species do not engage in direct competition for food or living space. Examples of metamorphosis include the tadpole, an aquatic larval stage that transforms into the land-dwelling frog (class Amphibia). Starfishes and other echinoderms undergo a metamorphosis that includes a change from the bilateral symmetry of the larva to the radial symmetry of the adult. Metamorphic patterns are well-known in crabs, lobsters, and other crustaceans and also in snails, clams, and other mollusks. The larval form of the urochordate (*e.g.,* the tunicate, or sea squirt) is tadpole-like and free swimming; the adult is sessile and somewhat degenerate. Among the most dramatic and thoroughly studied examples of metamorphosis are the insects. Because development is not the same in all insects, it is convenient to group them into major categories according to the pattern of structural changes: ametabolous, hemimetabolous, and holometabolous. In ametabolous development there is simply a gradual increase in the size of young until adult dimensions are attained. This kind of development occurs in the silverfish, springtail, and other primitive insects. In more advanced insects (*e.g.,* grasshoppers, termites, true bugs) a phenomenon known as gradual, or hemimetabolous, metamorphosis occurs. The hemimetabolous life cycle consists of egg, nymph, and adult. The nymph, or immature insect, resembles the adult in form and eating habits, differing in size, body proportions, and colour pattern. Rudimentary wings are visible and develop externally. Development is gradual through a series of moults (periodic shedding of the outer skeleton), the adult emerging from the final moult. Complete, or holometabolous, metamorphosis is characteristic of beetles, butterflies and moths, flies, and wasps. Their life cycle includes four stages: egg, larva, pupa and adult. The larva differs greatly from the adult. It is wingless, and its form and habits are suited for growth and development rather than reproduction. The change to the adult occurs during the inactive, non-feeding pupal stage. At this time the larva undergoes a transformation in which the wings appear externally, larval organs and tissues are broken down, and adult structures are developed.

Hypermetamorphosis, a form of complete metamorphosis, occurs in some beetles, flies, and other insects and is characterized by a series of larval stages.

70. In flowering plants, the embryo develops into a seedling when the seed ……

A. fertilizes
B. germinates
C. differentiates
D. grows

Answer: B (Encyclopaedia Britannica)

Germination is the sprouting of a seed, spore, or other reproductive body, usually after a period of dormancy. The absorption of water, passage of time, chilling, warming, oxygen availability, and light exposure may all operate in initiating the process. Germination sometimes occurs early in the development process; the mangrove (*Rhizophora*) embryo develops within the ovule, pushing out a swollen rudimentary root through the still-attached flower. In peas and corn (maize), the cotyledons (seed leaves) remain underground; in other species (beans, sunflowers, etc.), the hypocotyl (embryonic stem) grows several inches above the ground, carrying the cotyledons into the light, in which they become green and often leaf-like. The carefully controlled mass germination of cereal seeds supplies enzymes for the making of alcoholic beverages and for other industries as well. Spores of the commercially cultivated edible mushroom *Agaricus brunescens* are also mass germinated.