# SRMJEEE Biology Sample Paper – 9

**Duration: 47 Minutes** **Maximum Marks: 40**

## Instructions

- This paper contains **40** Multiple Choice Questions (Single Correct Answer), modelled on the Biology section of **SRMJEEE** (SRM Joint Engineering Entrance Examination).
- Each correct answer carries **+1 mark**. There is **no negative marking**; an unattempted or wrong answer scores 0.
- Only **one** option is correct. Choose carefully.
- The actual SRMJEEE is a **computer-based test** conducted in remote-proctored online mode, with all sections sharing a common time window and no per-section limit.
- Personal calculators, mobile phones, log tables and other electronic gadgets are strictly prohibited.

**Q1.** Slime moulds and *Euglena* are both placed in the kingdom Protista. *Euglena* is described as *mixotrophic* because it can:

(A) photosynthesise in light but feed heterotrophically in the dark

(B) only make its own food by photosynthesis at all times

(C) only ingest solid food particles like an amoeba

(D) fix atmospheric nitrogen using heterocysts

**Q2.** *Cycas* and *Pinus* are grouped together as gymnosperms chiefly because they are:

(A) flowering plants with seeds enclosed in a fruit

(B) spore-bearing plants that never form seeds

(C) cone-bearing plants whose seeds are naked (not enclosed in an ovary/fruit)

(D) non-vascular plants lacking true roots

**Q3.** Which set of features correctly describes members of the class Aves (birds)?

(A) cold-blooded, scaly skin, three-chambered heart

(B) warm-blooded vertebrates with feathers and hollow (pneumatic) bones

(C) moist glandular skin with no exoskeleton and external fertilisation

(D) segmented body with jointed appendages and a chitinous cuticle

**Q4.** A herbarium, a botanical garden and a museum are all examples of:

(A) methods of asexual reproduction in plants

(B) categories in the taxonomic hierarchy

(C) plant growth regulators

(D) taxonomic aids that store and supply information for identification

**Q5.** When the sepals or petals in a flower bud just touch one another at their margins without overlapping, the type of aestivation is said to be:

(A) valvate

(B) twisted (contorted)

(C) imbricate

(D) vexillary

**Q6.** *Aloe* and *Asparagus* are placed in the family Liliaceae. A typical floral feature of this monocot family is that the flowers are:

(A) tetramerous with a papilionaceous corolla

(B) trimerous with the perianth in two whorls of three (3+3) and six stamens

(C) pentamerous with bilaterally symmetrical, two-lipped flowers

(D) without any perianth, the flowers reduced to spikelets

**Q7.** In the alimentary canal of the cockroach, the part with thick muscular walls and chitinous teeth that grinds the food is the:

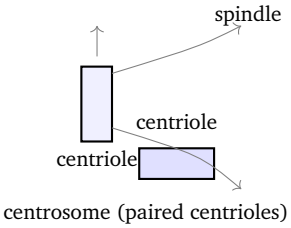
(A) crop, which only stores food

(B) hepatic caeca, which only secrete enzymes

(C) gizzard (proventriculus)

(D) rectum, which absorbs water

**Q8.** The organelle shown below consists of a pair of cylindrical centrioles set at right angles, and it organises the spindle fibres during cell division. It is the:




(A) ribosome

(B) lysosome

(C) Golgi apparatus

(D) centrosome (with its centrioles)

**Q9.** Some bacteria are surrounded outside the cell wall by a thick, tough mucilaginous layer called the capsule (glycocalyx). Its main role is to:

(A) protect the cell and help it resist drying and host defences (phagocytosis)

(B) carry out photosynthesis for the cell

(C) act as the site of protein synthesis

(D) store the bacterial genetic material

**Q10.** A single nucleotide of a nucleic acid is formed by joining three components. These are:

(A) two amino acids and a peptide bond

(B) glycerol, a fatty acid and a phosphate

(C) a nitrogenous base, a pentose sugar and a phosphate group

(D) glucose, fructose and a glycosidic bond

**Q11.** In a dividing plant cell, cytokinesis differs from that in an animal cell because the new wall between the daughter cells is laid down by the:

(A) pinching in of the plasma membrane to form a cleavage furrow

(B) formation of a cell plate that grows outward to the parent wall

(C) splitting of the centromeres

(D) breakdown of the nuclear envelope

**Q12.** The failure of homologous chromosomes or sister chromatids to separate during meiosis is called non-disjunction. Its direct consequence is the production of gametes that:

(A) have an extra or a missing chromosome (aneuploidy)

(B) always have exactly the normal haploid number

(C) contain no chromosomes at all

(D) have a doubled (tetraploid) set in every case

**Q13.** In the apoplast pathway of water movement across the root, water travels:

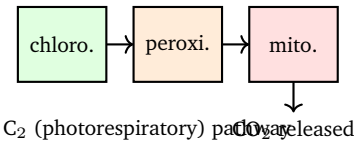
(A) from cell to cell only through the plasmodesmata

(B) exclusively through the vacuoles of living cells

(C) upward through the xylem vessels against gravity by active transport

(D) through the cell walls and intercellular spaces, without crossing membranes

**Q14.** In the leaf cell shown, when $O_2$ levels are high RuBisCO fixes $O_2$ instead of $CO_2$, starting the photorespiratory ($C_2$) pathway across the chloroplast, peroxisome and mitochondrion. In $C_3$ plants this process is wasteful because it:




(A) produces extra ATP and sugar for the plant

(B) consumes energy and releases $CO_2$ without making any sugar, lowering net yield

(C) splits water to release oxygen

(D) fixes atmospheric nitrogen into ammonia

**Q15.** At the end of the electron transport chain in aerobic respiration, the final (terminal) electron acceptor is:

(A) $NAD^+$, which is reduced to NADH

(B) pyruvate, which is reduced to lactate

(C) molecular oxygen ($O_2$), which combines with electrons and protons to form water

(D) carbon dioxide, which is reduced to glucose

**Q16.** Which of the following would most directly break the dormancy of many seeds and promote their germination?

(A) treatment with gibberellic acid (and removal of inhibitors such as abscisic acid)

(B) raising the abscisic acid level inside the seed

(C) complete absence of water and oxygen

(D) keeping the seed in permanent darkness with no temperature change

**Q17.** The rhythmic wave of contraction and relaxation of the smooth muscle that pushes food forward along the alimentary canal is called:

(A) deglutition

(B) egestion

(C) assimilation

(D) peristalsis

**Q18.** In the respiratory disorder *emphysema*, breathing efficiency falls mainly because:

(A) the bronchi go into sudden reversible spasm, as in an asthma attack

(B) the walls of the alveoli are damaged and break down, reducing the surface area for gas exchange

(C) the pleural membranes become inflamed and stick together

(D) extra haemoglobin is produced in the blood

**Q19.** Cardiac output, the volume of blood pumped by each ventricle per minute, is correctly given by:

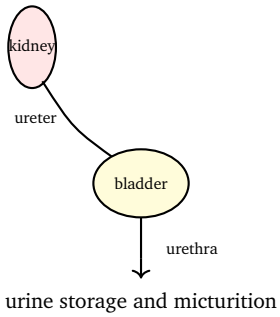
(A) heart rate divided by stroke volume

(B) stroke volume divided by heart rate

(C) stroke volume $\times$ heart rate

(D) stroke volume $+$ heart rate

**Q20.** In the system shown, urine collected from the kidney is stored in the bladder and expelled through the urethra during *micturition*. Normal human urine is mostly water together with:



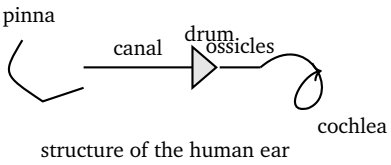

(A) nitrogenous wastes such as urea, uric acid and creatinine, plus some salts

(B) large amounts of glucose and plasma proteins

(C) red blood cells and whole blood plasma

(D) digestive enzymes and bile pigments only

**Q21.** In the human ear shown, the coiled, fluid-filled structure of the inner ear that contains the receptor cells for hearing (the organ of Corti) is the:



structure of the human ear

(A) pinna

(B) cochlea

(C) ear ossicles (malleus, incus, stapes)

(D) eustachian tube

**Q22.** An excess of growth hormone secreted in an adult, after the long bones have stopped growing, produces the disorder called:

(A) dwarfism

(B) diabetes mellitus

(C) goitre

(D) acromegaly

**Q23.** The plant shown spreads by a slender, horizontal above-ground stem that roots at its nodes to form new daughter plants. This mode of natural vegetative propagation is by a:


runner rooting at the nodes

(A) bulb

(B) rhizome

(C) runner

(D) leaf cutting

**Q24.** In many flowering plants, even when viable pollen lands on the stigma of the same flower, fertilisation does not occur. This genetic device that prevents self-fertilisation is called:

(A) self-incompatibility (self-sterility)

(B) parthenocarpy

(C) apomixis

(D) polyembryony

**Q25.** During early human pregnancy, the hormone secreted by the developing placenta (and detected in pregnancy tests) that maintains the corpus luteum is:

(A) follicle stimulating hormone (FSH)

(B) luteinising hormone (LH)

(C) oxytocin

(D) human chorionic gonadotropin (hCG)

**Q26.** Among the following, which is a *barrier* method of contraception used in family planning?

(A) the oral contraceptive pill

(B) the condom

(C) tubectomy

(D) the copper-T intra-uterine device

**Q27.** The Punnett square shows a heterozygous tall pea plant ($Tt$) crossed back to its homozygous *dominant* parent ($TT$). The phenotype of *all* the offspring of this cross is:

| | $T$ | $T$ |
|---|---|---|
| $T$ | $TT$ | $TT$ |
| $t$ | $Tt$ | $Tt$ |

(A) half tall and half dwarf

(B) all dwarf

(C) all tall

(D) one-quarter dwarf

**Q28.** In a human pedigree chart used to trace the inheritance of a trait, a circle and a square are used, by convention, to represent respectively a:

(A) female individual and a male individual

(B) male individual and a female individual

(C) affected person and an unaffected person

(D) marriage and an offspring

**Q29.** Down's syndrome, caused by an extra copy of chromosome 21, can be detected before birth by a foetal test that examines the chromosomes in cells of the amniotic fluid. This test is called:

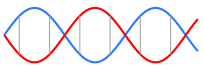
(A) electrocardiography

(B) gel electrophoresis

(C) the polymerase chain reaction

(D) amniocentesis (karyotyping of amniotic fluid cells)

**Q30.** Griffith's transformation experiment and the Hershey–Chase experiment with the bacteriophage shown both led to the same conclusion, namely that:



DNA is the transforming/genetic material

(A) protein is the genetic material of the cell

(B) DNA is the genetic (hereditary) material

(C) RNA alone carries all genetic information in bacteria

(D) lipids store and transmit genetic information

**Q31.** In a typical eukaryotic gene, the coding sequences that are retained in the mature mRNA after splicing are the exons, while the intervening non-coding sequences that are removed are the:

(A) cistrons

(B) codons

(C) introns

(D) anticodons

**Q32.** When a few individuals migrate and start a new, small, isolated population, the allele frequencies in the new group may differ markedly from the original population purely by chance. This is the:

(A) founder effect, a form of genetic drift

(B) result of directional natural selection

(C) outcome of large-scale gene flow

(D) effect of disruptive selection

**Q33.** Which of the following correctly matches a pathogen with the disease it causes in humans?

(A) *Wuchereria* — typhoid

(B) *Salmonella* — ringworm

(C) *Plasmodium* — pneumonia

(D) *Entamoeba histolytica* — amoebic dysentery

**Q34.** Which statement about lymphocytes is correct?

(A) B-lymphocytes provide cell-mediated immunity by attacking infected cells directly

(B) B-lymphocytes provide humoral immunity by producing antibodies, while T-lymphocytes provide cell-mediated immunity

(C) T-lymphocytes secrete the circulating antibodies of the blood plasma

(D) both B and T cells engulf pathogens by phagocytosis only

**Q35.** Statins, drugs widely used to lower blood cholesterol, are obtained commercially as a metabolic product of the yeast:

(A) *Monascus purpureus*

(B) *Trichoderma polysporum*

(C) *Clostridium butylicum*

(D) *Streptococcus* species

**Q36.** Before a host bacterial cell can take up recombinant DNA, it must be made "competent". A common way of doing this is to treat the cells with:

(A) restriction enzymes to cut their cell wall open

(B) a strong acid that dissolves the cell membrane permanently

(C) divalent calcium ($CaCl_2$) followed by a brief heat shock

(D) antibiotics that select for the recombinant cells

**Q37.** In India, the body that examines the safety of genetically modified organisms and approves their use in research and for public release is the:

(A) Indian Council of Agricultural Research (ICAR)

(B) Genetic Engineering Appraisal Committee (GEAC)

(C) Botanical Survey of India (BSI)

(D) Food Safety and Standards Authority of India (FSSAI)

**Q38.** The technique in which DNA-coated tiny gold or tungsten particles are fired into plant cells with a "gene gun" to introduce foreign genes is called:

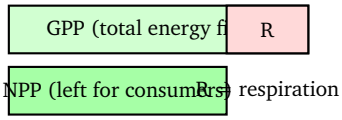
(A) microinjection

(B) electroporation

(C) liposome-mediated transfer

(D) biolistics (the gene gun method)

**Q39.** In the productivity scheme shown, gross primary productivity (GPP) is the total rate at which producers capture energy, and net primary productivity (NPP) is the energy left for the next trophic level. NPP is therefore correctly expressed as:




(A) NPP = GPP − respiratory losses (R) of the producers

(B) NPP = GPP + respiratory losses (R)

(C) NPP = respiration − GPP

(D) NPP is always equal to GPP

**Q40.** Observations of the latitudinal gradient in biodiversity show that, in general, species richness:

(A) is highest at the poles and decreases towards the equator

(B) is the same everywhere on Earth regardless of latitude

(C) increases from the poles towards the equator, being greatest in the tropics

(D) is highest in the deserts of the mid-latitudes

## Detailed Solutions

**Q1.**

**Solution**

**Concept — Kingdom Protista:** Protista is the kingdom of mostly single-celled *eukaryotes* that do not fit neatly into plants, animals or fungi. It is a varied group that includes protozoa, the photosynthetic protists (such as *Euglena* and dinoflagellates) and the slime moulds.

**Key fact:** *Euglena* is *mixotrophic* — in sunlight its chloroplasts photosynthesise to make food, but in the dark (or when light is scarce) it switches to feeding heterotrophically on dissolved organic matter. This dual nutrition is its defining feature.

**Why other options are wrong:**

- (B) A purely photosynthetic organism is an autotroph, not mixotrophic.
- (C) *Euglena* does not engulf solid particles as an amoeba does; (D) nitrogen fixation with heterocysts is a feature of cyanobacteria (Monera).

**Final Answer:** *Euglena* photosynthesises in light and feeds in the dark $\Rightarrow$ $\boxed{\text{A}}$

**Answer: (A)** Go Back to Q1

**Q2.**

**Solution**

**Concept — Gymnosperms:** Gymnosperms (Greek *gymnos* = naked, *sperma* = seed) are vascular, seed-bearing plants in which the ovules, and the seeds that develop from them, are *not* enclosed within an ovary or fruit but lie exposed on the surface of cone scales (or similar structures).

**Key fact:** *Cycas* (a cycad) and *Pinus* (the pine) both bear their seeds naked on cones, so they are placed together as gymnosperms. They are heterosporous and lack true vessels in the xylem and companion cells in the phloem.

**Why other options are wrong:**

- (A) Seeds enclosed in a fruit describes angiosperms, not gymnosperms.
- (B) Both plants do form seeds, so they are not spore-only plants; (D) they are well-developed vascular plants with true roots.

**Final Answer:** Cone-bearing, naked-seeded plants $\Rightarrow$ $\boxed{\text{C}}$

**Answer: (C)** Go Back to Q2

## Q3.

### Solution

**Concept — Class Aves:** Birds form the class Aves, a group of vertebrates beautifully adapted for flight. They are *warm-blooded* (homeothermic) and their bodies are covered with feathers, a unique avian feature.

**Key fact:** To reduce body weight for flight, the long bones of birds are *pneumatic* (hollow, air-filled). Other adaptations include a four-chambered heart, forelimbs modified into wings, a beak without teeth and air sacs connected to the lungs.

**Why other options are wrong:**

- (A) Cold-blooded, scaly skin and a three-chambered heart describe reptiles.
- (C) Moist glandular skin with external fertilisation describes amphibians; (D) a jointed-appendage, chitinous body describes arthropods.

**Final Answer:** Warm-blooded vertebrates with feathers and pneumatic bones $\Rightarrow$ B

**Answer: (B)** Go Back to Q3

## Q4.

### Solution

**Concept — Taxonomic aids:** Taxonomic aids are the collections, tools and institutions that help biologists identify, name and classify organisms and store specimens for reference and study.

**Key fact:** A *herbarium* is a store of dried, pressed and mounted plant specimens on sheets; a *botanical garden* maintains living collections of plants for reference; and a *museum* keeps preserved specimens of plants and animals. All three serve as taxonomic aids.

**Why other options are wrong:**

- (A) They are not methods of reproduction.
- (B) Categories of the taxonomic hierarchy are species, genus, family, etc., not these collections; (C) they are not plant growth regulators.

**Final Answer:** Herbarium, botanical garden, museum = taxonomic aids $\Rightarrow$ D

**Answer: (D)** Go Back to Q4

## Q5.

### Solution

**Concept — Aestivation:** Aestivation describes the arrangement of sepals or petals in a flower bud before it opens. The main types are valvate, twisted (contorted), imbricate and vexillary.

**Key fact:** In *valvate* aestivation the sepals or petals merely *touch* one another at their margins without overlapping (e.g. *Calotropis*). This is exactly the arrangement described in the question.

**Why other options are wrong:**

- (B) In twisted aestivation one margin of each member overlaps the next in a regular direction (e.g. *Hibiscus*).
- (C) In imbricate aestivation the margins overlap but not in any set direction; (D) vexillary is the special five-petal overlap of the pea (Fabaceae).

**Final Answer:** Margins just touching = valvate $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q5

## Q6.

### Solution

**Concept — Family Liliaceae:** Liliaceae is a monocot family (the "lily family"). *Aloe* and *Asparagus*, along with lily, tulip and onion, are typical members.

**Key fact:** The flowers are *trimerous* and follow the monocot floral plan: a perianth (undifferentiated tepals) in two whorls of three (3+3), *six* stamens, and a tricarpellary, syncarpous, superior ovary. The fruit is a capsule or berry.

**Why other options are wrong:**

- (A) A tetramerous, papilionaceous flower is not a Liliaceae feature (papilionaceous belongs to Fabaceae).
- (C) Two-lipped bilaterally symmetrical flowers describe families such as Lamiaceae; (D) reduction to spikelets describes grasses (Poaceae).

**Final Answer:** Trimerous, 3+3 perianth with six stamens $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q6

## Q7.

**Solution**

**Concept — Cockroach alimentary canal:** The gut of the cockroach has a foregut (mouth, pharynx, oesophagus, crop and gizzard), a midgut and a hindgut, with hepatic caeca and Malpighian tubules opening at junctions along the way.

**Key fact:** The *gizzard (proventriculus)* has thick muscular walls lined internally with six chitinous teeth (denticles); it grinds the food into fine particles and also strains it before it passes to the midgut.

**Why other options are wrong:**

- (A) The crop is a thin-walled sac that only *stores* food temporarily; it does not grind.
- (B) The hepatic caeca secrete digestive enzymes at the start of the midgut; (D) the rectum absorbs water in the hindgut.

**Final Answer:** The grinding organ is the gizzard $\Rightarrow$ $\boxed{\text{C}}$

**Answer: (C)** Go Back to Q7

## Q8.

**Solution**

**Concept — The centrosome and centrioles:** The centrosome is a non-membranous organelle found near the nucleus of animal cells. It contains a pair of cylindrical *centrioles* lying at right angles to each other, each made of nine triplets of microtubules (the 9+0 pattern).

**Key fact:** During cell division the centrosome organises the microtubules and forms the *spindle fibres* that move the chromosomes. It is therefore the main microtubule-organising centre of the cell, as shown by the spindle radiating in the figure.

**Why other options are wrong:**

- (A) Ribosomes are the sites of protein synthesis and have no centrioles.
- (B) Lysosomes are membrane-bound sacs of digestive enzymes; (C) the Golgi apparatus is a stack of flattened cisternae for packaging.

**Final Answer:** Paired centrioles forming the spindle = centrosome $\Rightarrow$ $\boxed{\text{D}}$

**Answer: (D)** Go Back to Q8

## Q9.

**Solution**

**Concept — The bacterial glycocalyx:** Many bacteria secrete a sticky layer of polysaccharide (and sometimes protein) outside the cell wall. When this layer is thick and firmly attached it is called a *capsule*; when loose it is a slime layer. Together they are the glycocalyx.

**Key fact:** The capsule *protects* the bacterium: it helps the cell resist desiccation, aids attachment to surfaces, and shields the pathogen from being engulfed by the host's phagocytes, so capsulated strains are often more virulent.

**Why other options are wrong:**

- (B) Photosynthesis (in photosynthetic bacteria) occurs on internal membranes, not the capsule.
- (C) Protein synthesis occurs on ribosomes; (D) the genetic material lies in the nucleoid inside the cell.

**Final Answer:** The capsule protects the cell $\Rightarrow$ $\boxed{\text{A}}$

**Answer: (A)** Go Back to Q9

## Q10.

**Solution**

**Concept — Structure of a nucleotide:** Nucleic acids (DNA and RNA) are polymers built from repeating monomers called nucleotides. A nucleotide is itself made of three joined parts.

**Key fact:** Each nucleotide consists of a *nitrogenous base*, a *pentose sugar* (deoxyribose in DNA, ribose in RNA) and one or more *phosphate groups*. Nucleotides are linked by phosphodiester bonds between the sugar of one and the phosphate of the next, building a polynucleotide chain with a sugar–phosphate backbone.

**Why other options are wrong:**

- (A) Amino acids joined by peptide bonds make proteins, not nucleic acids.
- (B) Glycerol + fatty acid + phosphate describes a phospholipid; (D) glucose + fructose forms the disaccharide sucrose.

**Final Answer:** Base + pentose sugar + phosphate $\Rightarrow$ $\boxed{\text{C}}$

**Answer: (C)** Go Back to Q10

## Q11.

**Solution**

**Concept — Cytokinesis:** Cytokinesis is the division of the cytoplasm that follows nuclear division (karyokinesis). The way it happens differs between animal and plant cells because plant cells have a rigid cell wall.

**Key fact:** In plant cells a *cell plate* forms in the middle of the cell from Golgi-derived vesicles and grows *outward* (centrifugally) until it fuses with the parent cell wall, dividing the cell into two. This becomes the new middle lamella and cell walls.

**Why other options are wrong:**

- (A) A cleavage furrow formed by pinching of the membrane is how *animal* cells divide.
- (C) Splitting of centromeres occurs in anaphase (karyokinesis), not cytokinesis; (D) breakdown of the nuclear envelope happens in prophase.

**Final Answer:** Plant cells divide by a cell plate $\Rightarrow$ $\boxed{\text{B}}$

**Answer: (B)** Go Back to Q11

## Q12.

**Solution**

**Concept — Non-disjunction:** During normal meiosis, homologous chromosomes separate in anaphase I and sister chromatids separate in anaphase II, so each gamete ends up with one of each chromosome. Non-disjunction is the failure of this separation.

**Key fact:** When chromosomes fail to separate, one gamete receives an *extra* chromosome (n+1) and the other a *missing* one (n−1). Fertilisation then gives a zygote with an abnormal chromosome number, a condition called *aneuploidy* (e.g. trisomy-21, Down's syndrome).

**Why other options are wrong:**

- (B) Normal separation, not non-disjunction, gives the correct haploid number.
- (C) Gametes still carry chromosomes, just the wrong number; (D) doubling of the whole set is polyploidy, a different error.

**Final Answer:** Non-disjunction produces aneuploid gametes $\Rightarrow$ $\boxed{\text{A}}$

**Answer: (A)** Go Back to Q12

## Q13.

### Solution

**Concept — Apoplast and symplast pathways:** Water absorbed by the root moves across the cortex towards the xylem by two routes. The *symplast* is the continuous living cytoplasm linked by plasmodesmata; the *apoplast* is the continuous system of cell walls and intercellular spaces.

**Key fact:** In the *apoplast* pathway water moves entirely through the cell walls and the spaces between cells *without* ever crossing a plasma membrane, so it offers the least resistance and accounts for most of the water flow until it is blocked by the Casparian strip in the endodermis.

**Why other options are wrong:**

- (A) Movement through plasmodesmata is the *symplast* pathway, not apoplast.
- (B) Travel through vacuoles is the transcellular/vacuolar route; (C) apoplast movement is passive and not confined to the xylem.

**Final Answer:** Apoplast = through walls and spaces, no membranes $\Rightarrow$ D

**Answer: (D)** Go Back to Q13

## Q14.

### Solution

**Concept — Photorespiration (the $C_2$ cycle):** The enzyme RuBisCO can fix either $CO_2$ or $O_2$. When $O_2$ is high and $CO_2$ low, it fixes $O_2$ onto RuBP, producing a 2-carbon compound (phosphoglycolate) and starting the photorespiratory pathway that runs across the chloroplast, peroxisome and mitochondrion.

**Key fact:** Photorespiration is *wasteful* in $C_3$ plants because it *consumes ATP and reducing power and releases $CO_2$ without producing any sugar or net energy*. It can lower the net photosynthetic yield of a $C_3$ crop by as much as 25%.

**Why other options are wrong:**

- (A) It does the opposite — it makes no sugar and wastes energy.
- (C) Splitting of water occurs in the light reaction (Photosystem II), not photorespiration; (D) nitrogen fixation is unrelated.

**Final Answer:** Photorespiration wastes energy and releases $CO_2$ with no sugar $\Rightarrow$ B

**Answer: (B)** Go Back to Q14

## Q15.

### Solution

**Concept — The electron transport chain (ETC):** In aerobic respiration, NADH and $FADH_2$ donate electrons to a chain of carriers on the inner mitochondrial membrane. The electrons pass down the chain, releasing energy used to pump protons and make ATP.

**Key fact:** The *terminal electron acceptor* of the ETC is molecular *oxygen* ($O_2$). It accepts the electrons at the end of the chain and combines with protons ($H^+$) to form water: $\frac{1}{2}O_2 + 2H^+ + 2e^- \rightarrow H_2O$. This is why oxygen is essential for aerobic respiration.

**Why other options are wrong:**

- (A) $NAD^+$ accepts electrons *earlier* (in glycolysis and the Krebs cycle), not at the terminal step.
- (B) Pyruvate to lactate happens in anaerobic fermentation; (D) $CO_2$ is a waste product, not the electron acceptor here.

**Final Answer:** The terminal acceptor is $O_2$, forming water $\Rightarrow$ C

**Answer: (C)** Go Back to Q15

## Q16.

### Solution

**Concept — Seed dormancy and germination:** A dormant seed is alive but does not germinate even under apparently favourable conditions, often because of inhibitors (such as abscisic acid), a hard or impermeable seed coat, or an immature embryo.

**Key fact:** Dormancy is broken and germination promoted when the balance of growth regulators shifts in favour of promoters. *Gibberellic acid* (GA) breaks dormancy and triggers germination (it switches on enzymes such as amylase), while *removing or lowering abscisic acid* releases the brake. Adequate water, oxygen and suitable temperature are also needed.

**Why other options are wrong:**

- (B) Raising abscisic acid *deepens* dormancy — ABA is the dormancy-inducing hormone.
- (C) Without water and oxygen the seed cannot germinate at all; (D) permanent darkness does not break dormancy in light-sensitive seeds.

**Final Answer:** Gibberellic acid breaks dormancy $\Rightarrow$ A

**Answer: (A)** Go Back to Q16

## Q17.

### Solution

**Concept — Movement of food along the gut:** The wall of the alimentary canal contains smooth (involuntary) muscle. Coordinated contraction of this muscle moves the food (bolus) onward from the oesophagus to the rectum.

**Key fact:** *Peristalsis* is the successive wave of contraction (behind the bolus) and relaxation (ahead of it) of the circular and longitudinal muscles that propels food along the gut. It is an involuntary movement controlled by the autonomic nervous system.

**Why other options are wrong:**

- (A) Deglutition is the act of swallowing food into the oesophagus.
- (B) Egestion is the removal of undigested faeces; (C) assimilation is the use of absorbed nutrients by body cells.

**Final Answer:** The propelling wave = peristalsis $\Rightarrow$ D

**Answer: (D)** Go Back to Q17

## Q18.

### Solution

**Concept — Respiratory disorders:** In *asthma*, the bronchi and bronchioles undergo sudden, reversible spasm and inflammation, causing difficulty in breathing with wheezing. In *emphysema*, a chronic disorder (often from smoking), the delicate walls of the alveoli are progressively destroyed.

**Key fact:** In emphysema the breakdown of alveolar walls makes the alveoli merge into larger air spaces, which drastically *reduces the respiratory surface area* available for gas exchange. The lungs lose elasticity, so the patient cannot exchange oxygen and carbon dioxide efficiently and becomes breathless.

**Why other options are wrong:**

- (A) Reversible bronchial spasm describes *asthma*, not emphysema.
- (C) Inflammation of the pleura is pleurisy; (D) extra haemoglobin would aid, not hinder, oxygen carriage.

**Final Answer:** Emphysema destroys alveolar walls, cutting the gas-exchange surface $\Rightarrow$ B

**Answer: (B)** Go Back to Q18

## Q19.

### Solution

**Concept — Cardiac output:** Cardiac output is the volume of blood pumped out by each ventricle of the heart in one minute. It depends on how much blood is ejected per beat and how many beats occur per minute.

**Key fact:** Cardiac output $=$ *stroke volume* $\times$ *heart rate*. With a stroke volume of about 70 mL and a heart rate of about 72 beats per minute, the cardiac output of a healthy adult at rest is roughly $70 \times 72 \approx 5000$ mL (5 L) per minute.

**Why other options are wrong:**

- (A),(B) Dividing the two quantities gives meaningless units, not a volume per minute.
- (D) Adding stroke volume and heart rate is dimensionally wrong; output must be a product.

**Final Answer:** Cardiac output $=$ stroke volume $\times$ heart rate $\Rightarrow$ C

**Answer: (C)** Go Back to Q19

## Q20.

### Solution

**Concept — Composition of urine and micturition:** The nephrons form urine, which drains through the ureters into the urinary bladder for storage. When the bladder fills, the stretch reflex and voluntary control trigger *micturition*, the expulsion of urine through the urethra.

**Key fact:** Normal human urine is about 95% *water* together with dissolved *nitrogenous wastes* — chiefly *urea*, with smaller amounts of uric acid and creatinine

— plus excess ions and salts. A healthy adult passes roughly 1–1.5 litres per day.

**Why other options are wrong:**

- (B) Glucose and plasma proteins are normally fully reabsorbed; their presence indicates disease.
- (C) Red blood cells in urine are abnormal (haematuria); (D) digestive enzymes and bile pigments are not excreted in urine.

**Final Answer:** Urine = water plus urea and other nitrogenous wastes $\Rightarrow$ $\boxed{\text{A}}$

**Answer: (A)** Go Back to Q20

## Q21.

### Solution

**Concept — The human ear:** The ear has three regions — the outer ear (pinna and canal), the middle ear (eardrum and three ossicles) and the inner ear, which contains the cochlea and the vestibular apparatus.

**Key fact:** The *cochlea* is the coiled, fluid-filled tube of the inner ear that houses the *organ of Corti*, whose hair cells are the actual receptors of sound. Vibrations of the fluid bend these hair cells, generating nerve impulses that the auditory nerve carries to the brain for hearing.

**Why other options are wrong:**

- (A) The pinna only collects and funnels sound waves.
- (C) The ear ossicles amplify and transmit vibrations to the inner ear but are not the receptor; (D) the eustachian tube equalises air pressure across the eardrum.

**Final Answer:** The hearing receptor organ is in the cochlea $\Rightarrow$ $\boxed{\text{B}}$

**Answer: (B)** Go Back to Q21

## Q22.

**Solution**

**Concept — Disorders of growth hormone:** Growth hormone (GH, somatotropin) from the anterior pituitary controls body growth. Both too little and too much GH cause characteristic disorders, and the effect depends on whether the bones are still growing.

**Key fact:** An *excess of GH in an adult*, after the epiphyseal plates of the long bones have closed, causes *acromegaly* — abnormal thickening and enlargement of the bones of the hands, feet, jaw and face (the bones cannot lengthen any more, so they grow thicker).

**Why other options are wrong:**

- (A) Dwarfism is caused by a *deficiency* of GH in childhood.
- (B) Diabetes mellitus is due to insulin problems; (C) goitre is caused by iodine deficiency affecting the thyroid.

**Final Answer:** Excess GH in an adult = acromegaly $\Rightarrow$ $\boxed{\text{D}}$

**Answer: (D)** Go Back to Q22

## Q23.

**Solution**

**Concept — Vegetative propagation:** Many plants reproduce asexually through vegetative parts. Natural devices include runners, rhizomes, bulbs, tubers and offsets, while artificial methods include cuttings, layering and grafting.

**Key fact:** A *runner* (stolon) is a slender stem that creeps *horizontally above the ground* and produces roots and a new shoot at each node, giving rise to independent daughter plants (e.g. grass, strawberry, *Oxalis*). The figure shows exactly this rooting at the nodes.

**Why other options are wrong:**

- (A) A bulb (onion) is a short underground stem with fleshy scale leaves, not a creeping stem.
- (B) A rhizome grows horizontally *underground*; (D) a leaf cutting is an artificial method using a detached leaf (e.g. *Bryophyllum*).

**Final Answer:** Horizontal above-ground stem rooting at nodes = runner $\Rightarrow$ $\boxed{\text{C}}$

**Answer: (C)** Go Back to Q23

## Q24.

**Solution**

**Concept — Outbreeding devices:** To promote cross-pollination and avoid the harmful effects of continued self-fertilisation, plants have evolved several devices, including unisexuality, dichogamy, herkogamy and self-incompatibility.

**Key fact:** *Self-incompatibility* (self-sterility) is a genetic mechanism that prevents the pollen of a flower from fertilising the egg of the *same* flower (or same plant): the self pollen fails to germinate or its tube fails to grow down the style. This forces cross-fertilisation and maintains genetic variation.

**Why other options are wrong:**

- (B) Parthenocarpy is the formation of fruit without fertilisation.
- (C) Apomixis is seed formation without fertilisation; (D) polyembryony is the formation of more than one embryo in a seed.

**Final Answer:** Genetic block to self-fertilisation = self-incompatibility $\Rightarrow$ $\boxed{\text{A}}$

**Answer: (A)** Go Back to Q24

## Q25.

**Solution**

**Concept — Hormones of pregnancy:** After implantation, the placenta becomes a major endocrine organ. Together with the ovary it secretes the hormones that maintain pregnancy — human chorionic gonadotropin (hCG), progesterone and oestrogen.

**Key fact:** *hCG* (human chorionic gonadotropin) is produced by the developing placenta in early pregnancy; it maintains the *corpus luteum* so that it keeps secreting progesterone. Because hCG appears in the mother's urine, it is the hormone detected by pregnancy test kits.

**Why other options are wrong:**

- (A) FSH and (B) LH are pituitary hormones of the ovarian cycle, suppressed during pregnancy.
- (C) Oxytocin is released at the time of childbirth to cause uterine contractions, not to maintain the corpus luteum.

**Final Answer:** Placental hormone maintaining the corpus luteum = hCG $\Rightarrow$ $\boxed{\text{D}}$

**Answer: (D)** Go Back to Q25

## Q26.

**Solution**

**Concept — Methods of contraception:** Family-planning methods are grouped as natural (rhythm, withdrawal), *barrier*, intra-uterine (IUD), hormonal (pills), and surgical (sterilisation) methods. Barrier methods physically stop the sperm from meeting the egg.

**Key fact:** The *condom* is a barrier device: a thin sheath placed over the penis (or lining the vagina) that prevents the semen from being deposited in the female tract, so sperm cannot reach the egg. Diaphragms and cervical caps are other barrier methods.

**Why other options are wrong:**

- (A) The oral pill is a *hormonal* method that prevents ovulation.
- (C) Tubectomy is a *surgical* (sterilisation) method; (D) the copper-T is an *intra-uterine device*, not a barrier.

**Final Answer:** The barrier method here is the condom $\Rightarrow$ B

**Answer: (B)** Go Back to Q26

## Q27.

**Solution**

**Concept — The back cross:** A back cross is a cross of an $F_1$ individual back to one of its parents. When the $F_1$ heterozygote ($Tt$) is crossed to the *homozygous dominant* parent ($TT$), the outcome differs from a test cross (to the recessive parent).

**Step 1 — Read the square:** The four boxes are $TT$, $TT$, $Tt$ and $Tt$ — a genotypic ratio of $1\,TT : 1\,Tt$ (i.e. 2 homozygous and 2 heterozygous).

**Step 2 — Convert to phenotype:** Since $T$ (tall) is dominant, both $TT$ and $Tt$ are tall. Therefore *all* the offspring are tall and no dwarf plant appears.

**Why other options are wrong:**

- (A) Half-and-half (1:1 tall:dwarf) is the result of a *test* cross ($Tt \times tt$), not this back cross.
- (B) "All dwarf" is impossible when a dominant allele is present; (D) no $tt$ box appears, so no dwarf offspring.

**Final Answer:** $Tt \times TT$ gives all tall offspring $\Rightarrow$ C

**Answer: (C)** Go Back to Q27

## Q28.

### Solution

**Concept — Pedigree analysis:** A pedigree chart is a diagram that records the occurrence of a trait across the generations of a family. It is used to trace how a character is inherited and whether the allele is dominant, recessive or sex-linked.

**Key fact:** By standard convention, a *circle* represents a *female* and a *square* represents a *male*. A horizontal line joining a circle and a square shows a mating, and shaded symbols denote affected individuals.

**Why other options are wrong:**

- (B) The assignment is reversed — the square is the male, the circle the female.
- (C) Whether a symbol is affected is shown by shading, not by its shape; (D) a marriage is a connecting line, not a single symbol.

**Final Answer:** Circle = female, square = male $\Rightarrow$ A

**Answer: (A)** Go Back to Q28

## Q29.

### Solution

**Concept — Down's syndrome and prenatal detection:** Down's syndrome is caused by trisomy of chromosome 21 (an extra chromosome 21, giving 47 in all). It can be detected before birth by examining the chromosomes of foetal cells.

**Key fact:** *Amniocentesis* is a prenatal test in which a sample of amniotic fluid is withdrawn; the foetal cells in it are cultured and their chromosomes are arranged into a *karyotype*. The presence of three copies of chromosome 21 confirms Down's syndrome.

**Why other options are wrong:**

- (A) Electrocardiography records the heart's electrical activity, not chromosomes.
- (B) Gel electrophoresis separates DNA fragments; (C) PCR amplifies DNA — neither directly counts chromosomes for this diagnosis.

**Final Answer:** Prenatal chromosome test = amniocentesis $\Rightarrow$ D

Answer: (D) Go Back to Q29

## Q30.

### Solution

**Concept — The genetic material:** A series of classic experiments established which molecule carries hereditary information. Griffith (1928) showed a "transforming principle" passed from dead virulent to live non-virulent pneumococci, and Hershey & Chase (1952) used radioactively labelled bacteriophages to track what enters the host cell.

**Key fact:** In the Hershey–Chase experiment only the *DNA* ($^{32}$P-labelled) of the phage entered the bacterium and directed the production of new phages, while the protein coat ($^{35}$S-labelled) stayed outside. Together with Avery's follow-up to Griffith, this proved that *DNA is the genetic (transforming) material*.

**Why other options are wrong:**

- (A) The protein coat did not enter the cell, so protein is not the genetic material in these organisms.
- (C) RNA is the genetic material only in certain RNA viruses, not in these experiments; (D) lipids never store genetic information.

**Final Answer:** The experiments proved DNA is the genetic material $\Rightarrow$ B

Answer: (B) Go Back to Q30

## Q31.

### Solution

**Concept — Split genes and RNA splicing:** A *cistron* is a segment of DNA coding for one polypeptide. In eukaryotes most cistrons are "split": their coding stretches (exons) are interrupted by non-coding stretches.

**Key fact:** The non-coding intervening sequences are the *introns*. During the processing of the primary transcript (hnRNA), the introns are cut out and the exons are joined together in a step called *splicing*, producing the mature mRNA that is finally translated.

**Why other options are wrong:**

- (A) A cistron is the whole gene (the coding unit), not the removed sequence.
- (B) A codon is a triplet of bases coding for an amino acid; (D) an anticodon is the complementary triplet on tRNA.

**Final Answer:** The removed non-coding sequences are introns $\Rightarrow$ C

**Answer: (C)** Go Back to Q31

## Q32.

### Solution

**Concept — Genetic drift:** Genetic drift is the random change in allele frequencies of a population from one generation to the next, due purely to chance. Its effect is strongest in *small* populations.

**Key fact:** The *founder effect* is a special case of genetic drift: when a few individuals leave a large population and found a new, small, isolated colony, their gene pool is only a chance sample of the original, so the new population's allele frequencies can differ sharply from the parent population. This can lead to rapid divergence.

**Why other options are wrong:**

- (B) Directional selection changes frequencies by differential survival, not by chance sampling.
- (C) Large-scale gene flow tends to make populations more similar, not different; (D) disruptive selection favours both extremes within one population.

**Final Answer:** A few founders, chance frequency change = founder effect (drift) $\Rightarrow$ A

**Answer: (A)** Go Back to Q32

## Q33.

### Solution

**Concept — Pathogens and the diseases they cause:** Knowing which organism causes which human disease is a standard host–parasite match. Diseases may be caused by viruses, bacteria, protozoa, fungi or helminths.

**Key fact:** *Entamoeba histolytica*, a protozoan parasite of the large intestine, causes *amoebic dysentery* (amoebiasis), with symptoms of stomach pain and stools with mucus and blood. This is the correctly matched pair.

**Why other options are wrong:**

- (A) *Wuchereria* causes filariasis (elephantiasis), not typhoid (which is caused by *Salmonella typhi*).

- (B) *Salmonella* causes typhoid/food poisoning, while ringworm is caused by fungi; (C) *Plasmodium* causes malaria, not pneumonia.

**Final Answer:** *Entamoeba histolytica* $\rightarrow$ amoebic dysentery $\Rightarrow$ $\boxed{\text{D}}$

**Answer: (D)** Go Back to Q33

## Q34.

### Solution

**Concept — Lymphocytes and the two arms of immunity:** The acquired immune response has two arms carried out by two kinds of lymphocyte. B-lymphocytes mediate *humoral* (antibody-mediated) immunity and T-lymphocytes mediate *cell-mediated* immunity.

**Key fact:** *B-lymphocytes* respond to antigens by multiplying into plasma cells that secrete *antibodies* into the blood and lymph (humoral immunity). *T-lymphocytes* do not make antibodies; instead they directly attack infected or foreign cells and help coordinate the response (cell-mediated immunity).

**Why other options are wrong:**

- (A) It reverses the roles — cell-mediated immunity is the job of T cells, not B cells.
- (C) T-lymphocytes do not secrete circulating antibodies; B cells do; (D) lymphocytes act through antibodies and direct cell killing, not by phagocytosis (that is the role of macrophages/neutrophils).

**Final Answer:** B cells = humoral (antibodies); T cells = cell-mediated $\Rightarrow$ $\boxed{\text{B}}$

**Answer: (B)** Go Back to Q34

## Q35.

### Solution

**Concept — Microbes as sources of medicine:** Besides antibiotics, microbes give us several therapeutic agents. Statins are an important class of cholesterol-lowering drugs derived from a fungus.

**Key fact:** *Statins*, produced as a metabolic product by the yeast *Monascus purpureus*, lower blood cholesterol by competitively inhibiting the enzyme (HMG-CoA reductase) that the body uses to synthesise cholesterol. They are widely prescribed to reduce the risk of heart disease.

**Why other options are wrong:**

- (B) *Trichoderma polysporum* yields cyclosporin A, an immunosuppressant.
- (C) *Clostridium butylicum* is an industrial source of butyric acid; (D) *Streptococcus* (streptokinase) gives a clot-dissolving ("clot buster") enzyme, not statins.

**Final Answer:** Statins come from *Monascus purpureus* $\Rightarrow$ A

**Answer: (A)** Go Back to Q35

## Q36.

### Solution

**Concept — Competent host cells:** DNA is a large, hydrophilic, negatively charged molecule, so it cannot pass freely across the equally charged bacterial cell membrane. To make a host cell take up recombinant DNA, the membrane must first be made permeable — the cell is made "competent".

**Key fact:** A standard method is to treat the cells with a specific concentration of a *divalent cation, calcium ($CaCl_2$)*, which increases the membrane's permeability to DNA, and then give a brief *heat shock* (placing them on ice, then at about 42 °C, then back on ice) so the DNA is drawn in.

**Why other options are wrong:**

- (A) Restriction enzymes cut DNA, they do not open cell walls for uptake.
- (B) A strong acid would kill the cell; (D) antibiotics are used *afterwards* to select recombinant cells, not to make them competent.

**Final Answer:** Make cells competent with $CaCl_2$ and heat shock $\Rightarrow$ C

**Answer: (C)** Go Back to Q36

## Q37.

### Solution

**Concept — Biosafety regulation of GMOs:** Because genetically modified organisms can affect health and the environment, their use is regulated by the government. In India, the Ministry of Environment, Forest and Climate Change oversees this through a dedicated committee.

**Key fact:** The *Genetic Engineering Appraisal Committee (GEAC)* is the statutory

body in India that appraises the safety of GM organisms and recombinant research, and grants approval for the large-scale use and environmental release of GMOs and their products.

**Why other options are wrong:**

- (A) ICAR coordinates agricultural research, not GMO biosafety approval.
- (C) The BSI surveys plant resources; (D) FSSAI regulates food safety standards generally, not GMO release approval.

**Final Answer:** GMO approval body in India = GEAC $\Rightarrow$ B

**Answer: (B)** Go Back to Q37

## Q38.

### Solution

**Concept — Direct gene-delivery methods:** To make a transgenic organism, foreign DNA must be delivered into the host cell. When no biological vector is used, several physical (direct) methods are available, including microinjection, electroporation and the gene gun.

**Key fact:** In *biolistics* (the "gene gun" or particle-gun method), the host cells (especially plant cells) are bombarded with high-velocity microscopic particles of *gold or tungsten coated with DNA*, which carry the DNA through the cell wall and membrane into the cell.

**Why other options are wrong:**

- (A) Microinjection delivers DNA by injecting it directly into a cell or nucleus with a fine needle — it does not fire particles.
- (B) Electroporation uses an electric pulse to open pores; (C) liposome-mediated transfer wraps DNA in lipid vesicles. None of these is the gene gun.

**Final Answer:** Firing DNA-coated metal particles = biolistics (gene gun) $\Rightarrow$ D

**Answer: (D)** Go Back to Q38

## Q39.

**Solution**

**Concept — Primary productivity:** Primary productivity is the rate at which producers fix energy (or build biomass) by photosynthesis. *Gross* primary productivity (GPP) is the *total* rate of energy capture, while *net* primary productivity (NPP) is what remains after the producers use some energy in their own respiration.

**Key fact:** The relationship is $NPP = GPP - R$, where R is the respiratory loss of the producers. NPP is the energy actually stored as new biomass and available to the herbivores (consumers) of the next trophic level, as the figure shows.

**Why other options are wrong:**

- (B) Adding respiration would overstate the energy; respiration is a loss, so it is subtracted.
- (C) "Respiration − GPP" is not a meaningful productivity term; (D) NPP equals GPP only if respiration were zero, which never happens.

**Final Answer:** NPP = GPP − respiration ⇒ $\boxed{\text{A}}$

**Answer: (A)** Go Back to Q39

## Q40.

**Solution**

**Concept — The latitudinal gradient in biodiversity:** One of the most consistent patterns in ecology is that the diversity of species is not spread evenly over the Earth but varies in a regular way with latitude.

**Key fact:** Species richness generally *increases from the poles towards the equator*, so the tropics (low latitudes) harbour far more species than the temperate or polar regions. The tropical rainforests of the Amazon, for example, are the most species-rich habitats on Earth. This is attributed to a long, stable evolutionary history, a constant warm climate and high productivity in the tropics.

**Why other options are wrong:**

- (A) The trend is the opposite — diversity is *lowest*, not highest, at the poles.
- (B) Diversity clearly varies with latitude; (D) mid-latitude deserts are relatively species-poor, not the richest.

**Final Answer:** Diversity is greatest in the tropics, rising towards the equator ⇒ $\boxed{\text{C}}$

Answer: (C) Go Back to Q40

# Answer Key

| Q | Ans | Q | Ans | Q | Ans | Q | Ans | Q | Ans |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | 2 | C | 3 | B | 4 | D | 5 | A |
| 6 | B | 7 | C | 8 | D | 9 | A | 10 | C |
| 11 | B | 12 | A | 13 | D | 14 | B | 15 | C |
| 16 | A | 17 | D | 18 | B | 19 | C | 20 | A |
| 21 | B | 22 | D | 23 | C | 24 | A | 25 | D |
| 26 | B | 27 | C | 28 | A | 29 | D | 30 | B |
| 31 | C | 32 | A | 33 | D | 34 | B | 35 | A |
| 36 | C | 37 | B | 38 | D | 39 | A | 40 | C |