

**CSEC AGRICULTURAL SCIENCE SA MAY/JUNE 2014 PAPER 1**

<p>1. Peter Brown is employed as a Plant Quarantine Officer in the Ministry of Agriculture. His role is MOST likely to</p> <p>(A) inspect plants being imported and exported</p> <p>(B) produce plants mainly for export to Caribbean countries</p> <p>(C) inspect plants for insects and diseases at the Agricultural Research Station</p> <p>(D) provide a direct link between the crop farmer and the Agricultural Research Station</p>	<p>Answer: C</p> <p>Plant quarantine is a technique for ensuring disease-free and pest-free plants, whereby plant material (plants, fruits, flowers, plant parts etc.) is isolated, inspected and tested to detect the presence of pests or diseases. It is used to reduce entry of agricultural pests or diseases into a country via mandatory (required by law or rules) quarantine of plant material entering the country at government-operated quarantine stations.</p>
<p>2. Which institution has the following objectives?</p> <p>I. To facilitate trade between member countries</p> <p>II. To develop a common trade policy</p> <p>III. To act as a bargaining body when negotiating with outside forces</p> <p>(A) Caribbean Community (CARICOM)</p> <p>(B) Caribbean Development Bank (CDB)</p> <p>(C) Caribbean Food and Nutrition Institute (CFNI)</p> <p>(D) Caribbean Research and Development Institute (CARDI)</p>	<p>Answer: A</p> <p>CARICOM is the Caribbean Community and Common Market, also called the Caribbean Community Secretariat. It is a regional political and economic organisation of Caribbean countries that:</p> <ul style="list-style-type: none"><li>• Creates conditions to increase output of agricultural and manufacturing products in member countries.</li><li>• Facilitates trade among members</li><li>• Develops a common trade policy.</li><li>• Eliminates charges (duties) on imported goods which originate in member countries</li><li>• Acts as a single bargaining body in negotiations with outside countries &amp; international institutions</li></ul> <p>The CDB is the Caribbean Development Bank. It is a regional agricultural financial institution that provides loans to Caribbean governments for development of:</p> <ul style="list-style-type: none"><li>• Agriculture - credit, marketing, storage, land development, fisheries, forestry, irrigation, training</li><li>• Infrastructure - roads, bridges, water supply etc.</li></ul> <p>The CFNI is the Caribbean Food and Nutrition Institute. It is a regional food and nutrition institution. It is part of the Pan-American Health Organization/World Health Organization (PAHO/WHO). It promotes food security and nutritional health.</p> <p>CARDI is the Caribbean Agricultural Research and Development Institute. It is a regional agricultural development and research institution that:</p> <ul style="list-style-type: none"><li>• Provides for research and development needs of CARICOM states</li><li>• Provides longterm research in agriculture</li><li>• Co-ordinates and agricultural integrate research and development efforts of CARICOM states</li><li>• Provides teaching &amp; training</li><li>• Provides technology services, for example, the supply of quality plant products &amp; genetic products and services</li></ul>

Answer: D

Agriculture's contribution to Caribbean economies:

Contribution to National Income and GDP

National Income is the total amount of money earned within a country. Gross Domestic Product (GDP) is the market value of all the goods and services produced in a country within a specific time period, usually annually. The value of agricultural goods and services contributes to National Income & GDP.

Creation of Employment

Agriculture provides opportunities for employment. There are many different jobs in or relating to agriculture, from unskilled labor to highly-skilled jobs.

Contribution to Food Security

Food security is a country's ability to supply its people with a sufficient quantity of affordable, nutritious food at all times. Agriculture contributes to food security by supplying the country with enough affordable nutritious food for its citizens.

Production of Raw Materials

Agriculture provides raw materials for downstream industries (industries that use products manufactured by industries before them to manufacture their own products). For example:

- Agriculture produces wheat (Industry #1)
- Wheat is used to make flour (industry #2, downstream of #1)
- Flour is used to make bread (industry #3, downstream of #2)

Earning of Foreign Exchange

Foreign exchange is foreign currency, e.g. U.S. money is foreign exchange in Trinidad and Tobago. All countries need foreign exchange, usually U.S. dollars (\$US), to pay for imports (good & services purchased from another country). Agriculture earns foreign exchange by producing goods that can be exported (sold to other countries), which pay Trinidad and Tobago in foreign exchange.

Saving of Foreign Exchange via Import Substitution

Import substitution is an economic practice in which foreign goods & services are replaced with local goods & services. Agriculture can contribute to import substitution by supplying locally produced agricultural goods and services in the place of foreign ones. This means less foreign exchange is spent importing agricultural goods and services; foreign exchange is therefore saved.

Reduction of Food Import Bill

A country's food import bill is the money spent by the country to import food. Agriculture produces food locally, therefore it reduces the need to import food and so reduces a country's food import bill.

3. Which of the following can be considered roles of agriculture in the economy of Caribbean territories?

- I. Contributing to the G.D.P.
  - II. Reducing the regional food import bill
  - III. Securing foreign exchange
- (A) I and II only  
 (B) I and III only  
 (C) II and III only  
 (D) I, II and III

4. Which of the following aim to produce safe, high-quality products in an environmentally responsible way?

- (A) Good soil practices
- (B) Good irrigation practices
- (C) Good agricultural practices
- (D) Good pest control practices

Answer: D

Good agricultural practices (GAPs) are a set of essential operational, technical and managerial practices necessary to prevent or reduce the risk of food safety hazards enabling the delivery of safe fresh fruits and vegetables to the consumer, sustainability and reduction in negative environmental impact

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5. A bioterrorism attack on agriculture may result in

- I. an increase in food prices
- II. destruction of ecological habitats
- III. destabilization of a system of food security

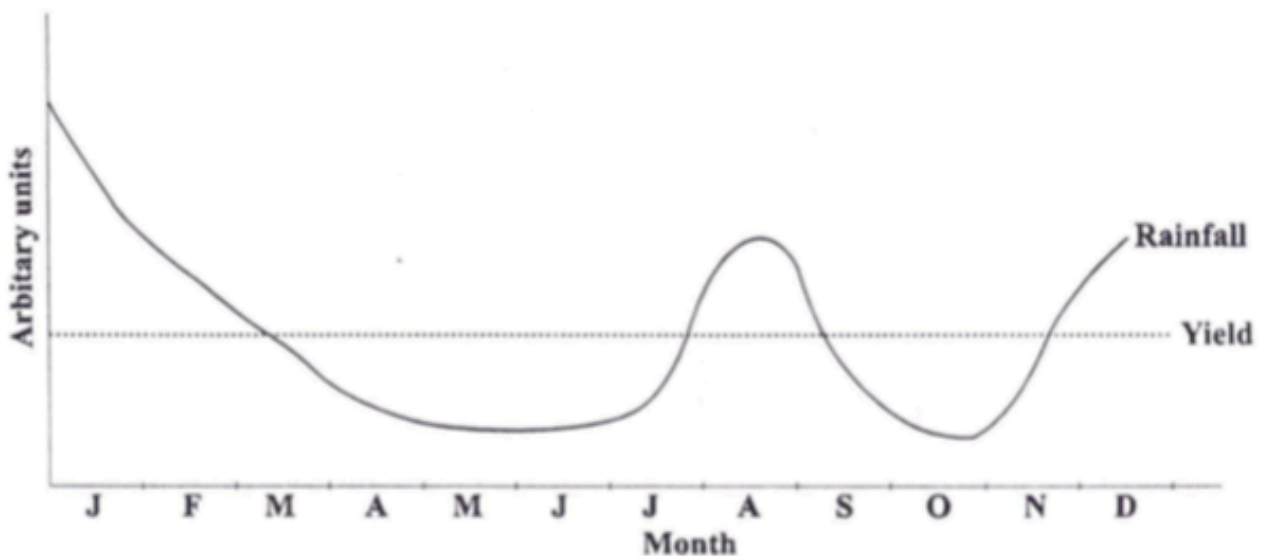
- (A) I and II only
- (B) I and III only
- (C) II and III only
- (D) I, II and III

Answer: D

Bioterrorism is terrorism involving the use of harmful biological agents, e.g. the release of pathogens (disease-causing organisms) to intentionally cause outbreaks of disease among people and livestock.

Since food stocks and production are affected, the price of food that is safe and available rises. Ecological habitats are destroyed, and food security (a country's ability to supply its people with a sufficient quantity of affordable, nutritious food at all times) is destabilized.

Item 6 refers to the following graph which shows the relationship between rainfall and yield of tomato during 2012.



6. The yield of tomato is steady because the crop is MOST likely

- I. produced in an undercover system
- II. grown intensively in the field
- III. grown on a sandy soil which is well fertilized

- (A) I only
- (B) II only
- (C) II and III only
- (D) I, II and III

Answer: A

The yield of tomato remains constant regardless of rainfall. This suggests the use of an undercover system. Normally crop production varies with rainfall. However in systems such as hydroponics and other undercover agricultural systems, also called protected agricultural systems, there is no such relationship because carefully controlled irrigation provides adequate water for the crops, regardless of rainfall.

7. Biodiversity refers to the

- (A) sum of all the species in a habitat
- (B) size of the species in different habitats
- (C) weight of the species in different habitats
- (D) origin of all the species in different habitats

Answer: A

Biodiversity is all the diverse ecosystems & the organisms in them. It may be referred to as the diversity of all species in a habitat, or sum of all species in a habitat.

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<p>8. The growing of crops in a liquid nutrient medium is known as</p> <p>(A) trough culture          (B) hydroponics          (C) organic farming          (D) subsistence farming</p>	<p>Answer: B</p> <p>Hydroponics is the practice of growing plants in a nutrient solution or aggregate with added nutrients, but without using soil. Instead of soil, plants are grown in one of the following:</p> <ul style="list-style-type: none"> <li>• A nutrient solution; this is circulated by a pump to ensure the plants get a constant supply of nutrients. The nutrient solution is aerated (e.g. with an air pump &amp; air stone) to ensure that the roots of the plants are constantly supplied with oxygen for respiration.</li> <li>• An aggregate, which is an inert (chemically inactive) growing medium e.g. sand, gravel, perlite or vermiculite through which a nutrient solution flows. The nutrient solution is circulated through the aggregate. Aeration is unnecessary, since the spaces between the aggregate have air, which contains oxygen for the plants' roots.</li> </ul> <p>Trough culture involves growing crops in shallow troughs. Troughs can be filled with an inert, soil-free medium such as rock wool and are connected to a drip system that supplies water and nutrients in solution; trough culture is therefore similar to hydroponics.</p> <p>Organic farming is a non-conventional farming system in which the use of synthetic chemicals is restricted. Organic farming restricts the use of synthetic chemicals, which are usually harmful to the environment, to increase biodiversity.</p> <p>Subsistence farming is the practice of growing crops and raising livestock sufficient only for one's own use, without any surplus for trade, or very little surplus for trade..</p>
<p>9. Which of the following terms refers to the utilization of commodities that are produced?</p> <p>(A) Price          (B) Marketing          (C) Production          (D) Consumption</p>	<p>Answer: D</p> <p>Marketing is all of the activities involved in moving goods and services from the producer to the consumer. Marketing links production and consumption; it incorporates several business activities in a coordinated way to move goods and services from the site of production to the site of sale to consumers.</p> <p>Production is the process of combining various material inputs (raw materials, labor etc.) with relevant plans and expertise in order to make a product or service.</p> <p>Consumption is the purchase and use of goods and services by clients and customers, known as consumers.</p>
<p>10. Nigel makes a profit by producing corn on two hectares of land using machinery. Which of the following is NOT a factor of production in his enterprise?</p> <p>(A) Corn          (B) Land          (C) Profit          (D) Machinery</p>	<p>Answer: C</p> <p>The economic factors of agricultural production are land, labor, capital and management.</p> <p>Land is not necessarily a field on which to do agriculture. Technically, land is any suitable space for agricultural production, e.g. for broiler production, land is the space where the broiler houses are sited.</p> <p>Capital is all the money, buildings, machinery, equipment, tools, materials, tree crops and livestock that are used to produce agricultural goods and services on a continuing basis. Therefore in corn production, corn and machinery are part of capital.</p> <p>Profit is the difference between income (the amount of money generated from sales of produce) and expenditure (the amount of money spent on production). Profit is not an economic factor of agricultural production.</p>



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<p>11. In economic terms, a surplus is created when</p> <p>(A) supply is less than demand (B) supply is equal to demand (C) supply is greater than demand (D) demand is greater than supply</p>	<p>Answer: C</p> <p>Demand is the quantity of a product that consumers are willing to buy at a certain price at a particular time. Demand is directly related to price. A decrease in price will lead to an increase in demand. An increase in price will lead to a decrease in demand. Demand is one of a commodity's two market forces (forces that determine sales of the commodity). The other is supply.</p> <p>Supply is the quantity of a product that vendors put on the market for sale at certain price at a particular time. Supply is directly related to price. A decrease in price will lead to a decrease in supply. An increase in price will lead to an increase in supply. Supply is one of a commodity's two market forces (forces that determine sales of the commodity). The other is demand.</p> <p>When supply is greater than demand, this leaves an amount of the commodity that is not sold because there is more of the commodity than is demanded. This is called a surplus, or glut. When supply is less than demand, this causes the commodity to run out and leaves some consumers unable to get it because there is no more available. This is called a shortfall.</p>
<p>12. Which of the following is responsible for integrating the Caribbean as a single economic block?</p> <p>(A) WTO (B) CSME (C) CARIFTA (D) CARICOM</p>	<p>Answer: D</p> <p>CARICOM is the Caribbean Community and Common Market, also called the Caribbean Community Secretariat. It is a regional political and economic organisation of Caribbean countries that:</p> <ul style="list-style-type: none"><li>• Creates conditions to increase output of agricultural and manufacturing products in member countries.</li><li>• Facilitates trade among members</li><li>• Develops a common trade policy.</li><li>• Eliminates charges (duties) on imported goods which originate in member countries</li><li>• Acts as a single bargaining body in negotiations with outside countries &amp; international institutions</li></ul> <p>The WTO is the World Trade Organization. It is an international trade regulation and dispute settlement body.</p> <p>In 2006, after considering the challenges of an increasingly globalized economy and the need to increase competitiveness of its goods and services, the Caribbean Community Secretariat (CARICOM) set up the Caribbean Single Market and Economy (CSME). The CSME enables the free movement of goods, services, capital and people across member states in the Caribbean. This means that production and marketing operations are promoted and supported in an enlarged, single economic area. There is a better environment for the competitive production of goods and services for external markets and for markets within the region (intra-regional markets). The removal of trade barriers and the opening up of new opportunities for 18,500,000 CARICOM nationals enables the CSME to stimulate growth.</p> <p>The Caribbean Free Trade Association (CARIFTA) was organized on May 1, 1968, to provide a continued economic linkage between the English-speaking countries of the Caribbean.</p>
<p>13. The cost of using money borrowed from an agricultural bank is known as</p> <p>(A) loan (B) interest (C) finance (D) capital</p>	<p>Answer: B</p> <p>When repaying a loan from from an agricultural bank, or indeed from any lending institution, the borrower pays interest. Interest is calculated as a percentage of the money borrowed, paid by the borrower to the lender periodically for being allowed to borrow the money. It may be thought of as a cost that the institution charges the lender for allowing the lender to borrow the money.</p>

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<p><b>14.</b> A farmer may be guaranteed a good credit rating if he</p> <ul style="list-style-type: none"><li>I. works out a realistic plan for the repayment of the loan</li><li>II. is prompt in taking care of all financial obligations</li><li>III. uses agricultural loans for their intended purpose</li></ul> <p>(A) I only (B) I and II only (C) II and III only (D) I, II and III</p>	<p>Answer: D</p> <p>A credit rating is an estimate of the ability of a person or organization to fulfill financial commitments, based on previous dealings. For example a farmer will have a good credit rating if he has a history of taking loans and paying installments in full and on time. Credit rating also involves paying bills on time and other financial obligations.</p> <p>If the farmer is able to agree with financial institution son a realistic plan to repay loans, is prompt in meeting all financial obligations such as bill payments, and uses agricultural loans for their intended purpose, he can be guaranteed to have a good credit rating.</p>
<p><b>15.</b> Which of the following is NOT a likely role of agricultural cooperatives?</p> <p>(A) Enable farmers to remain in business (B) Provide scholarships for farmers to study (C) Assist farmers in the marketing of produce (D) Access government support services</p>	<p>Answer: B</p> <p>A cooperative is a business venture that is collectively owned, controlled, operated, used and managed by its members on a non-profit or cost basis, for the economic benefit of all its members.</p> <p>A an agricultural cooperative can enable farmers who are members to stay in business e.g. by providing low cost loans for input purchases. It can assist farmers in marketing produce and help farmers access government support services for agriculture e.g. artificial insemination services. Cooperatives do not provide scholarships for study.</p>
<p><b>16.</b> Which of the following are benefits of price supports to farmers?</p> <ul style="list-style-type: none"><li>I. Economic security for farmers</li><li>II. Free farming materials</li><li>III. Guaranteed prices for certain products</li></ul> <p>(A) I and II only (B) I and III only (C) II and III only (D) I, II and III</p>	<p>Answer: B</p> <p>Price support is government assistance in maintaining the levels of market prices regardless of supply or demand. Farmers can be guaranteed minimum prices by the government, referred to as guaranteed prices, for selected crops or commodities. The commodities may be export-oriented or for domestic consumption. These guaranteed prices are incentives to production. The guaranteed prices show that the government is committed to helping farmers.</p>
<p><b>17.</b> Information written on paper or stored on a computer about the various activities on a farm is called</p> <p>(A) a record (B) a budget (C) a statement (D) an inventory</p>	<p>Answer: A</p> <p>Farm records store essential data about all the agricultural enterprises on a farm. The data includes records of production, transactions, costs, information and observations, and is essential in determining &amp; tracking the economic performance of the farm.</p>

Item 18 refers to the following information.

The yield and average price per kilogram of four crops are given in the table below.

Crop	Yield (thousand kg)	Price (dollar per kg)
Cabbage	27	2.00
Cauliflower	17	3.50
Lettuce	27	1.25
Tomato	22	2.50

18. Based on gross returns alone, which is the MOST profitable crop for the farmer to plant?

- (A) Cabbage
- (B) Cauliflower
- (C) Lettuce
- (D) Tomato

Answer: B

The gross return of:

Cabbage = 27,000 kg × \$2.00 per kg = 27,000 × 2.00 = \$54,000.

Cauliflower = 17,000 kg × \$3.50 per kg = 17,000 × 3.50 = \$59,500.

Lettuce = 27,000 kg × \$1.25 per kg = 27,000 × 1.25 = \$33,750.

Tomato = 22,000 kg × \$2.50 per kg = 22,000 × 2.50 = \$55,000.

Therefore, based only on gross returns, the most profitable crop for a farmer to plant is cauliflower.

Note that gross return is the same as gross income: Gross income, also called total income, is all of the money that a business receives from sales of goods and services.

19. Which of the following pairs of inputs of production comprises variable costs?

- (A) Seeds and medication
- (B) Fertilizers and buildings
- (C) Medication and machinery
- (D) Management and buildings

Answer: A

Variable costs (VCs) are costs that increase or decrease with the level of production. Examples include the cost of fuel, feed, fertilisers, medications and pesticides. For example, to increase production on a chicken farm, the farmer will increase the number of chicks he purchases, as well as the amount of feed, medicines etc. he purchases. Thus the amount of money spent on these inputs increases with the increased production, i.e. the cost of these inputs increases with increased production. If production decreases, so to does the money spent on these inputs, so the cost of these inputs decreases with decreasing production.

Fixed costs (FCs) are costs that do not increase or decrease with the level of production. Examples include land rental, machinery, buildings, insurance premiums (the amount of money paid for an insurance policy), taxes, loan installments and depreciation (a reduction in the value of an asset over time, due in particular to wear and tear). Other variable costs include all repairs and maintenance, labor, etc. No matter how much or little production occurs, these costs do not change, e.g. suppose a farmer buys a tractor and is paying \$5,000 per month. That monthly payment is his loan installment. Regardless of how much or little production happens, the farmer still has to pay that money every month; it does not change.

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<p>20. Which of the following is NOT a reason for budgeting?</p> <p>(A) Keeping records (B) Determining profit or loss (C) Procuring goods and services (D) Determining demand and supply</p>	<p>Answer: D</p> <p>A budget is an estimate of expected quantity of inputs, costs, outputs, income and profit related to an enterprise. In terms of agribusiness, a budget is an estimate of the expected quantity of agricultural inputs (land, seeds, feed, fertilizer etc.) &amp; their costs, outputs (crops, meat, milk, eggs etc. produced for sale), expected income from the sale of the expected outputs, and expected net profit and gross margin.</p> <p>Budgets are a form or records. Budgets show expected profits and losses. Budgets are requirements for agricultural businesses to secure loans to purchase goods and services. Additionally, information on amounts of input goods and services procured are part of budgets. Demand and supply determination is not done by budgeting; they are determined by preparation of demand and supply schedules. A demand schedule is a table showing the amount of a commodity demanded by consumers at various prices. A supply schedule is a table showing the amount of a commodity supplied to consumers at various prices.</p>
<p>21. Unless soil conservation measures are continually practised, the Caribbean will grow more dependent on foreign countries for food.</p> <p>The problem referred to here is MOSTLY one of</p> <p>(A) erosion (B) finance (C) flooding (D) land use</p>	<p>Answer: A</p> <p>Soil conservation refers to protecting the soil from erosion and maintaining its fertility. It is of great importance to agriculture in the Caribbean region. Soil erosion is the process by which particles of topsoil are carried away from one area, by water, wind, or other factors such as human activity, and deposited at another area.</p>



Answer: A

Soil texture is the fineness or coarseness of the soil. It is determined by the proportion of different-sized mineral particles (sand, silt & clay) present. For the farmer, soil texture is related to the workability of the soil and how easy it is to plough. Some soils are 'light' as they are easy to till (sandy soils). Some soils are 'heavy' (clay soils) and other soils are 'intermediate' (loam soils).

Soil structure is the arrangement of the various particles, cemented together into clusters called aggregates that create a network of cracks and pores in the soil. These cracks and pores are necessary for the soil to hold air and water and for water to drain through the soil. Although aggregates may be made up of similar types of particles, they generally differ in size, shape, particle composition and arrangement and stability. Aggregates contain pore spaces between their particles (intra-pore spaces) and there are spaces between adjacent aggregates (inter-pore spaces).

Soil capillarity is the movement of water upwards in the pore spaces of the soil due to capillary action. In capillary action, water molecules stick to the sides of very small channels (such as soil pore spaces), causing water to be pulled up along the space. The narrower the space, the higher up the water rises. The smaller the pore spaces, the higher the water rises upward in the soil. Sandy soils have low capillarity due to their large pore spaces. Clay soils have high capillarity due to their small pore spaces. Capillary water in soil pore spaces is the water that is available to plant roots.

Soil pH is the acidity or alkalinity of a soil. pH is measured in pH units on a scale running from pH 0 (completely acidic) to pH 14 (completely alkaline). A pH of 7 is neutral (neither acidic nor alkaline). As the pH gets lower, i.e. from 6.9 down to 0, the acidity gets higher, As the pH gets higher, i.e. from 7.1 to 14, the alkalinity gets higher. Soils generally range from pH of 3 to 10. Plant nutrients become unavailable according to a soil's pH level. If the pH is too low, i.e. the soil is too acidic, plants can get poisoned. Deficiencies of major plant nutrients often occur in very acidic soil because nutrients are less available to plants in acidic soils. Alkalinity impairs plant growth by restricting water supply to the roots, thus obstructing root development. It results to phosphorus and zinc deficiencies, and possibly iron deficiency and boron toxicity. Plants have less ability to extract essential nutrients from the soil when damaged by alkalinity.

Texture, structure and capillarity are all physical soil properties. Soil pH is a chemical soil property.

22. Which of the following is NOT a physical property of soil?

- (A) pH
- (B) Texture
- (C) Structure
- (D) Capillarity

23. An orange tree, exhibiting premature falling of flower buds, is MOST likely deficient in
- (A) sulphur
  - (B) nitrogen
  - (C) potassium
  - (D) phosphorus

Answer: D

Sulphur is a secondary plant macronutrient. A plant macronutrient or plant major nutrient is a nutrient that is needed by plants in relatively large amounts. Sulphur is part of proteins. Deficiency results in stunted growth, and younger leaves become yellow.

Nitrogen is a primary plant macronutrient. It is absorbed as ammonium ions  $NH_4$  and nitrate ions  $NO_3$ . It promotes vegetative growth (growth of leaves, stems & branches). It is easily leached (drained out of the soil by water dissolving it as it runs through the soil). Deficiency results in stunted growth, yellowing of leaves and leaf drop.

Potassium is a primary plant macronutrient. It is absorbed as potassium ions. It is essential for carbohydrate formation & transfer. It promotes flowering and fruiting. Deficiency results in leaf drying & decay from the tips backward, irregular yellowing (mottling) of leaves; & premature falling of flower buds.

Phosphorus is a primary plant macronutrient. It is absorbed as phosphate ions. It stimulates root growth. Deficiency results in purple discoloration of leaves, stunting of green parts & poor root development.

24. The climate of a region refers to the
- (A) rainfall over a long period of time
  - (B) weather conditions over a long period of time
  - (C) temperature over a long period of time
  - (D) rainfall and humidity over a long period of time

Answer: B

Climate is the weather conditions prevailing in an area in general or over a long period.

25. An Agricultural Science student is asked by his teacher to measure rainfall and temperature. His choice of equipment should be
- (A) rain gauge and anemometer
  - (B) anemometer and barometer
  - (C) rain gauge and thermometer
  - (D) thermometer and hygrometer

Answer: C

A rain gauge measures rainfall. An anemometer measures windspeed. A barometer measures atmospheric pressure. A hygrometer measures atmospheric humidity (the amount of moisture in the atmosphere). A thermometer measure temperature.



Rain Gauges



Anemometer



Analog Barometer



Digital Barometer



Analog Hygrometer



Digital Hygrometer



Thermometer

<p>26. Harrowing, ridging and rotavating are BEST described as</p> <p>(A) zero tillage                  (B) primary tillage                  (C) secondary tillage                  (D) tertiary tillage</p>	<p>Answer: C</p> <p>Primary tillage is breaking up the surface of the soil by ploughing (plowing in American English). Ploughing is turning up the soil. An implement called a plough (or plow) is used. Ploughing may be by hand or using a plough pulled by an animal or a tractor. At the end of primary tillage, the soil is in large clods or lumps. Ploughing and subsoiling are examples of primary tillage. The effect of primary tillage is to:</p> <ul style="list-style-type: none"> <li>• Loosen or break up the soil surface</li> <li>• Allow air and water to enter the soil more freely</li> <li>• Bury or mix organic matter with the soil</li> </ul> <p>Secondary tillage is breaking up large clods of soil into smaller pieces, or aggregates, and the production of a tilth suitable for seed germination and crop growth. The process may be done manually using a hoe, rake or hand fork or, mechanically using a harrow and a rotovator. Ridging is also a secondary tillage operation. The effect of secondary tillage is to:</p> <ul style="list-style-type: none"> <li>• Obtain a tilth suited to the crop</li> <li>• Produce a seedbed for the cultivation of crops</li> <li>• Cut up and mix organic matter (crop residues or stubble) into the soil</li> <li>• Allow the roots of crop plants to penetrate easily and grow freely in the soil</li> </ul>
<p>27. Dicotyledonous plants do NOT have</p> <p>(A) broad leaves                  (B) netted venation                  (C) a tap root system                  (D) parallel venation</p>	<p>Answer: C</p> <p>Monocot leaves have a long &amp; narrow lamina with no definite midrib, but with parallel veins. Examples are leaves e.g. of all grasses &amp; cereal grains maize, wheat, rice, barley, rye, palm trees e.g. coconut, etc.</p> <p>Dicot leaves are of variable sizes and shapes, with a definite midrib &amp; veins branching off of the midrib in a net-like pattern. Examples are leaves of most plants other than plants of the grass family e.g. pak-choi, sweet pepper, cucumber etc.</p>
<p>28. Which of the following structures regulate(s) water loss in a leaf?</p> <p>(A) Cuticle                  (B) Guard cells                  (C) Epithelial cells                  (D) Mesophyll cells</p>	<p>Answer: B</p> <p>The stomata of a leaf are pores on the underside of the leaf through which carbon dioxide enters the leaf (carbon dioxide is used for photosynthesis) and through which water vapor leaves the leaf via transpiration. Stomata are opened and closed by cells called guard cells. Therefore they determine the rate of water loss from a leaf by controlling the amount of water lost by transpiration. High air temperatures increase transpiration. High humidity (high water vapor content in the air) decreases transpiration. High air movement (windspeed) increases transpiration. High light intensity (brightness) increases transpiration.</p> <p>Epithelial cells are found in animals, not plants. Mesophyll cells are found in leaf tissue. There are two types: palisade and spongy. Palisade mesophyll tissue is where most photosynthesis occurs. Spongy mesophyll allows diffusion of carbon dioxide through the leaf from the stomata into the palisade mesophyll.</p>

29. Grafting is described as the insertion of a
- (A) root stock into a stem
  - (B) root stock into a scion
  - (C) scion into a root stock
  - (D) single bud into a root stock

Answer: C

In agriculture, plant propagation is the production of new plants. This can either be sexual (from seeds produced by flowers) or asexual, also called vegetative (without using seeds). Vegetative propagation can either be natural or artificial. Natural vegetative propagation uses the natural ability of some plants to reproduce vegetatively. Artificial vegetative propagation, which is the subject of this question, induced plants that do not have a tendency to reproduce vegetatively to do so.

**Sexual reproduction in plants**

The flowers of seed plants contain the organs of sexual reproduction. Most flowers, for example, guava, contain both male and female parts in one flower and are called hermaphrodite. But other plants, for example, pumpkins, produce separate male flowers and female flowers on the same plant.

A typical flower has the following parts:

- a flower stalk, or pedicel, which attaches the flower to the stem
- a receptacle, which is the swollen tip of the pedicel that all the other floral parts are attached to
- a ring of sepals called the calyx, which is usually green and protects the other flower parts when in a bud
- a ring of petals called the corolla, which is usually brightly colored to attract pollinating insect; the male parts of the flower called stamens; each stamen consists of a filament or stalk that has anthers that form the pollen grains containing the male gametes
- the female parts of the flower called carpels; each carpel consists of a receptive surface (the stigma) attached to the ovary by the style; the ovary contains ovules, which contain the female gametes, or egg cells.





## Pollination

**Pollination** is the transfer of pollen from the anthers to the stigma. In **self-pollination**, the pollen may be transferred from the anthers to the stigma of the same flower or to another flower on the same plant. **Cross-pollination** is when pollen is transferred from the anthers of one flower to the stigma of another flower on a different plant of the same species.

Pollination is essential for the production of economic crops, such as cereals and fruits. Increased pollination leads to increased yields, which results in higher incomes for the farmers. Cross-pollination is used in plant breeding to increase the vigour of a species and to produce plants that are more resistant to pests and diseases. Farmers are encouraged to place beehives in their orchards and to avoid excessive use of insecticides during the flowering period of crops. These measures increase the chance of cross-pollination.

Pollination can be done by people, birds and other small animals, but the main agents are wind and insects. Wind-pollinated flowers and insect-pollinated flowers are adapted to the method of pollination (see Table 4.5).

Wind-pollinated flowers	Insect-pollinated flowers
Flowers are often small; petals and sepals may be absent; no scent.	Flowers are often large, with brightly coloured petals to attract insects; may be scented.
No nectaries.	Nectaries produce sugary nectar to attract insects.
Anthers have long filaments and dangle outside the flower.	Anthers have short filaments and are fixed inside the flower.
Stigmas are long and feathery to trap the pollen.	Stigmas are sticky so that pollen from insect's body attaches.
Very large amounts of pollen produced.	Much smaller amounts of pollen produced.
Pollen grains are small, light and smooth.	Pollen grains are heavier and sticky; the outer wall is often sculptured.
Examples: grasses, cereals	Examples: beans, guavas

## Fertilisation

**Fertilisation** is the fusion (joining) of a **male gamete** with a **female gamete** to form a zygote. This develops into the embryo. After pollination, pollen grains germinate on the surface of the stigma, and pollen tubes grow down through the tissues of the style to the ovary. At the tip of each pollen tube are three nuclei: two male nuclei (the male gametes) and a pollen tube nucleus. When the pollen tube reaches an ovule, the tip releases the nuclei. One male nucleus fuses with the egg cell (female gamete) in the ovule to form the zygote. The second fuses with nuclei in the ovule to form food storage tissue. The zygote develops into the embryo.

## Seed formation

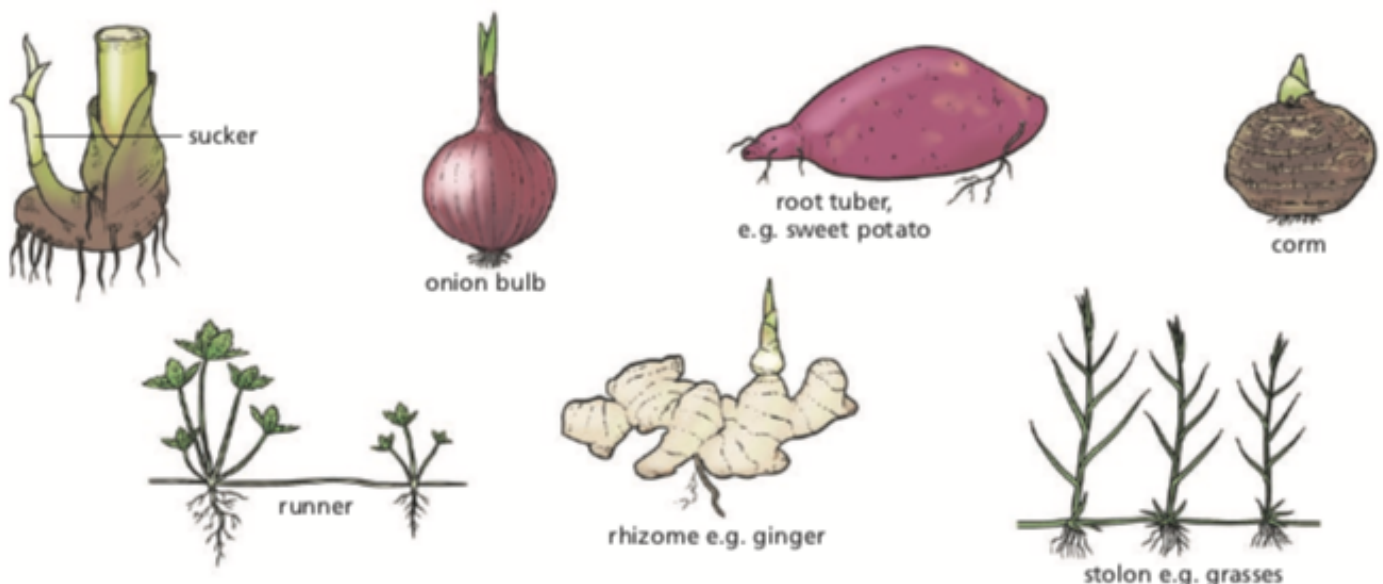
After fertilisation, **seed formation** occurs. The fertilised egg develops into the embryo of the new plant. Food made during photosynthesis in the parent plant is stored in the endosperm tissue. In some seeds, such as peas and beans, the food store develops in two cotyledons, which become swollen. In other seeds, such as castor beans and maize, food is not stored in the cotyledons, but remains as a separate tissue. The tissues that surrounded the ovule in the ovary become the seed coat.

## Asexual reproduction

**Asexual reproduction** refers to the propagation of plants by vegetative parts and does not involve gametes. Asexual reproduction can be achieved by natural methods, for example, tubers, suckers and rhizomes, or artificially by cuttings, budding, grafting and using tissue culture.

### Natural methods of asexual reproduction

Several crops produce vegetative parts (see Figure 4.18), which farmers use as planting materials. A farmer can grow bananas from banana suckers, yams from yam tubers and eddoes from eddoe corms. These vegetative parts are referred to as **organs of perennation**. They store food, enabling the plant to survive in a dormant state during the dry season and to resume growth when conditions become favourable (see Table 4.6). Many of the plant parts used in natural vegetative propagation (for example, potato tubers) are eaten by people and animals.



Vegetative organs	Description	Example
Sucker	Underground shoot growing from the basal part of the parent plant.	Banana; pineapple
Tuber	Swollen underground stem or root: <ul style="list-style-type: none"> <li>• stem tuber: with axillary buds and scale leaves</li> <li>• root tuber: without axillary buds and scale leaves</li> </ul>	<ul style="list-style-type: none"> <li>• Yam and Irish potato are stem tubers</li> <li>• Sweet potato and cassava are root tubers (sweet potato, with portion of stem attached, will sprout but cassava does not sprout)</li> </ul>
Rhizome	Thick, underground stem: branched with axillary and terminal buds and scale leaves.	Ginger; saffron; canna lily; ginger lily
Corm	Short, swollen underground stem arising from the parent plant.	Eddo; tannia; dasheen
Bulb	Very short, disc-like stem with tightly rolled, fleshy and scale leaves.	Onion; lily
Stolon	Slender, creeping stem: usually underground, branched, rooting at the nodes.	Bahama grass; nut grass
Runner	Creeping stem: usually on the soil surface, with long internodes, rooting at the nodes.	Strawberry; savanna grass; pumpkin

## Sexual and asexual reproduction in relation to crop production

### Sexual reproduction and crop plants

Sexual reproduction results in fruits and seeds, so it is vital in the production of rice, maize, cereals and fruits of all kinds.

The production of seeds is also necessary if the farmer is to grow other crops, as most leaf and root vegetables are raised from seed. In the past, the farmer would allow some of the crop to produce seeds, which were kept for planting the following year. Nowadays, the farmer buys seeds from a seed merchant, expecting a high percentage to germinate and grow.

### Asexual reproduction and crop plants

Growing some crops from seed (for example, fruit trees) takes a long time and the plants are not always 'true to type'. In such cases, vegetative means of propagation can be used so that the offspring are genetically identical to the parent plant.

Some plants, such as banana, pineapple and breadfruit, do not produce viable seeds. These are often propagated artificially.

Table 4.7 describes the advantages and disadvantages of asexual reproduction.

Advantages	Disadvantages
<ul style="list-style-type: none"> <li>• New plants are true to type, as they are genetically identical to the parent plant.</li> <li>• Large numbers of plants can be produced in a short time.</li> <li>• Scions can be grafted on to disease-resistant stocks.</li> <li>• Plants that do not produce viable seeds can be propagated.</li> <li>• Budding and grafting scions on to dwarf stocks (plants that are smaller than normal for their species) make it more convenient for farmers to prune and harvest the crop.</li> <li>• Scions can be chosen for their fruit quality.</li> </ul>	<ul style="list-style-type: none"> <li>• There is lack of variety and diversity in the new plants.</li> <li>• The risk of total crop loss through disease is greater than with seeds.</li> <li>• Some of the techniques involved in artificial propagation require skills that may not be available, e.g. budding and grafting.</li> <li>• Techniques such as tissue culture are expensive to set up and are economical only when very large numbers of plants are produced.</li> </ul>



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The rhizomes of ginger, saffron and arrowroot can be cut into sections and, if each section has at least one lateral bud, new plants can result. Bulbs, such as onions and garlic, produce offset bulbs that are then separated and planted. Stem tubers of Irish potato are used to produce new plants, and yam tubers can be made to form buds that produce shoots.



## Artificial propagation

The main methods of artificial propagation are:

- cuttings, for example, cocoa and guava
- layering, for example, rose and lime
- budding, for example, orange and avocado
- grafting, for example, mango
- tissue culture, for example, orchid and banana.

## Cuttings

Cuttings are pieces of stem, root or leaf taken from a plant and given the right conditions for growth. They contain cells capable of dividing and producing new tissues. After cuttings have been taken from the parent plant, they need to be kept in suitable conditions of humidity, light and temperature. High humidity prevents cuttings from drying out, so they are usually kept in a propagator.

Types of **stem cuttings** (pieces of stem from which new plants will grow) are listed in Table 4.8.

Type of stem cutting	Details of technique	Examples
Hardwood; taken from mature plants with bark.	Length 12–20 cm with four buds; leaves removed; stem planted soon after removal from plant.	Grape, pomegranate
Semi-hardwood; taken where bark is not fully developed.	Length 15–20 cm with four buds; some leaves removed; must not be allowed to dry out.	Cassava, sugar cane, citrus (limes)
Softwood or herbaceous; taken from new (non-woody) growth.	Length less than 10 cm; must not be allowed to dry out; quick to root.	Sweet potato, oleander, coleus

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Stem cuttings are usually taken from plants early in the morning when plant cells are turgid and then wrapped in a moist tissue. Before planting in a propagator with a suitable soil mixture, the base of each cutting is trimmed with a sharp knife and the leaves removed or partially trimmed if necessary. The base is then dipped in a rooting hormone that encourages the growth of roots. The soil is watered and the propagator is placed in suitable conditions of light and temperature. The soil and atmosphere around the cutting are kept moist.

Some stem cuttings, such as sugar cane, cassava and sweet potato, are planted directly into the field plots as they produce roots easily.

**Root cuttings** are pieces of root from which new plants grow. They are taken just before the rainy season, when parent plants are not actively growing. In the propagation of breadfruit, lengths of root 10–13 cm long are taken, a sloping cut is made at the lower end, and the cutting is pushed into the rooting medium with the top at soil level.

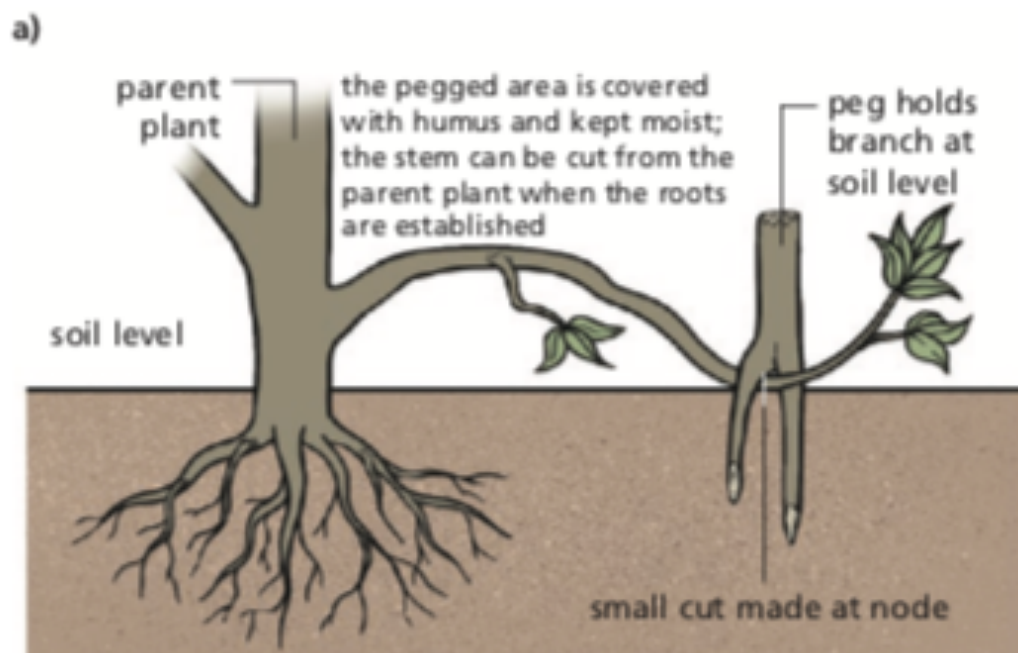
## Layering

In layering, a young branch of a parent plant is encouraged to produce **adventitious roots** by making an incision in the branch, bending it down and covering it with soil. Two techniques are used: tongue layering and air layering. Adventitious roots form from a section of the plant that is not underground.

**Tongue layering** is carried out on plants that have spreading branches close to the ground.

- A suitable branch 5–8 mm thick is selected.
- The leaves are removed from the area to be layered.
- A diagonal cut is made into the middle of the stem on the underside of the branch.
- The branch is held down in position on the ground by a wooden peg.

Roots form after 14–21 days. The newly layered plant can be cut from the parent and transferred to a pot in a garden nursery.





## Budding

**Budding** is a form of grafting in which a single bud (the **scion**) from one plant is inserted into the stem of another plant (the **stock**). The stock plant is rooted and may be of the same species as the scion, or a related species.

To carry out patch budding you need to:

- remove leaves from the selected area of the stem of the stock plant
- lift a rectangular area of bark from the stem of the stock plant 20–30 cm from the tip
- choose a plump and healthy bud on the scion and carefully cut and lift off a similar size of bark around it
- place the scion material on to the stock plant
- apply a fungicide to the area
- apply tape to the budded area leaving the bud exposed
- place the stock plant with its new bud in a cool area and water regularly.

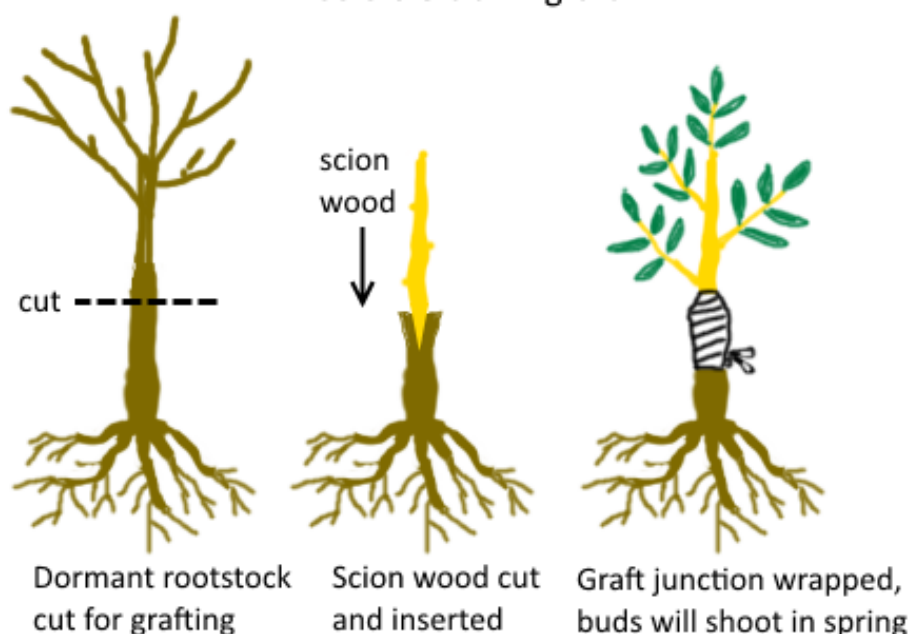
## Grafting

In **grafting**, the scion consists of a piece of stem with several buds on it. It is inserted into the stem of the stock plant with the cut surface of the scion in direct contact with the cut surface of the stock, so that the tissues of the two plants grow together. For grafting to be successful, the scion and the stock have to be related: either different varieties of the same species or belonging to closely related species. Grafting is used to propagate mango, avocado and sapodilla.

There are two types of grafting.

- **Side or veneer grafting:** The scion is inserted into a cut made on the side of the stem of the stock. The scion is 5–8 cm in length and fits snugly into the cut on the stock. The two are securely taped together.
- **Top or cleft grafting:** The top of the stock plant is cut off, a wedge-shaped cut is made and the scion is inserted. The two are taped together securely.

Basic Cleft or V-graft





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The terminal bud of the stock plant can be removed to encourage the growth of the scion. Sometimes an inverted T-shaped cut is made in the bark of the stock plant and the bud is inserted into the cut. The scion is taped to the stock as before to secure and protect the bud. This method is commonly used for propagating citrus plants.

## Tissue culture

**Tissue culture** is another artificial method of plant propagation. In this method, a piece of plant tissue, such as stem, leaf or root, is cultured in a growing medium of agar, nutrients and plant hormones to produce new plants. The technique requires sterile, controlled conditions and results in large numbers of identical plants, called clones. Orchid, banana and pineapple plants can be mass-produced in this way.

30. To reduce the environmental shock at transplanting, seedlings grown in a nursery should be
- (A) shaded
  - (B) irrigated
  - (C) fertilized
  - (D) hardened off

Answer: C

See notes the following notes.

## The nursery

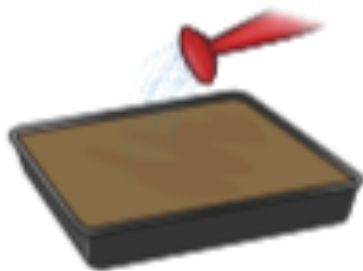
A **nursery** is where young plants are housed while being reared for transplanting into field plots.

The main features of a nursery should include:

- a steel or wooden construction so that it is sturdy
- a graded concrete floor for efficient drainage
- a roof covered with transparent polythene, so that light can enter but the seedlings are protected from rain
- saran netting placed on the windward side to protect seedlings from wind damage
- concrete stands for seedboxes, seedling trays and containers.

## Thinning-out

Thinning-out gives each seedling more space for growth. It also reduces competition for light, water and nutrients, so that growth is more vigorous. If seedlings are spaced, they can be lifted out with a pylon (ball of soil around the roots) when transplanting. In thinning-out, or pricking-off, seedlings are carefully removed from their original container or seedbed and transferred to another prepared container. The newly thinned-out seedlings need to be protected from direct sunlight and rain.



1. water soil in seedbox



2. make holes with the dibber



3. carefully select a seedling



4. gently position soil around the roots



5. water the seedlings



6. place under the shade of a tree

### Looking after seedlings

In the nursery, seedlings need to be watered regularly using a watering can with a fine rose. Weeds should be removed by uprooting or using a dibber, and the soil surface broken up to prevent compaction and to increase aeration. Fine pen manure or liquid manure can be applied to the soil surface after it has been broken up. To control pests and diseases, seedlings should be inspected and treated with insecticides if necessary. Seedlings may be attacked by a fungus that causes a disease called damping off. This weakens the stems allowing the seedlings to topple over. The disease can be controlled by aerating the soil, reducing the watering and, if necessary, applying a fungicide to seedlings and soil.

### Transplanting

Before **transplanting**, seedlings should be exposed gradually to sunlight over a period of 7–10 days. This is called **hardening** and helps to strengthen the young plants so that they can withstand full sunlight by the time they are transferred to field plots.

Transplanting is carried out early in the morning, late in the evening or when it is cloudy to:

- protect the seedlings from the sun
- reduce wilting.

The field plot is prepared by digging holes for the seedlings, using the recommended spacing, and placing pen manure or compost into each hole. The soil of the containers is watered and the seedlings are removed, each with some soil around the roots. Each seedling is placed in its prepared hole, ensuring that it is not planted too deeply, and the soil is gently firmed around it so that the seedling stays upright. Seedlings should be watered after transplanting; this reduces wilting and settles the loose soil, bringing soil particles in closer contact with roots.



1. water seedlings in seedbox



2. remove seedling with a trowel



3. position in the soil



4. gently firm the soil



5. water the transplanted seedlings

## Stages of plant growth

During the life of a plant, there are two main stages of growth: the vegetative stage and the reproductive stage.

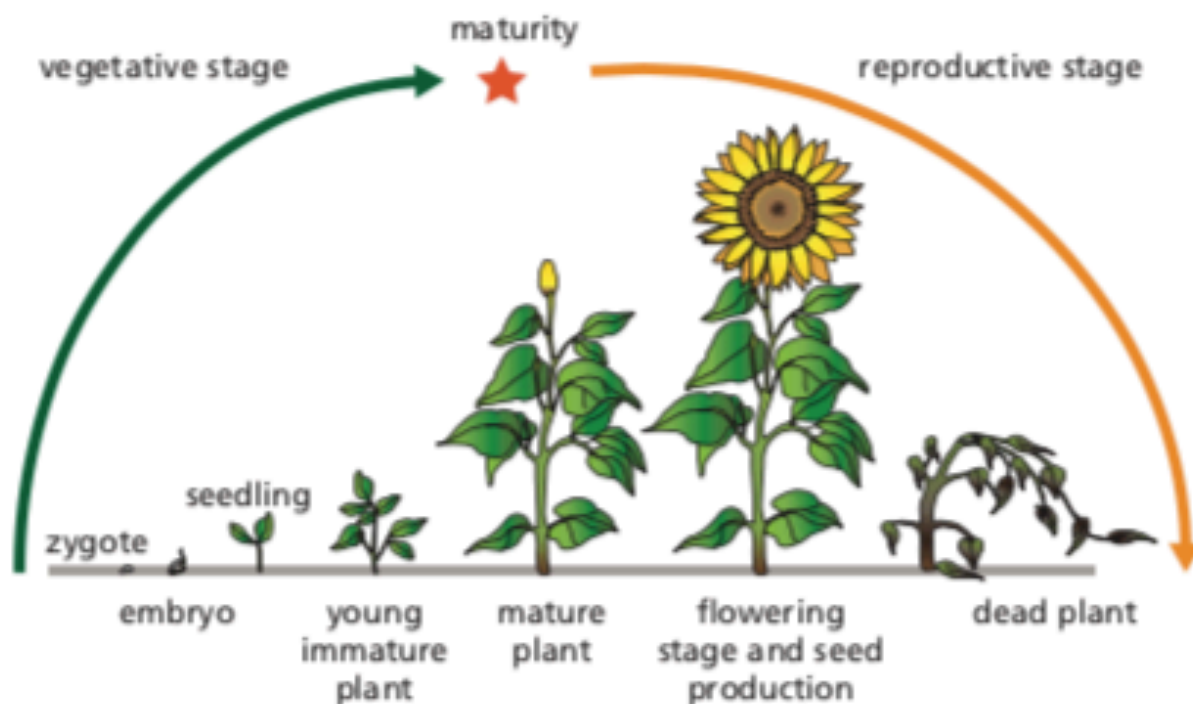
The **vegetative stage** involves:

- the growth of the zygote into the embryo, the embryo into the seedling, and the seedling into a mature plant
- the rapid increase in cell division, cell enlargement and differentiation into specialised tissues and functions
- the rapid increase in plant size and weight
- a large amount of branching and leaf development.

In the **reproductive stage**:

- the general increase in plant size slows down and the development of new branches and leaves occurs
- flowers, fruits and seeds are produced, continually or seasonally, until the plant dies.

These stages are illustrated in Figure 4.33.



31. The process whereby two purebred plants are crossed to produce a heterozygous individual is known as

- (A) progeny
- (B) genetics
- (C) heredity
- (D) hybridization

Answer: D

Hybridization is the process of interbreeding between purebred individuals of different species (called **interspecific hybridization**) or genetically divergent individuals from the same species (called **intraspecific hybridization**). Offspring produced by hybridization may be fertile, partially fertile, or sterile. Plants hybridize much more easily than animals. Genetically, the offspring is said to be heterozygous, combining traits from the two species.



<p>32. Genetic engineering refers to the removal or insertion of</p> <p>(A) traits (B) genes (C) membranes (D) chromosomes</p>	<p>Answer: B</p> <p>Genetic engineering, also called genetic modification or genetic manipulation, is the direct manipulation of an organism's genes via biotechnology. Genes are transferred from 1 organism to another, producing transgenic organisms. A transgenic organism is an organism that contains genes that have been transferred into it from another species.</p>
<p>33. The BEST irrigation system for water conservation is</p> <p>(A) drip (B) furrow (C) surface (D) sprinkler</p>	<p>Answer: A</p> <p>See notes below.</p>

### Irrigation technologies

- Surface irrigation, often called flood irrigation, is where land is flooded regularly. Farmers use shallow ditches to catch the water to keep it on the land to irrigate the crops. If river levels are low and flooding is unlikely to occur, water can be pumped or lifted from the river, by people or animals, to the level of the fields.
- Drip (or micro) irrigation, also called trickle irrigation, is where water is delivered at or near the root zone of plants, drop by drop. This method can be the most water-efficient method of irrigation and, if it is managed properly, it can minimise evaporation and runoff.
- Sprinkler irrigation, sometimes called overhead irrigation, has water piped to one or more central locations within the field and then distributed by overhead high-pressure sprinklers. A system using sprinklers, sprays or guns mounted overhead on permanently installed risers is called a solid-set irrigation system. Sprinklers that can rotate are called rotary irrigation systems and the rotations can be a full or partial circle. Travelling sprinkler systems are those where the sprinklers are mounted on automated moving platforms connected to the water source by a hose. Sprinkler systems can irrigate land unattended.
- Sub-irrigation, or seepage irrigation, is used where field crops are grown in areas with high water tables. It is a method of artificially raising the water table to allow the soil to be moistened from below the plants' root zone. Often those systems are located on permanent grasslands in lowlands or river valleys and combined with drainage infrastructure. Sub-irrigation is also used in commercial greenhouse production, usually for potted plants. Water is delivered from below, absorbed upwards, and the excess collected for recycling.

34. Which of the following methods are referred to as cultural means of pest control?

- I. Crop rotation
- II. Field sanitation
- III. Application of pesticides
- IV. Setting of insect traps

- (A) I and II only
- (B) II and III only
- (C) II, III and IV only
- (D) I, II, III and IV

Answer: A

This question is about pest and disease management. See notes below.

Plants can be protected from pests and diseases in a number of ways involving cultural techniques, chemical and biological control, and integrated pest management (IPM).

### Cultural techniques

These cultural techniques can be used.

- Removal of pests by hand: This is time-consuming but effective for caterpillars on cabbages. It avoids the use of toxic chemicals, which could contaminate the produce, but it is difficult to carry out for most pests.
- Disinfection and sterilisation of the soil: This technique kills weed seeds, insect eggs, larvae and fungal spores. Banana corms can be disinfected with hot water.
- Destruction of any infected plants or produce: Citrus trees infected with a virus can be burned.
- Crop rotation: This reduces the spread of insect pests that infect specific crops.
- Planting disease-resistant varieties of crop plants: This prevents or reduces infection. Disease resistance can be selectively bred and many varieties of crop plants are available.

## Chemical control

A **pesticide** is a chemical substance used to control pests. It is poisonous (toxic) to the pest but does not harm the crop. Pesticides are classified according to the type of pest they control and include herbicides (to kill weeds), insecticides (to kill insects), fungicides (to kill fungi) and nematicides (to kill nematodes). Some naturally occurring insecticides, such as pyrethrum and nicotine, have been in use for hundreds of years, but many newer artificial chemicals are now in use. Pesticides can also be classified according to the way in which they work.

- **Contact pesticides** are sprayed onto crops to coat the plants. Contact fungicides treat fungal diseases and are absorbed by the fungal pathogens. Contact insecticides get into the bodies of insect pests through their respiratory systems. These pesticides do not persist for long on the crop plants because they may get washed off by rain or irrigation, so they have to be reapplied to control the pest. They are relatively cheap and effective. Examples include organochlorines (DDT is one of these), pyrethroids and carbamates. These pesticides disrupt the cellular functions of organisms and are thought to affect human cells in a carcinogenic (cancer-causing) way.
- **Systemic pesticides** are absorbed through the leaves and roots of crop plants and are translocated (moved) around the plant. The cell sap becomes toxic to the pest, which is destroyed as it feeds on the crop. The advantage of systemic pesticides is that they remain in the plant for a long time and can protect the crop from possible infestations before they occur. Examples are organophosphates and some carbamates. There is evidence that carbamates cause neuro-behavioural effects in humans and exposure to this pesticide increases the risk of neurological conditions such as dementia.
- **Residual pesticides** are sprayed on the land before a crop is planted. They kill weed seedlings, fungal spores, insect eggs and larvae. They have a relatively long-lasting effect, although heavy rainfall will cause leaching. They may be used as part of the land preparation operations undertaken before sowing or planting. Most residual pesticides have their effect through direct contact with the pest.
- **Non-residual pesticides** work instantly but then disappear. The most obvious ones are insect sprays, which need to make contact with the insects to kill them, but then disperse very quickly.

## Biological control

**Biological control** relies on the natural predators or parasites of the pest organism. For example, ladybirds and hover flies feed on aphids, birds eat caterpillars and fish eat insect larvae. The term is usually used to mean the deliberate introduction of one species (the predator) to control another species (the prey). The pest is eaten by the predator.



Biological control is mainly used against insect pests. Other examples of this predator-prey relationship include:

- the control of rabbits in arable crops and pasture by introducing the myxomatosis virus
- the introduction of the Argentinean moth borer to control the growth of prickly pear on grazing land
- the control of malaria by the introduction of fish to eat the mosquito larvae
- the control of stem borer in sugar cane by introducing wasps from India, *Apanteles flavipes* and *Paratheresia*, and the Cuban fly, *Lexophaga*.

The most successful use of biological control has been in the protection of greenhouse crops, where conditions are controlled and the pest insects and their predators are contained in an enclosed area. The aim is to control the pest but not eliminate it totally as this deprives the predator of food. The numbers of pest insects and predators will change but the level of infestation is kept low. This type of control has been used to protect cucumbers, tomatoes and other salad crops. Whitefly, a cucumber pest, is easily controlled by the tiny wasp *Encarsia formosa*.

Natural predators of insects are often found on vegetation bordering field plots. The predators can be encouraged by leaving the edges of fields uncultivated. Sometimes, strips of uncultivated land are left within field plots. These are referred to as 'beetle banks' and they provide a habitat for insect predators. These measures often mean that less pesticide is needed.

## Integrated pest management

**Integrated pest management** aims to control pests by using a combination of methods to keep pest populations at low levels rather than totally eliminating them. IPM uses cultural and biological control methods instead of relying solely on chemicals.

If pesticides are used, they should be chosen for their short-term toxicity so that they break down into harmless substances in a short amount of time. They should not be used over a long period as the insect pests could develop resistance to them. Developing pesticides is expensive, so relying only on pesticides will cost the farmer more money than integrating cultural and biological control methods.

## The importance of plant quarantine

**Alien pests** and **alien diseases** are pests and diseases that do not occur naturally in a country. Their introduction into a country can cause widespread damage. With an increase in world trade, much agricultural produce is now exported and imported. In most countries, strict regulations ensure that only the highest-quality pest-free produce is exported and that all imported goods are inspected.

The introduction of alien pest species, such as weeds and insects, can cause havoc to agricultural production in island territories such as the Caribbean. There may be no natural predators for the pests, so they could spread rapidly and damage crops. Imported plant material can carry viruses and it would be dangerous if such material were to be used for plant breeding.

To avoid these problems, plant quarantine centres have been established by the Ministry of Agriculture at airports and ports and employ qualified personnel to inspect agricultural products. Each territory in the Caribbean has its own regulations and operates its own quarantine centres.



**CSEC AGRICULTURAL SCIENCE SA MAY/JUNE 2014 PAPER 1**

35. Which of the following is NOT true when importing produce?

- (A) Permits must be obtained to import certain commodities.
- (B) Imported materials must be from areas that are pest and disease free.
- (C) The price of imported produce must be lower than local produce.
- (D) Commodities imported should be accompanied by a phytosanitary certificate.

Answer: C

To import agricultural produce, permits must be obtained from the Ministry of Agriculture. No importation from countries that are known to have pests and diseases is allowed. This especially from areas where there are outbreaks of economically important pests and diseases; these are pests and diseases that cause large-scale economic losses in terms of crop and livestock damage and death. The produce must also have a phytosanitary certificate before being allowed into the country; this is a certificate that certifies the produce as pest and disease free.

The price of imported produce vs. the price of local produce is a purely economic consideration; it is non necessary for imported produce to be cheaper than local produce for it to be allowed into the country.

36. Which of the following is NOT a postharvest operation?

- (A) Sorting
- (B) Washing
- (C) Moulding
- (D) Packaging

Answer: C

Postharvest operations are operations that are done after harvesting, usually to prepare the produce for sale. Sorting, washing, and packaging are all postharvest operations. Moulding usually when soil is scraped up and heaped around the base of a plant to form a small mound using a hoe or trowel. This is done during growth of the plant, not after harvesting.

Item 37 refers to a situation where a field of cabbages shows signs of a heavy attack by larvae of the cabbage white butterfly.

37. Which of the following symptoms are the plants MOST likely to show?

- (A) Entire leaf veins eaten
- (B) Root system destroyed
- (C) Leaves yellow and plant stunted
- (D) Severe damage to leaves and heads

Answer: D

The cabbage white butterfly is a pest of crops in the *Brassica* family. This includes cabbage, broccoli, cauliflower, kale & pak-choi. The adult butterflies are harmless, but their larvae (caterpillars) are highly destructive. The caterpillars feed very heavily, consuming leaves and heads of any plant of the *Brassica* family..

38. Which of the following instructions for harvesting are appropriate?

I.	Tomatoes	Pick when fruits are dark green in colour.
II.	Beans	Pick when pod will snap clean when broken.
III.	Cabbage	Uproot from the ground.
IV.	Sweet potato	Dig when leaves begin to dry, avoid bruising and do not break roots.

- (A) I and II only
- (B) I and III only
- (C) II and III only
- (D) II and IV only

Answer: D

Tomatoes should be harvested when they just begin to turn color. Leaving them to ripen on the plant risks damage from feeding birds.

Beans should be harvested at the snap stage. This is when they snap clean when broken.

Cabbages should be harvested by cutting off the head from the root with a sharp knife 3 to 4 months after transplanting.

Sweet potato should be harvested by digging them up when leaves begin to dry. Bruising and breakage of the root tubers should be avoided.

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39. The process of fermentation results in the

- (A) release of CO<sub>2</sub> into the atmosphere
- (B) destruction of the product
- (C) oxidation of the product
- (D) removal of CO<sub>2</sub> from the atmosphere

Answer: A

Fermentation is the chemical breakdown of a substance by bacteria, yeasts, or other microorganisms, typically involving effervescence (fizzing) and the giving off of heat. It is used to convert carbohydrates to alcohol in brewing beer and winemaking. Carbon dioxide is released in the process.

40. Which of the following are advantages of processing?

- I. Allows the farmer to maximise profits
  - II. Reduces the incidence of postharvest diseases
  - III. Prolongs the storage life of the produce
- (A) I and II only
  - (B) I and III only
  - (C) II and III only
  - (D) I, II and III

Answer: D

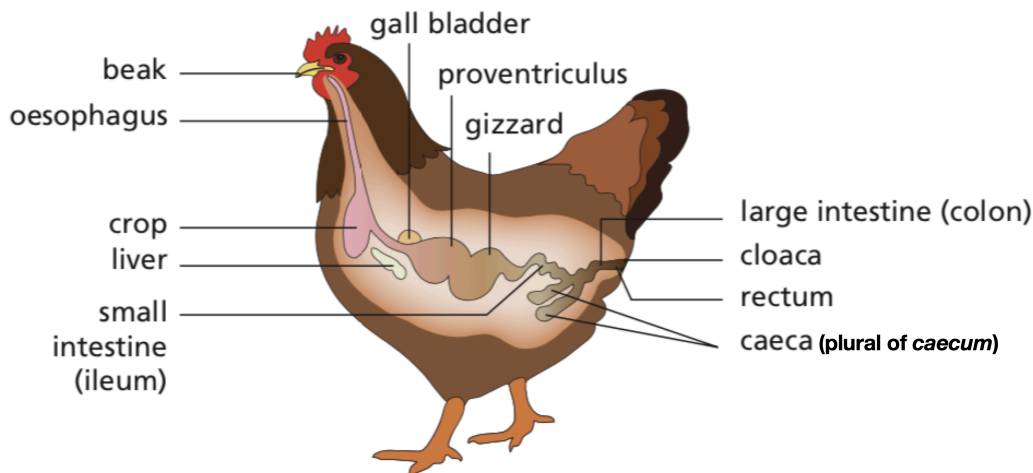
Processing adds value to agricultural produce e.g. orange juice can be sold for a higher price than oranges. This can maximize the farmer's profits. Processing also reduces post harvest disease incidence and increases product shelf life.

41. The purpose of the crop in the alimentary canal of a bird is to

- (A) store ingested food
- (B) absorb digested food
- (C) churn and grind food
- (D) secrete digestive enzymes

Answer: C

The table under the following diagram outlines the digestive system of poultry.

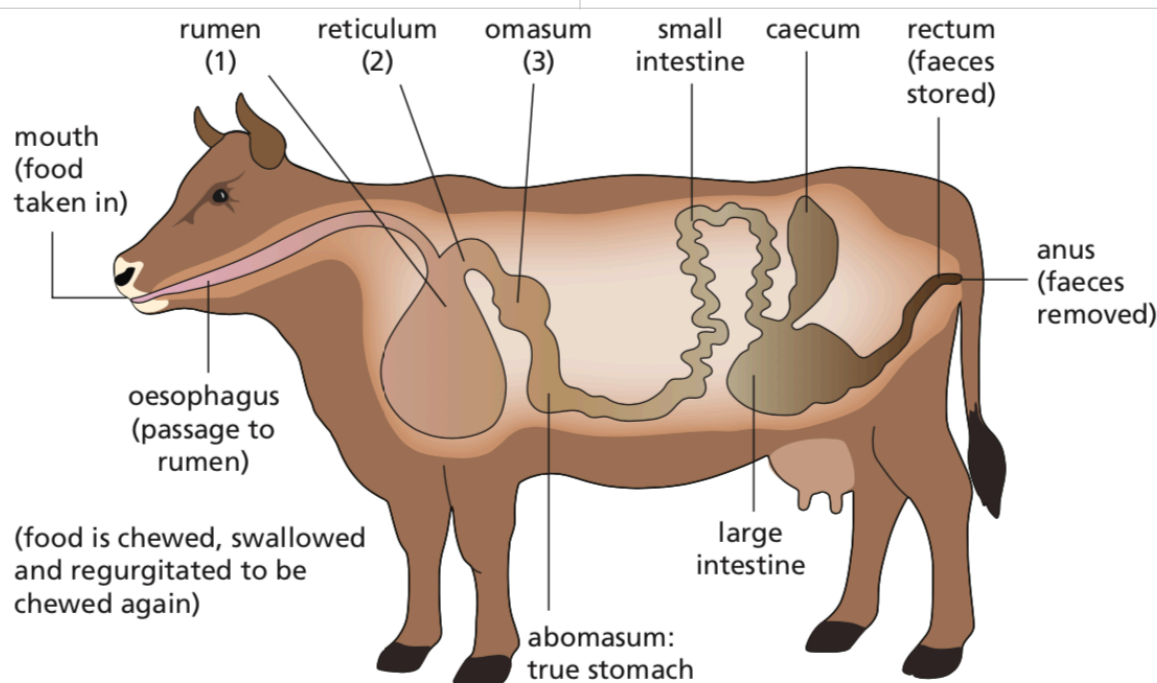


Structure	Functions
Beak	Covers the jaws; picks up food and takes it into the mouth; can break up food mechanically.
Mouth	Takes in food and swallows it using the tongue; no chewing as no teeth present.
Oesophagus (gullet)	Carries food to the crop.
Crop	Moistens food with digestive juice containing the enzyme salivary amylase; stores ingested food temporarily.
Proventriculus	Glandular part of the stomach, which secretes enzymes; also stores food.
Gizzard	Muscular part of the stomach; contains small stones that help to grind food.
Liver	Secretes bile, which is involved with the digestion of fats.
Ileum	Produces some digestive enzymes; absorbs the products of digestion.
Caecum	Usually two caeca; some digestion here of limited amounts of cellulose, through microbial activity.
Rectum	Absorbs water from the faeces; stores faeces before egestion.
Cloaca	Common opening of the digestive, reproductive and urinary systems.

42. Cellulose digestion in sheep starts in the

- (A) abomasum
- (B) reticulum
- (C) omasum
- (D) rumen

Answer: D



Bacteria and other micro-organisms in (1) and (2) break down cellulose. Water is absorbed from (3). Digestion continues in the true stomach and small intestine.

Structure	Functions
Mouth	Ingests and masticates food; chews the cud.
Oesophagus	Transports food from the mouth to the rumen; brings regurgitated food (boluses) from the rumen back into the mouth for rumination.
Rumen	Stores ingested food; adds saliva to food; enzymes secreted by bacteria and protozoa digest cellulose.
Reticulum	Separates larger pieces of food for regurgitation to the mouth via the oesophagus.
Omasum	Stores liquefied food; muscular contractions grind food into finer particles; water and finer food particles moved into the abomasum.
Abomasum	Stores liquefied food; enzymes carry out chemical digestion of food (proteins).
Duodenum	Adds bile and pancreatic juice; similar to the pig.
Ileum	Similar to the pig.
Colon	Absorbs water from the undigested material; transport of this material to the rectum.
Rectum	Stores undigested material (faeces).
Anus	Egests the faeces.

43. Eggs or ova are produced in female animals in the
- (A) uterus
  - (B) ovaries
  - (C) fallopian tubes
  - (D) rectum (cloaca)

Answer: B

The ovaries produce ova. Mature ova are released from the ovaries into the fallopian tubes or oviducts. This is called ovulation. In some animals such as cattle, only one ovum is released, leading to the development and birthing of one offspring. In other animals such as pigs, several ova are released at the same time, leading to development and birthing of several offspring; each ovum develops into an offspring upon fertilization. Therefore, if eg. 9 ova are released and fertilized, 9 offspring develop and are birthed.

As an ovum travels down the fallopian tube, it encounters sperm from a male animal that has copulated with the female (if the female has mated). The sperm cells converge on the ovum and attempt to penetrate it. Only one succeeds; the rest die and are absorbed by the female's body. The nucleus of the successful sperm fuses with that of the ovum. This is called fertilization.

Fertilization results in a new cell called a zygote that immediately begins to develop into offspring. It does so by continually dividing to produce new cells. Over the course of the development of the offspring, these cells divide even more, and differentiate to produce the specialized cells that form the animals tissues e.g. bone, blood, muscle, skin etc.

The dividing zygote continues down the fallopian tube and enters the uterus. Here it implants itself into the uterus wall. This is called implantation and begins pregnancy, or gestation: the condition of having offspring developing in the uterus.

When the offspring is developed, it emerges from the mother's body. This process is generally called birthing, giving birth, or parturition. In specific animals it has specific names e.g. in pigs it is called farrowing, and in rabbits it is called kindling.

44. A poultry farmer adds double the recommended dosage of antibiotics to the drinking water of his broilers. He is advised that this practice is wrong MAINLY because it may
- (A) endanger the farm workers
  - (B) reduce the growth rate of the broilers
  - (C) endanger the health of his consumers
  - (D) lead to a low mortality rate of his birds

Answer: C

Antibiotics are drugs that kill bacteria when administered internally to an animal or human. They are used to treat diseases caused by bacteria.

However, excessive exposure to an antibiotic can cause the bacteria to develop resistance to the antibiotic via mutation. Thus the antibiotic no longer is effective, resulting in the presence of antibiotic resistant bacteria being consumed by consumers who purchase products from the animals (meat, eggs, milk etc.) This engages consumers' health.

Additionally, ingested antibiotic residues can lead to harmful effects on consumers such as allergic reactions.



<p>45. Which of the following feeds contains the HIGHEST percentage of protein per unit weight?</p> <p>(A) Fish meal (B) Broken rice (C) Coconut meal (D) Cocoa pod meal</p>	<p>Answer: A</p> <p>A feedstuff is any food provided for livestock. Feedstuffs, provide nutrients for energy, growth, development, maintenance, production and reproduction.</p> <p>There are 4 types of feedstuffs: forages, fodder, silage and concentrates. A forage is any food obtained by animals via grazing. Fodder is dried feedstuffs, such as hay, straw and chaff; they are used when forage is unavailable.</p> <p>Fodder can also include green chopped feedstuffs, for example, corn stalks, elephant grass and kudzu. Silage is pasture grasses, legumes and other crops that have been conserved and stored in silos. Concentrates are produced commercially in feed mills using local and imported feedstuffs. They are designed to suit the maintenance and production needs of different farm animals and they can be mixed, mashed, ground, granulated or pelleted.</p> <p>Concentrates may be high protein, low protein, high fibre, low fibre, high carbohydrate, rich in essential vitamins and minerals, or have a low percentage of fat or low moisture content.</p> <p>Rice, wheat middlings, brewer's grain and molasses are feedstuffs that are all high in carbohydrates. Soybean, acacia, kudzu and gliricidia are all forage legumes; these are high in proteins. Fish meal is also high in proteins. The other feedstuffs provide various nutrients, such as lipids, vitamins and minerals.</p>
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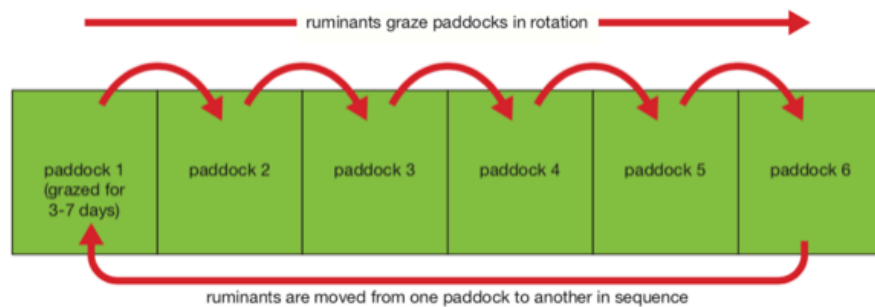
<p>46. Which of the following demonstrate a good rotational grazing system?</p> <p>I. Animals are placed in paddocks for four to six days. II. Milking animals are grazed first followed by dry and non-productive cows. III. Undergrazing is done to conserve on fodder.</p> <p>(A) I and II only (B) I and III only (C) II and III only (D) I, II and III</p>	<p>Answer: D</p> <p>The following information outlines grazing systems.</p>
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## Zero Grazing

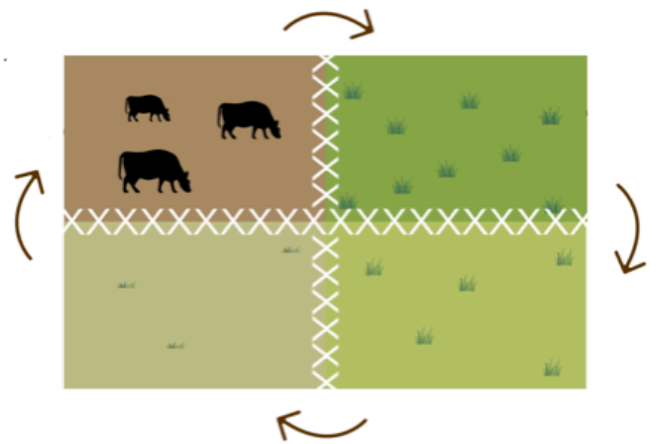
- **Zero grazing** refers to the cutting, chopping and feeding of forage crops to ruminants housed in pens or stalls. The animals feed on grass without having to graze, hence the term zero grazing.
- Grass or leafy plants raised as feed for fenced-in livestock is called **soilage**. Examples of the soilage or legume mixtures used in this system include:
  - ❖ Elephant grass
  - ❖ Guinea grass, also known kudzu
  - ❖ Guatemala grass
  - ❖ Pangola grass

# Rotational Grazing

- In **rotational grazing**, the pasture area is subdivided into six or eight **paddocks**. Each paddock is systematically grazed in sequence, with the ruminants being moved from one paddock to another. The stocking rate is usually high, 20 –25 cows per hectare.
- Each paddock is grazed for three to seven days, depending on the stocking rate (the number of animals present in the paddock) and herbage growth. After that time, the paddock is rested and the animals are moved to another paddock.
- The system continues until the last paddock has been grazed and the cycle is then repeated. When paddocks are not being grazed they undergo **pasture management**.

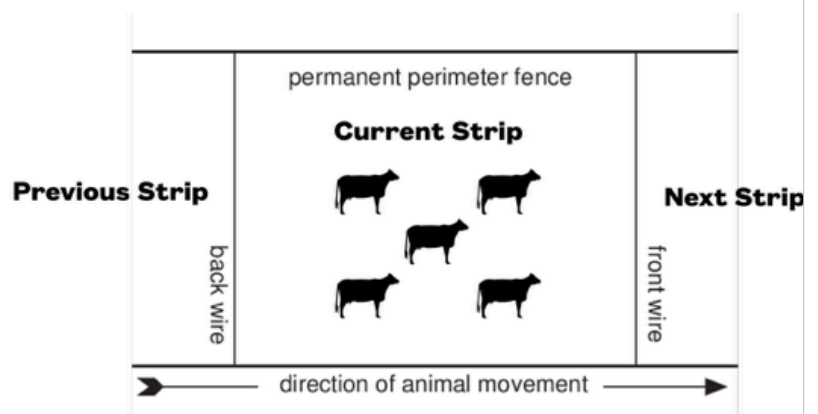


- Large pastures are broken into sections called **paddocks**.
- The herd *must* be moved to another paddock when 50% to 70% of the current paddock's soilage has been eaten.
- Paddocks not currently being grazed are left to rest for a period of 25 - 30 days.
- Rotation of paddocks may be in a circle instead of a straight line.



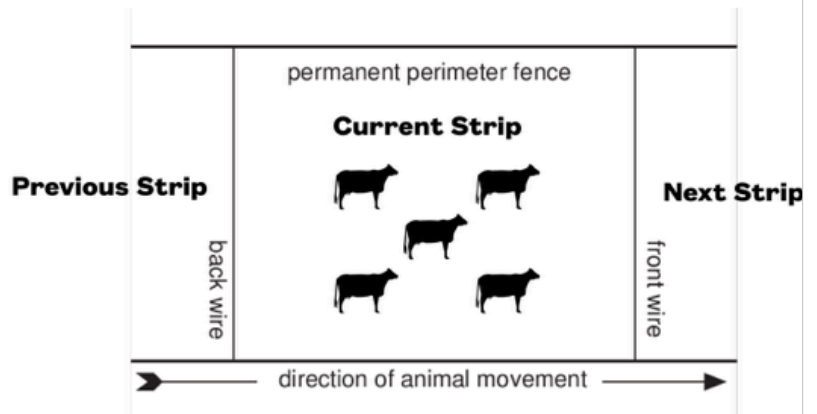
# Strip Grazing

- **Strip grazing** is a variation of the rotational system.
- A single paddock is grazed progressively, strip by strip, using movable electric fences to restrict the animals.
- The fences can be moved forwards once or twice daily, offering the animals a strip of fresh pasture for grazing.



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## Deferred Grazing

- In **deferred grazing**, certain paddocks of pasture grass or legumes are withheld for later use.
- In tropical countries, it is the practice of conserving 'standing hay'.
- The forage that is withheld usually matures, loses its succulence, palatability and some nutritive value, but it is important as a maintenance ration, especially in the dry season.
- Leafier grasses and legumes, such as Guinea grass or kudzu, and giant star grass, are most suitable for this type of grazing.

47. Which type of equipment is used to lift frames from the 'super' in a hive?

- (A) Smoker
- (B) Hive tool
- (C) Bee net
- (D) Decapping knife

Answer: B

The following information outlines apiculture equipment. Apiculture is beekeeping.

## Beekeeping Equipment



**Hive tool** - used for removal of frames from bee hives



**Uncapping knife** - used to uncap the wax layer that the bees cover their honey with



**Bee brush** - used to harmlessly remove bees from a surface



**Smoker** - used to calm bees while the apiarist (beekeeper) works in the hive.



**Protective clothing** - used to protect the apiarist (beekeeper)



**Honey extractor or spinner** - used to extract honey from honeycombs



**Settling tank** - used to settle collected honey so that impurities rise to the surface for removal

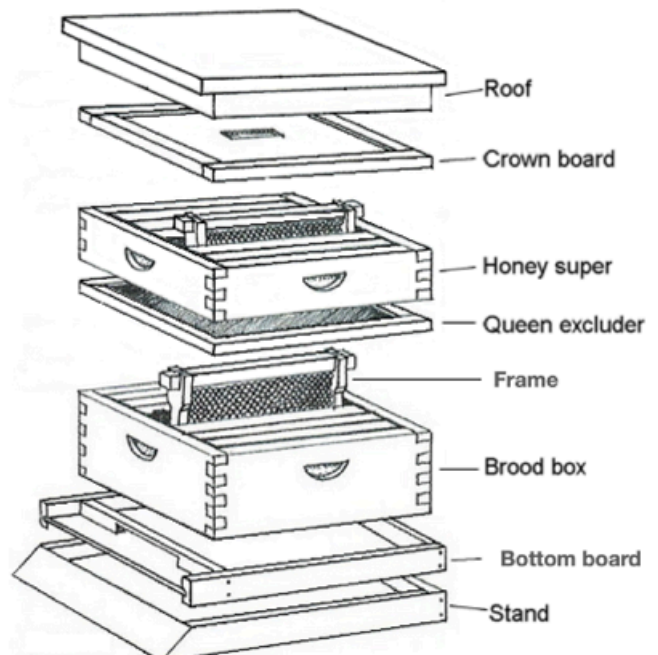
## Parts of a Hive

### ● Stand

- ❖ Lifts the hive 75 cm off the ground
- ❖ Protects hive against ground predators

### ● Bottom board

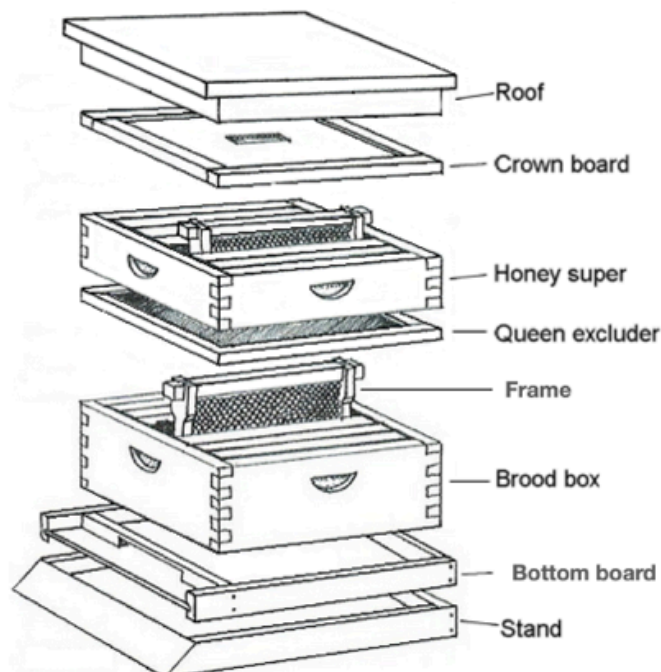
- ❖ The floor of the hive
- ❖ Made of durable material





● **Brood box, brood chamber or body**

- ❖ Contains a number of **frames** for the bees to make **honeycombs**
- ❖ In a hive, **brood** is the name for all of the hive's larvae and eggs.
- ❖ A **honeycomb** is a structure of hexagonal cells of wax, made by bees to store honey, pollen and eggs
- ❖ The queen lays eggs here
- ❖ Workers are reared here
- ❖ Frames must be spaced 4 cm



● **Queen excluder**

- ❖ Keeps queens and drones out of the honey super, but allows workers into it

● **Honey super**

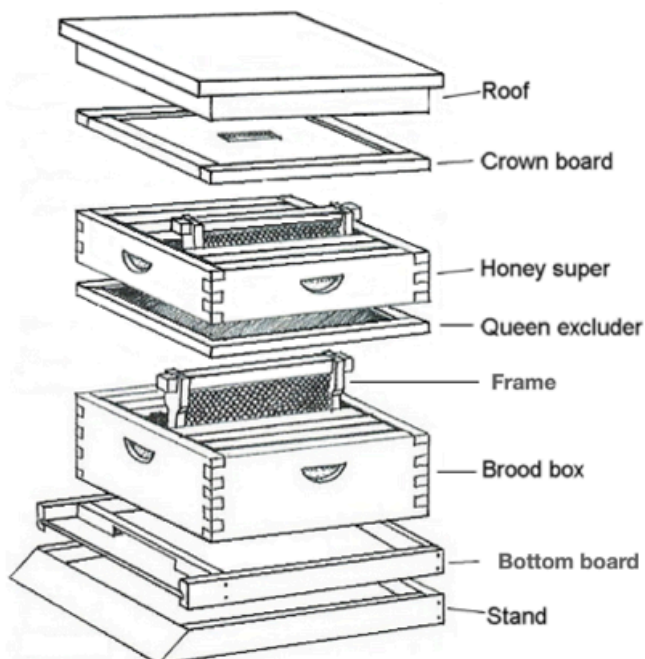
- ❖ A honey storage compartment
- ❖ Only the workers get in here, to make and store honey

● **Crown board**

- ❖ The ceiling of the hive
- ❖ Allows the roof to be removed without disrupting the hive

● **Roof**

- ❖ The roof of the hive



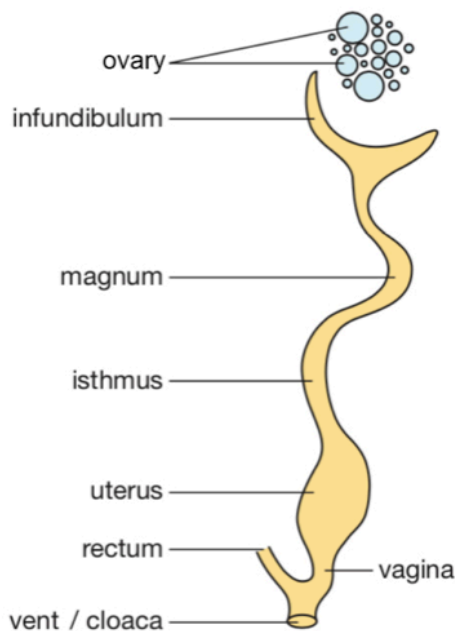
48. During the process of egg formation in poultry, the shell is formed in the

- (A) uterus
- (B) isthmus
- (C) magnum
- (D) infundibulum

Answer: A

The following information outlines a hen's reproductive system.

# A Hen's Reproductive System



Part of the oviduct	Time spent by ovum in each location	Functions
Infundibulum		Engulfs the yolk and deposits it in the magnum. If mating has occurred, fertilisation takes place here.
Magnum	About 3 hours	Albumen is produced here and surrounds the yolk. Thickened albumen forms the chalazae, which hold the yolk in a central position.
Isthmus	About 1 hour	Two shell membranes are placed around the egg.
Uterus / shell gland	18–20 hours	The shell, formed mainly of calcium carbonate, is deposited on the outer shell membrane.
Vagina	1–10 minutes	The egg stays here for a short time only, during which it is rotated through 180° so that it is laid large end first.
Vent / cloaca		The completed egg is expelled through this opening.

49. Which stage of growth is MOST appropriate for feeding layers with laying ration?

- (A) Less than one month
- (B) Two to three months
- (C) Three to four months
- (D) Five months and over

Answer: D

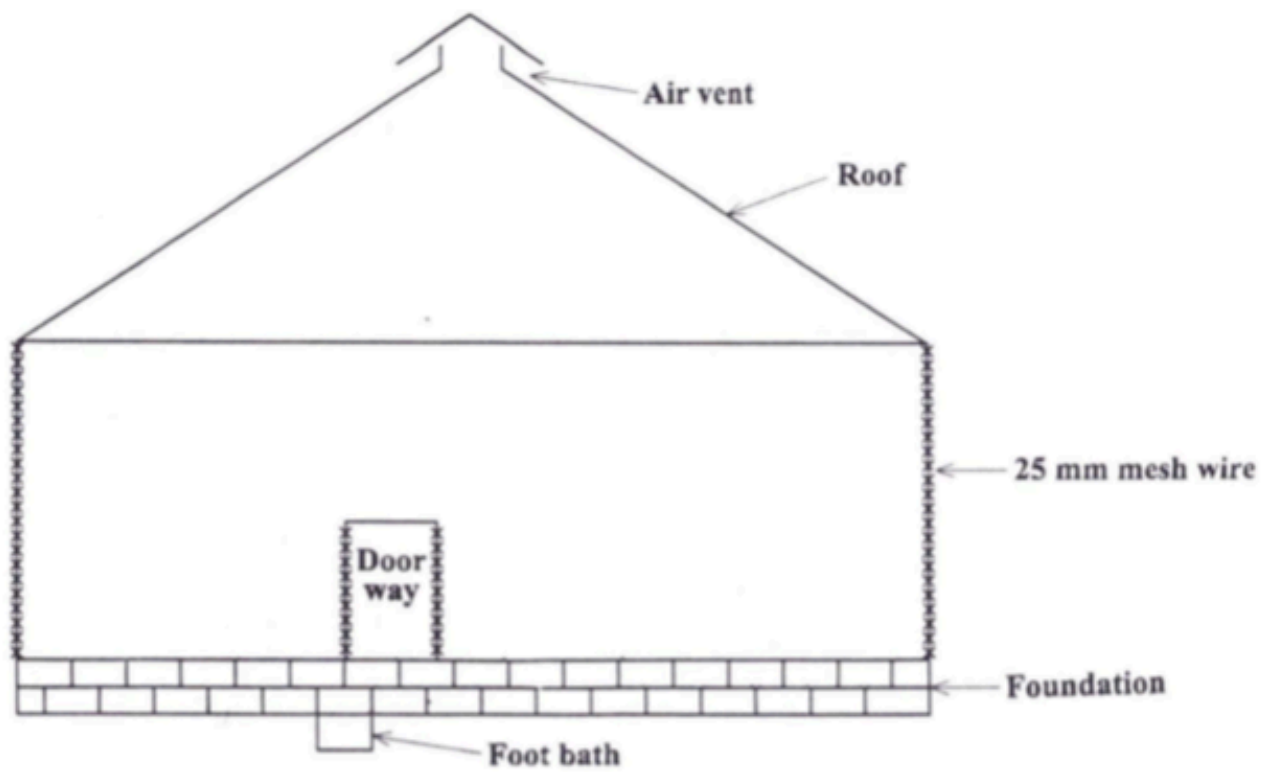
Layers start to lay from about 5 months; their economic life is about 2 years. Therefore laying ration is most appropriate from 5 months and over.

Layer chicks are fed chick starter for the first 5 weeks. They are then fed pullet developer, or grower, until 15 weeks old. A pullet is a hen that is not more than a year old.

From 5 months old (the age at which they start to lay), they are fed layer ration until they are culled (removed from the batch) due to natural reduction of egg production as they age beyond their most productive period (2 years old).

Broilers should never be fed layer ration. Layer ration is high in calcium. Layers need calcium for egg production, but the high calcium content in layer ration damages a broiler's kidneys.

Item 50 refers to the following diagram which shows a design of housing for a particular class of animal.

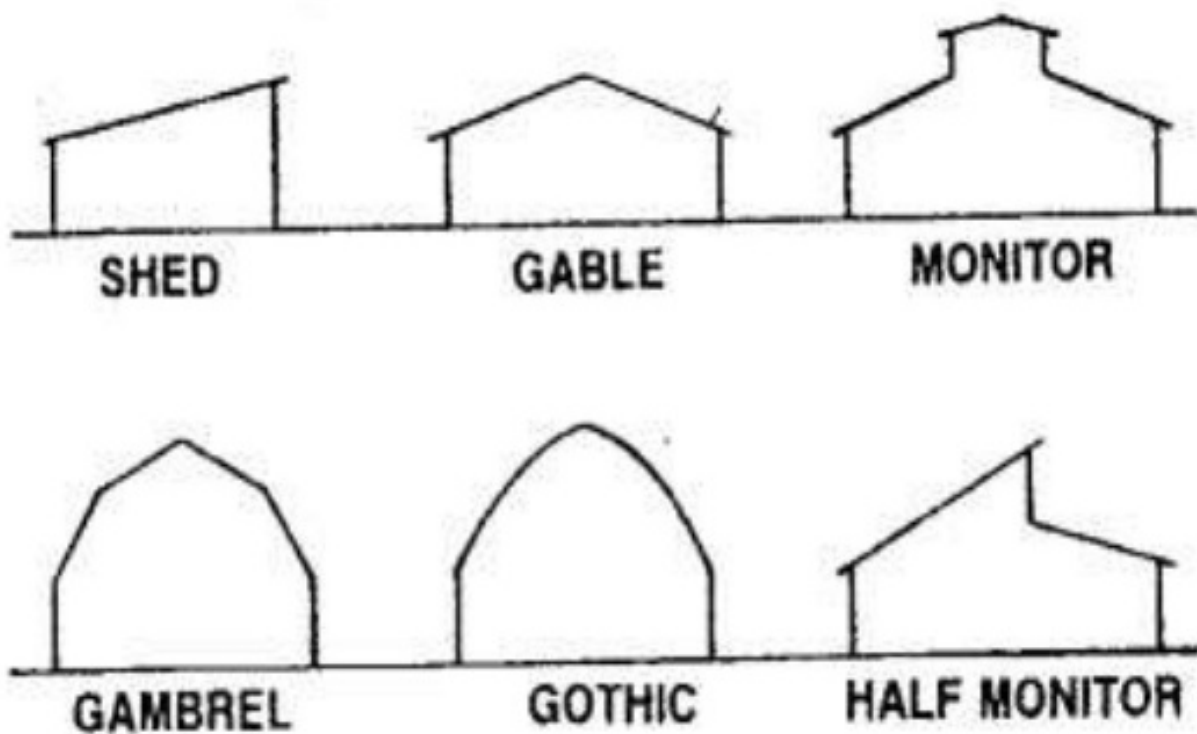


50. The type of roof shown in the diagram is

- (A) a hip roof
- (B) a gable roof
- (C) a lean-to roof
- (D) an insulated roof

Answer: B

The foot bath identifies this as a poultry house. Below are diagrams of roofs used in poultry housing. Note that this is actually a monitor roof, but that is not one of the options given. The closest one is gable.



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51. Which of the following is NOT a function of candling in poultry production?

- (A) Detecting abnormality in the egg
- (B) Determining the fertility of the egg
- (C) Determining the correct consistency of the egg
- (D) Checking whether the eggs are developing properly

Answer: B

Candling is the process by which eggs are tested for fertility. In this process, a light is shone through them. It gets its name from when candles were used as the light source. The process is carried out on artificially incubated eggs between days 9–15 of incubation so that infertile and bad eggs can be removed.

52. Oestrous cycle refers to the time

- (A) between conception and birth
- (B) when the animal comes on heat
- (C) when the animal is near to give birth
- (D) between one heat period and the next

Answer: D

The estrus cycle is a sequence of events occurring in female mammals, occurring over a specific number of days from the beginning of one heat period (estrus) to the beginning of the next heat period.

The heat period is the length of time during which the female farm animal is sexually receptive to the male farm animal. During this period, the female is said to be in heat. This means she will allow a male to copulate (have sexual intercourse) with her.

The estrus cycle is controlled by hormones. Once puberty is reached, female farm animals come into heat at regular intervals. Puberty is the period during which growing mammals reach sexual maturity and become capable of reproduction.

It is only when in heat that the female allows a male to copulate with her. Heat occurs as a result of the high levels of the hormone estrogen, produced by the ovaries, circulating in the blood.

Ovulation (the release of an ovum from the ovary) is closely associated with the heat period. It usually occurs during estrus or shortly after it. Mating during this time can result in fertilization and pregnancy.

53. Which white breed of pigs is noted for being excellent mothers, producing large litters, and having a deep body?

- (A) Duroc
- (B) Berkshire
- (C) Landrace
- (D) Hampshire

Answer: C

Landrace pigs have large, deep bodies. Sows are excellent mothers and have large litters.

54. Baby chicks require concentrate feeds which are high in

- (A) fats
- (B) fibre
- (C) proteins
- (D) carbohydrates

Answer: C

Chicks are fed starter, which has the high protein content needed for growth and development.



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<p>55. Young chicks are usually provided with a heat source during brooding in order to</p> <p>(A) provide light for egg shell development</p> <p>(B) maintain the body temperature of the birds</p> <p>(C) increase the temperature of litter to dry the watery faeces</p> <p>(D) prevent caking of the concentrate feed thrown on the floor</p>	<p>Answer: B</p> <p>Brooding is the special care given to day-old chicks for the first 2–3 weeks of their lives. It takes place in an enclosed area where the chicks are housed, protected, fed and kept warm. It is important because:</p> <ul style="list-style-type: none"> <li>• It provides comfort for the chicks.</li> <li>• It confines the chicks to an area in which they are as safe as possible.</li> </ul> <p>It allows for easy record-keeping e.g. of chick survival. There are two types of brooding:</p> <ul style="list-style-type: none"> <li>• Natural brooding</li> <li>• Artificial brooding</li> </ul> <p>In natural brooding, the hen incubates a clutch of eggs and produces a brood of chicks. She provides protection and warmth for the newly hatched chicks. She keeps them under her wings and feathered body until they develop feathers and are able to withstand colder weather conditions. If the area around the poultry house is securely fenced, the hen may roam freely with her chicks. Alternatively, she may be confined to a coop, which protects her and the chicks from rain, hot sun, draughts and predators such as rats, mongooses and stray cats. The farmer ensures that both the hen and the chicks have sufficient feed and water at all times.</p> <p>In artificial brooding, the day-old chicks are housed in a specially prepared area, usually a corner of the poultry house, where they are protected, kept warm and provided with litter, feed and water.</p> <p>A chick does not have normal feathers; it is instead covered with very fine, light feathers called down. Down, unlike normal feathers, cannot insulate the chick; thus the chicks get chilled quickly and die if they do not have a heating lamp to warm them if they are brooded artificially.</p>
<p>56. Debeaking layer birds is done to</p> <p>(A) prevent stress</p> <p>(B) prevent starvation</p> <p>(C) reduce cannibalism</p> <p>(D) reduce overcrowding</p>	<p>Answer: C</p> <p>Debeaking is the removal of about 2 mm of the chicken's upper beak using a hot iron. It prevents the birds from pecking at each other, and thus reduces/prevents cannibalism. It is no longer generally practiced as it has been found to be cruel.</p>
<p>57. Common internal parasites which affect poultry are</p> <p>(A) mites</p> <p>(B) ticks</p> <p>(C) round worms</p> <p>(D) poultry lice</p>	<p>Answer: C</p> <p>Mites, ticks, and poultry lice are all external parasites. Roundworms are common and are the largest worms affecting poultry. In appearance they are thick and white and up to 12 cm in length. These intestinal worms can cause intestinal impaction (compacting of the contents of the intestines) and fatalities in severe cases.</p>
<p>58. The disease of rabbits characterized by runny nose, coughing and sneezing is MOST likely</p> <p>(A) rabies</p> <p>(B) snuffles</p> <p>(C) heartwater</p> <p>(D) coccidiosis</p>	<p>Answer: B</p> <p>Snuffles is caused by a bacterial infection. Its symptoms include a nasal discharge of mucus, sneezing, and rubbing of the nose and eyes with the forepaws (front paws).</p>

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59. Which of the following is NOT a product obtained from poultry?

- (A) Meat
- (B) Feather
- (C) Leather
- (D) Dry shell

Answer: D

Poultry are mainly raised for meat. Feathers are also used. Skin from chicken legs and feet is also used to make leather.

60. The live weight of a goat is 50 kg. The dressed carcass weight is 30 kg. What is the dressing percentage?

- (A) 30
- (B) 40
- (C) 50
- (D) 60

Answer: D

Dressing percentage =  $(\text{Dressed weight} \div \text{Live weight}) \times 100$

Dressed weight = 30 kg

Live weight = 50 kg

Therefore dressing percentage =  $(30 \div 50) \times 100 = 60\%$