NEET Re-Exam 2026 Zoology

Question Paper with Solutions

Conducted by National Testing Agency (NTA)

General Instructions

(i) The test is of 3 hours and 15 minutes duration.

(ii) This test paper consists of 180 questions. The maximum marks are 720.

(iii) Physics and Chemistry contains 45 questions each and Biology (Botany and Zoology) contains 90 questions.

(iv) Each question carries +4 marks for correct answer and –1 mark for wrong answer.

Zoology

136. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: In recombinant DNA technology, lysozyme is used for disrupting bacterial cells while cellulase is used for plant cells.

Reason R: Isolation of genetic material needs disruption of cells.

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) A is not correct but R is correct

(B) Both A and R are correct and R is the correct explanation of A

(C) Both A and R are correct but R is not the correct explanation of A

(D) A is correct but R is not correct

Correct Answer: (B) Both A and R are correct and R is the correct explanation of A

Solution:

Concept:

- **Recombinant DNA Technology:** Requires pure DNA, free from other macromolecules.
- To release DNA, cells must be lysed using specific enzymes to digest cell walls:
  - Lysozyme is used for bacterial cell walls (peptidoglycan).
  - Cellulase is used for plant cell walls (cellulose).
  - Chitinase is used for fungal cell walls (chitin).

Step 1: Verify Assertion A

Assertion A states that lysozyme breaks down bacterial cells and cellulase breaks down plant cells.

This is true, as these enzymes degrade the biological polymers composing the respective cell walls.

Step 2: Verify Reason R

Reason R states that isolation of genetic material requires cell disruption.

This is true, as the cell membrane and cell wall must be broken to release DNA along with RNA, proteins, polysaccharides, and lipids.

Step 3: Check the explanation link

Why do we use specific enzymes like lysozyme and cellulase? We use them because the first step of isolating DNA requires breaking open the cells (disruption).

Therefore, R is the correct explanation of A.

Quick Tip:

Link assertions and reasons using the word "because". "Lysozyme is used for bacteria and cellulase for plants because isolation of genetic material needs cell disruption." Since this makes logical sense, R is the correct explanation.

Memorize the cell wall enzymes: Bacteria → Lysozyme, Plant → Cellulase, Fungi → Chitinase.

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137. The method of directly injecting a sperm into ovum in assisted reproductive technology is called:

(A) Embryo transfer (ET)

(B) Gamete intra fallopian transfer (GIFT)

(C) Zygote intra fallopian transfer (ZIFT)

(D) Intra cytoplasmic sperm injection (ICSI)

Correct Answer: (D) Intra cytoplasmic sperm injection (ICSI)

Solution:

Concept:

- Assisted Reproductive Technologies (ART) represent a range of specialized medical procedures utilized to address infertility challenges.
- Key techniques include:
  - **Embryo Transfer (ET):** The process of transferring lab-grown embryos directly into the uterus.
  - **Gamete Intra Fallopian Transfer (GIFT):** The collection of both eggs and sperm, which are then placed directly into the fallopian tubes to allow natural fertilization.
  - **Zygote Intra Fallopian Transfer (ZIFT):** In-vitro fertilization followed by the transfer of the resulting zygote (at the stage of up to 8 blastomeres) into the fallopian tube.
  - **Intra Cytoplasmic Sperm Injection (ICSI):** A specialized in-vitro fertilization procedure where a single viable sperm is micro-injected directly into the cytoplasm of an egg.

Step 1: Identify the key mechanism described in the question

The question highlights a highly specific mechanism: "directly injecting a sperm into ovum." This requires a physical puncture of the oocyte's outer membrane (zona pellucida and oolemma) to deliver the sperm head directly into the cytoplasm.

Step 2: Evaluate the options against the key mechanism

- **ET (Embryo Transfer):** This is a general stage where multicellular embryos (not individual gametes like sperm and ovum) are placed in the uterine cavity.
- **GIFT:** Unfertilized gametes are transferred together into the fallopian tube. Fertilization occurs naturally inside the body rather than via micro-injection.

- **ZIFT:** An already-formed zygote is transferred into the fallopian tube, meaning fertilization has already occurred prior to this transfer step.
- **ICSI:** This laboratory technique specifically involves selecting a single sperm and injecting it directly into the inner fluid (cytoplasm) of the mature egg.

Step 3: Formulate the final conclusion

By comparing the technical definitions, the process of direct micro-injection of sperm into the cytoplasm of the egg aligns with the definition of Intra Cytoplasmic Sperm Injection (ICSI).

Quick Tip:

- Keep the medical terminology literal: "Intra cytoplasmic" means inside the cytoplasm, and "sperm injection" refers to the direct delivery system.
- ICSI is particularly useful in cases of male-factor infertility, such as oligospermia (low sperm count) or asthenozoospermia (poor sperm motility).

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138. Adaptive radiation in placental mammals and Australian Marsupials leading to similarity between distant species is an example of

(A) genetic drift

(B) divergent evolution

(C) convergent evolution

(D) founder effect

Correct Answer: (C) convergent evolution

Solution:

Concept:

- **Adaptive Radiation:** The process of evolution where a single ancestral species diversifies into various forms, each adapting to a specific ecological niche in a given geographical area.
- **Divergent Evolution:** The accumulation of differences between closely related populations or species, leading to the creation of new species with distinct adaptations.
- **Convergent Evolution:** The independent evolution of similar structural or functional

features in unrelated or distantly related lineages, often driven by adaptation to similar environments or ecological roles.

Step 1: Analyze the independent evolution within isolated geographical areas

In isolated environments such as Australia, ancestral marsupials underwent adaptive radiation to occupy diverse ecological niches, resulting in species like the marsupial mole, Tasmanian wolf, and sugar glider. Similarly, in other parts of the world, ancestral placental mammals underwent a parallel adaptive radiation, producing placental moles, wolves, and flying squirrels.

Step 2: Compare the similarities between the two distinct lineages

When comparing these two distinct groups (placental mammals and Australian marsupials), we observe that pairs of species from different lineages share striking physical and functional similarities due to living in similar habitats:

- Placental Mole and Marsupial Mole
- Placental Wolf and Tasmanian Wolf (Marsupial Wolf)
- Flying Squirrel and Flying Phalanger

Step 3: Determine the evolutionary pattern and evaluate the options

Since these similarities developed in distantly related groups undergoing parallel adaptations in similar ecological niches, this process represents convergent evolution.

- **(A) Genetic drift** refers to random changes in allele frequencies in small populations, which does not account for these systematic, adaptive structural similarities.
- **(B) Divergent evolution** describes how closely related species develop different traits (such as the diversification within marsupials alone), rather than how distant lineages become similar.
- **(C) Convergent evolution** correctly describes independent lineages evolving similar traits.
- **(D) Founder effect** is a specific case of genetic drift occurring when a new population is established by a small group of individuals, which is not applicable here.

Hence, option (C) is the appropriate choice.

Quick Tip:

- Adaptive radiation within a single group (e.g., Darwin's finches or Australian marsupials alone) is an example of divergent evolution.
- However, comparing adaptive radiations across two distinct lineages (Placentals vs. Marsupials) in similar environments shows convergent evolution.
- Analogous organs are the anatomical outcomes of convergent evolution.

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139. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: In an experiment, Mendel observed that the F_1 progeny plants are all tall and none are dwarf.

Reason R: Stem height is a contrasting trait, with tall being dominant and dwarf being recessive.

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) A is not correct but R is correct

(B) Both A and R are correct and R is the correct explanation of A

(C) Both A and R are correct but R is not the correct explanation of A

(D) A is correct but R is not correct

Correct Answer: (B) Both A and R are correct and R is the correct explanation of A

Solution:

Concept:

- Mendel performed monohybrid crosses to study the inheritance of single characters like stem height.
- He crossed true-breeding tall (TT) and dwarf (tt) pea plants.
- According to the Law of Dominance, in a heterozygote, one allele masks the phenotypic expression of another allele at the same locus.
- The allele that expresses itself is dominant (tall, T), and the one that is masked is recessive (dwarf, t).

Step 1: Evaluate Assertion A

Assertion A states that all F_1 progeny plants are tall and none are dwarf.

This is true, as the genotype of the F_1 generation is completely heterozygous (Tt), expressing the dominant tall phenotype.

Step 2: Evaluate Reason R

Reason R states that tall is dominant and dwarf is recessive.

This is also true, and this dominance is precisely why the recessive dwarf trait cannot express itself in the heterozygous F_1 hybrid.

Step 3: Determine if R is the correct explanation of A

The reason why the F_1 progeny are all tall (Assertion) is because tall is dominant over dwarf (Reason).

Thus, R is the correct explanation of A.

Quick Tip:

The monohybrid phenotypic ratio in F_2 is 3 : 1 (Tall : Dwarf), while the genotypic ratio is 1 : 2 : 1 ($TT : Tt : tt$).

The recessive trait only expresses itself under homozygous conditions (tt), which is why it disappears in the F_1 generation and reappears in F_2.

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140. Arrange the following in descending order of number of species in the Amazonian rain forest.

(a) Plants

(b) Birds

(c) Fishes

(d) Invertebrates

(e) Mammals

Choose the correct answer from the options given below:

(A) (b) > (a) > (d) > (c) > (e)

(B) (c) > (b) > (d) > (e) > (a)

(C) (d) > (a) > (c) > (b) > (e)

(D) (e) > (b) > (a) > (c) > (d)

Correct Answer: (C) (d) > (a) > (c) > (b) > (e)

Solution:

Concept:

- The Amazonian rain forest in South America has the greatest biodiversity on Earth.
- The approximate species counts for various groups in this ecosystem are:
  - Invertebrates: More than $125,000$ species
  - Plants: More than $40,000$ species
  - Fishes: Around $3,000$ species
  - Birds: Around $1,300$ species
  - Mammals: Around 427 species
  - Amphibians: Around 427 species
  - Reptiles: Around 378 species

Step 1: Compare the species numbers of the given groups

Comparing the values:

$$125,000 \text{ (Invertebrates)} > 40,000 \text{ (Plants)} > 3,000 \text{ (Fishes)} > 1,300 \text{ (Birds)} > 427 \text{ (Mammals)}$$

Step 2: Arrange in descending order

Mapping the groups to their letters:

- Invertebrates = (d)
- Plants = (a)
- Fishes = (c)
- Birds = (b)
- Mammals = (e)

The descending order is (d) > (a) > (c) > (b) > (e).

Quick Tip:

Invertebrates represent the largest share of global species diversity, followed by plants.

Mammals and amphibians have roughly equal species counts (427) in the Amazonian rainforest, which is higher than reptiles (378).

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141. Sponges exchange O_2 with CO_2 by

(A) gills

(B) simple diffusion over their entire body surfaces

(C) moist cuticle

(D) tracheal tubes

Correct Answer: (B) simple diffusion over their entire body surfaces

Solution:

Concept:

- **Phylum Porifera:** Sponges belong to the phylum Porifera, characterized by a multicellular body with a cellular level of organization. They lack true tissues, organs, or specialized organ systems.
- **Water Canal System:** Water enters through microscopic pores (ostia) in the body wall, passes into a central cavity (spongocoel), and exits through a large opening (osculum).
- **Gas Exchange:** Without specialized respiratory structures, metabolic exchanges occur directly between the individual cells and the surrounding water.

Step 1: Analyze the cellular level of organization in sponges

Because sponges do not possess specialized respiratory tissues or organs (such as gills or lungs), every cell must interact directly with the aqueous environment to carry out physiological processes.

Step 2: Evaluate the mechanism of gas exchange

The water current flowing through the canal system brings dissolved oxygen close to the cells. Since the concentration of oxygen is higher in the incoming water than inside the cells, and the concentration of carbon dioxide is higher inside the cells than in the water, gases move along their concentration gradient. This movement occurs via simple diffusion across the cell membranes over the entire body surface exposed to water.

Step 3: Analyze the incorrect options

- **(A) Gills:** These are specialized vascularized structures found in more complex aquatic organisms, such as fish, molluscs, and crustaceans.
- **(C) Moist cuticle:** This respiratory surface is characteristic of annelids, such as earthworms, which use cutaneous respiration.
- **(D) Tracheal tubes:** This is a network of tubes used for gas exchange in terrestrial insects and some other arthropods.

Thus, simple diffusion over the body surface is the process utilized by sponges.

Quick Tip:

- Simple diffusion across the body surface is the primary mode of respiration for lower invertebrates, including sponges (Porifera), coelenterates (Cnidaria), and flatworms (Platyhelminthes).
- The water canal system in sponges serves a triple purpose: nutrition (food gathering), respiration (gas exchange), and excretion (removal of metabolic wastes).

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142. For a person with blood group 'O', which of the following is not a possible combination of parents' blood group genotypes ?

(A) Father : I^AI^B and Mother : I^Ai

(B) Father : I^Ai and Mother : I^Bi

(C) Father : I^Ai and Mother : I^Ai

(D) Father : I^Bi and Mother : I^Bi

Correct Answer: (A) Father : I^AI^B and Mother : I^Ai

Solution:

Concept:

- ABO blood groups are controlled by the I gene, which has three alleles: I^A, I^B, and i.
- Alleles I^A and I^B are co-dominant, while allele i is recessive.
- The genotype for blood group 'O' is homozygous recessive, represented as ii.

- For an offspring to have blood group 'O' (ii), they must inherit one i allele from the father and one i allele from the mother.

Step 1: Evaluate parent genotypes in Option (A)

Father's genotype: I^AI^B. The father can only pass on either the I^A or I^B allele.

Mother's genotype: I^Ai. The mother can pass on either I^A or i.

Since the father does not carry the recessive i allele, it is impossible for the offspring to inherit the ii genotype.

Thus, Option (A) is not a possible parental combination.

Step 2: Verify parent genotypes in other options

In Options (B), (C), and (D), both parents possess at least one i allele in their genotypes (I^Ai or I^Bi).

Therefore, in all these cases, there is a probability of producing an offspring with genotype ii (blood group 'O').

Quick Tip:

A parent with blood group AB (I^AI^B) can never have a biological child with blood group O (ii).

Likewise, a parent with blood group O (ii) can never have a biological child with blood group AB (I^AI^B).

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143. Given below are two statements:

Statement I: Modern Homo sapiens arose in Australia and moved across continents.

Statement II: Homo sapiens arose around 75000 to 10000 years ago.

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) Statement I is incorrect but Statement II is correct

(B) Both Statement I and Statement II are correct

(C) Both Statement I and Statement II are incorrect

(D) Statement I is correct but Statement II is incorrect

Correct Answer: (A) Statement I is incorrect but Statement II is correct

Solution:

Concept:

- Human evolution traces the origin and divergence of modern humans (*Homo sapiens sapiens*) from hominid ancestors.
- According to paleontological evidence, modern *Homo sapiens* arose in Africa and subsequently migrated across various continents, developing into distinct races.
- *Homo sapiens* arose during the last ice age, which occurred between 75,000 and 10,000 years ago.

Step 1: Analyze Statement I

Statement I states: "Modern Homo sapiens arose in Australia and moved across continents."

This statement is incorrect because modern humans originated in Africa, not Australia.

Step 2: Analyze Statement II

Statement II states: "Homo sapiens arose around 75000 to 10000 years ago."

This statement is correct, as the ice age between 75,000 and 10,000 years ago marks the period when modern *Homo sapiens* emerged.

Quick Tip:

Always pay close attention to geographic names mentioned in statements; a single incorrect location (like Australia instead of Africa) invalidates the entire statement.

Chronology of human ancestors: Australopithecus → Homo habilis → Homo erectus → Neanderthal → Homo sapiens.

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144. Which of the following is used as an effective sedative and painkiller for treating post-surgery patients ?

(A) Anti-retroviral drugs

(B) Interferon

(C) Antibiotics

(D) Morphine

Correct Answer: (D) Morphine

Solution:

Concept:

- Opioids are drugs that bind to specific opioid receptors present in our central nervous system and gastrointestinal tract.
- Morphine is a natural opioid alkaloid extracted from the latex of the poppy plant, *Papaver somniferum*.
- It acts as a strong analgesic (painkiller) and central nervous system depressant.

Step 1: Evaluate the biological actions of the given options

Anti-retroviral drugs are used to treat viral infections like HIV.

Interferons are proteins used in cancer therapy and viral defense.

Antibiotics are used to treat bacterial infections.

Morphine is a highly potent analgesic and sedative.

Step 2: Identify the drug used post-surgery

Due to its strong pain-relieving and sedative qualities, morphine is clinically prescribed to patients who have undergone major surgery to manage intense post-operative pain.

Quick Tip:

Morphine is a classic example of an opioid. Heroin (diacetylmorphine) is chemically synthesized from it via acetylation.

While highly useful in clinical settings, opioids have a very high potential for addiction and abuse.

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145. Which of the following plant produces non-albuminous seeds ?

(A) Pea

(B) Wheat

(C) Maize

(D) Barley

Correct Answer: (A) Pea

Solution:

Concept:

- Seeds are classified into two main groups depending on the persistence of the endosperm in the mature seed:

- **Non-albuminous (Exalbuminous) seeds:** These seeds do not retain endosperm at maturity because it is completely consumed by the developing embryo during embryogenesis (e.g., pea, groundnut, gram, beans).
- **Albuminous (Endospermic) seeds:** These seeds retain a portion of the endosperm as it is not entirely consumed during embryo development, serving as a food reserve for germination (e.g., wheat, maize, barley, castor, sunflower).

Step 1: Analyze the structural features of the given plant seeds

In angiosperms, double fertilization leads to the formation of a triploid endosperm, which provides nourishment to the developing embryo. The rate of endosperm consumption determines the final seed type.

Step 2: Evaluate each option based on endosperm retention

- **Pea (Option A):** A dicotyledonous plant where the developing embryo absorbs all the nutrients from the endosperm before the seed reaches maturity. The food is instead stored in the fleshy cotyledons, making the mature seed non-albuminous.
- **Wheat, Maize, and Barley (Options B, C, and D):** These are monocotyledonous cereal crops. In these plants, the endosperm persists in the mature seed as a major storage tissue, making them albuminous.

Step 3: Determine the correct choice

Since only the pea seed lacks residual endosperm at maturity, it represents the non-albuminous category among the given choices.

Quick Tip:

- As a general rule of thumb, most dicots produce non-albuminous seeds (exception: Castor is a dicot but produces albuminous seeds).
- Most monocots produce albuminous seeds (exception: Orchids are monocots but produce non-albuminous seeds).
- In some seeds, such as black pepper and beet, remnants of the nucellus also persist; this residual, persistent nucellus is called perisperm.

146. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: Abingdon tortoise in Galapagos islands became extinct within a decade after goats were introduced.

Reason R: Goats were more efficient at browsing than Abingdon tortoise.

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) A is not correct but R is correct

(B) Both A and R are correct and R is the correct explanation of A

(C) Both A and R are correct but R is not the correct explanation of A

(D) A is correct but R is not correct

Correct Answer: (B) Both A and R are correct and R is the correct explanation of A

Solution:

Concept:

- **Interspecific Competition:** Occurs when different species compete for the same limiting resources (like food).
- **Competitive Exclusion Principle (Gause):** States that two species competing for the same limiting resources cannot coexist indefinitely, and the competitively inferior species will eventually be eliminated.

Step 1: Evaluate Assertion A

Assertion A states that the Abingdon tortoise in the Galapagos Islands went extinct within a decade after goats were introduced.

This is a well-documented ecological fact resulting from intense interspecific resource competition.

Step 2: Evaluate Reason R

Reason R states that goats had greater browsing efficiency than the Abingdon tortoise.

This is true, as goats are agile and consume vegetation much faster and closer to the ground than the slow-moving tortoises.

Step 3: Determine if R is the correct explanation of A

The extinction of the tortoises (Assertion) occurred because the newly introduced goats consumed the limited vegetation far more efficiently (Reason), leaving no food for the tortoises.

Thus, R is the correct explanation of A.

Quick Tip:

This case study is a classic textbook illustration of Gause's Competitive Exclusion Principle in real-world habitats.

Introduced or invasive species often have superior resource exploitation traits, leading to the rapid decline of native species.

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147. The covering of ovum at ovulation is

(A) chorion

(B) endometrium

(C) zona radiata

(D) zona pellucida

Correct Answer: (D) zona pellucida

Solution:

Concept:

- **Oocyte Membranes:** During follicular development, the secondary oocyte is surrounded by distinct protective layers that play crucial roles in fertilization and early development.
- **Primary Membrane (Zona Pellucida):** An acellular, gel-like layer composed of glycoproteins (ZP1, ZP2, ZP3, and ZP4) secreted by the secondary oocyte itself.
- **Secondary Membrane (Corona Radiata):** An outer layer of radially arranged follicular (granulosa) cells that remains adhered to the zona pellucida upon ovulation.

Step 1: Analyze the state of the ovum at the time of ovulation

During ovulation, the Graafian follicle ruptures to release the secondary oocyte (often referred to as the ovum at this stage) into the peritoneal cavity, where it is swept into the fallopian tube. At this moment, the innermost specialized protective covering of the oocyte is the acellular glycoprotein envelope.

Step 2: Evaluate the options systematically

- **(A) Chorion:** This is the outermost extra-embryonic membrane formed later during embryonic development. It participates in the formation of the placenta and is not present on the unfertilized ovum at ovulation.

- **(B) Endometrium:** This refers to the glandular inner mucosal lining of the uterine wall, which prepares for implantation, rather than a membrane covering the ovum.
- **(C) Zona radiata:** While sometimes confused with the cellular *corona radiata*, "zona radiata" historically refers to striated membranes in the eggs of certain non-mammalian vertebrates (such as teleost fish) and is not the standard primary mammalian cover.
- **(D) Zona pellucida:** This is the non-cellular glycoprotein membrane that directly covers the plasma membrane of the mammalian secondary oocyte at ovulation.

Step 3: Confirm the correct choice

The primary acellular coat that encapsulates the oocyte at ovulation and must be penetrated by the sperm during fertilization is the zona pellucida. Thus, option (D) is the correct answer.

Quick Tip:

- **Acellular vs. Cellular:** The inner *zona pellucida* is non-cellular (glycoprotein-based), whereas the outer *corona radiata* is cellular (composed of granulosa cells).
- **Function of Zona Pellucida:** It contains species-specific sperm receptors (primarily ZP3) and undergoes the "cortical reaction" after sperm entry to prevent polyspermy.
- It also prevents premature implantation (ectopic pregnancy) of the blastocyst while it travels through the fallopian tube.

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148. Which of the following is used as a clot buster ?

(A) Statins

(B) Streptokinase

(C) Penicillin

(D) Cyclosporin A

Correct Answer: (B) Streptokinase

Solution:

Concept:

- Microorganisms are utilized commercially to produce several bioactive molecules, which are chemical compounds that possess therapeutic value in human medicine.

- Key bioactive molecules include:
  - **Streptokinase:** A thrombolytic enzyme obtained from cultures of the bacterium *Streptococcus*.
  - **Statins:** Compounds produced by the yeast *Monascus purpureus* that assist in managing blood lipid levels.
  - **Cyclosporin A:** An immunosuppressive peptide isolated from the fungus *Trichoderma polysporum*.
  - **Penicillin:** The first discovered broad-spectrum antibiotic, extracted from the fungus *Penicillium notatum*.

Step 1: Understand the clinical term "clot buster"

A "clot buster" (or thrombolytic agent) is a medical substance administered to dissolve blood clots (thrombi) that have formed inside blood vessels. This therapy is critical for patients suffering from acute myocardial infarction (heart attack) or stroke, where clot dissolution restores blood flow to ischemic tissues.

Step 2: Evaluate each option based on its medical application

- **(A) Statins:** These molecules act as competitive inhibitors of HMG-CoA reductase, the rate-limiting enzyme in cholesterol biosynthesis, and are used to lower blood cholesterol levels.
- **(B) Streptokinase:** This enzyme activates plasminogen to form plasmin, which directly breaks down fibrin networks within blood clots. Thus, it functions as an effective clot buster.
- **(C) Penicillin:** This is an antibiotic that target bacterial cell wall synthesis, making it ineffective against vascular blood clots.
- **(D) Cyclosporin A:** This is used as an immunosuppressant to inhibit T-cell activation and prevent graft rejection in organ transplant recipients.

Step 3: Determine the correct choice

Based on the therapeutic functions described, Streptokinase is the molecule used as a clot buster. This corresponds to option (B).

Quick Tip:

- **Mnemonic for Sources:**
  - *Streptococcus* → **Streptokinase** (Clot buster)
  - *Monascus purpureus* → **Statins** (Cholesterol reducer)
  - *Trichoderma polysporum* → **Cyclosporin A** (Immunosuppressant)
- Genetic engineering is used to modify natural streptokinase to minimize potential allergic reactions and improve its targeted efficacy in patients.

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149. Which of the following structure is not a part of the male reproductive system ?

(A) Infundibulum

(B) Rete testis

(C) Epididymis

(D) Vasa efferentia

Correct Answer: (A) Infundibulum

Solution:

Concept:

- **Male Reproductive System:** Comprises primary sex organs (a pair of testes), accessory ducts, accessory glands, and external genitalia.
- **Male Accessory Ducts:** These ducts store and transport sperm from the testes to the outside through the urethra. The pathway includes:
  - Rete testis
  - Vasa efferentia
  - Epididymis
  - Vas deferens
- **Female Reproductive System Accessory Ducts:** Include the fallopian tubes (oviducts), uterus, and vagina.

Step 1: Analyze the male accessory ducts and their pathways

Sperm produced in the seminiferous tubules of the testes travel through a specific network of

ducts.

- The tubules open into the **rete testis**.
- From the rete testis, sperm leave the testis through the **vasa efferentia**.
- The vasa efferentia open into the **epididymis**, which is located along the posterior surface of each testis and is responsible for sperm maturation and temporary storage.

Therefore, options (B), (C), and (D) represent essential components of the male reproductive tract.

Step 2: Analyze the female reproductive tract structures

The fallopian tube (oviduct) in females is divided into three main anatomical regions:

- **Infundibulum:** The funnel-shaped portion closest to the ovary.
- **Ampulla:** The wider, middle portion where fertilization typically occurs.
- **Isthmus:** The narrow, final portion that connects directly to the uterus.

Step 3: Identify the non-male structure

Because the infundibulum is a specialized section of the female fallopian tube, it does not exist in the male anatomy. This corresponds to option (A).

Quick Tip:

- The edge of the *infundibulum* possesses finger-like projections called *fimbriae*, which function to collect the secondary oocyte from the ovary during ovulation.
- Memory aid for the male sperm pathway: **S**eminiferous tubules → **R**ete testis → **V**asa efferentia → **E**pididymis → **V**as deferens (mnemonic: *Some Rete Vessels Enter Vas*).

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150. Given below are two statements:

Statement I: Ovulation is caused by LH surge leading to rupture of Graafian follicles.

Statement II: Graafian follicle remaining after ovulation transform into corpus luteum and secretes large amount of estrogen.

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) Statement I is incorrect but Statement II is correct

(B) Both Statement I and Statement II are correct

(C) Both Statement I and Statement II are incorrect

(D) Statement I is correct but Statement II is incorrect

Correct Answer: (D) Statement I is correct but Statement II is incorrect

Solution:

Concept:

- The menstrual cycle is regulated by pituitary hormones (LH, FSH) and ovarian hormones (estrogen, progesterone).
- In the middle of the cycle (around day 14), both LH and FSH attain a peak level.
- Rapid secretion of LH leading to its maximum level during the mid-cycle is called the **LH surge**.
- The LH surge induces the rupture of the mature Graafian follicle, releasing the secondary oocyte (ovulation).
- Following ovulation, the ruptured Graafian follicle transforms under the influence of LH into the **corpus luteum**.
- The corpus luteum secretes large amounts of **progesterone**, which is essential for maintaining the endometrium of the uterus.

Step 1: Evaluate Statement I

Statement I is correct: The LH surge is the direct trigger that causes the Graafian follicle to rupture and release the ovum.

Step 2: Evaluate Statement II

Statement II is incorrect: The corpus luteum secretes large amounts of progesterone, not estrogen. (While it does secrete small amounts of estrogen, its primary and major secretion is progesterone).

Quick Tip:

Progesterone is known as the "pregnancy-maintaining hormone" because it is secreted in large amounts by the corpus luteum during the luteal phase.

Estrogen levels peak twice: once before ovulation (follicular phase) and once moderately during the luteal phase.

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151. The opening between the right atrium and the right ventricle is guarded by

(A) sino-atrial node

(B) bicuspid valve

(C) tricuspid valve

(D) semilunar valve

Correct Answer: (C) tricuspid valve

Solution:

Concept:

- The human heart is divided into four chambers: two upper atria and two lower ventricles.
- To maintain unidirectional blood flow and prevent backflow, the openings between these chambers are regulated by specialized muscular valves:
  - **Atrioventricular (AV) Valves:** Positioned between the atria and the ventricles.
  - **Semilunar Valves:** Positioned at the junctions where major arteries exit the ventricles.

Step 1: Analyze the right side of the heart

Deoxygenated blood from the systemic circulation enters the right atrium and must pass into the right ventricle. The right atrioventricular aperture connects these two chambers. This specific opening is guarded by the **tricuspid valve**, which is composed of three distinct fibrous cusps or flaps.

Step 2: Evaluate the alternative options

- **(A) Sino-atrial node (SAN):** This is a specialized patch of neuromuscular tissue located in the upper wall of the right atrium. It serves as the natural pacemaker of the heart by generating electrical impulses, but it is not a physical valve.

- **(B) Bicuspid valve:** Also referred to as the mitral valve, this structure consists of two cusps and guards the opening between the left atrium and the left ventricle.
- **(D) Semilunar valves:** These half-moon-shaped valves guard the openings where the pulmonary artery leaves the right ventricle and where the aorta leaves the left ventricle.

Step 3: Formulate the final conclusion

Based on internal cardiac anatomy, the tricuspid valve regulates the passage of blood between the right atrium and right ventricle. Therefore, the correct option is (C).

Quick Tip:

- **Mnemonic to remember valve locations:**
  - **R-T**: **R**ight side has the **T**ricuspid valve.
  - **L-B**: **L**eft side has the **B**icuspid (Mitral) valve.
- The AV valves are attached to muscular projections called papillary muscles in the ventricular walls via fibrous cords called *chordae tendineae*, which prevent the valves from collapsing backward into the atria during ventricular contraction.

---

152. Which of the following is not evidence for evolution ?

(A) Divergent evolution of anatomical structures such as forelimbs

(B) Convergent evolution of traits like wings of birds and butterflies

(C) Paleontological evidence from fossil records

(D) Embryological support for evolution as proposed by Ernst Heckel

Correct Answer: (D) Embryological support for evolution as proposed by Ernst Heckel

Solution:

Concept:

- Evolutionary biology relies on several independent lines of evidence to reconstruct the history of life on Earth, including:
  - **Anatomical Evidence:** Homologous organs (arising from divergent evolution) and analogous organs (arising from convergent evolution).

- **Paleontological Evidence:** Morphological structures preserved in fossil records.
- **Embryological Evidence:** Comparative analyses of early developmental stages of organisms.

- The biogenetic law ("ontogeny recapitulates phylogeny") proposed by Ernst Haeckel (spelled "Heckel" in the question) stated that embryonic development mirrors the adult stages of evolutionary ancestors. This theory was contested and rejected by other embryologists.

Step 1: Evaluate the valid lines of evolutionary evidence

- **Option (A):** Divergent evolution of homologous structures (e.g., the anatomy of fore-limbs in whales, bats, cheetahs, and humans) demonstrates adaptation from a common ancestral form.
- **Option (B):** Convergent evolution of analogous structures (e.g., wings of birds and butterflies) demonstrates adaptation to similar environments from different ancestral lineages.
- **Option (C):** Paleontological studies (fossil records) provide physical historical evidence of structural transitions and lineages.

These three options represent established and validated categories of evolutionary evidence.

Step 2: Analyze the scientific status of Haeckel's embryological theory

Ernst Haeckel proposed that human and animal embryos pass through the fully formed adult stages of their evolutionary ancestors. However, this assertion was challenged by Karl Ernst von Baer, who demonstrated that embryos of different species do not pass through adult stages of other species, but rather diverge along distinct developmental pathways. Consequently, Haeckel's specific theory of embryological recapitulation is not accepted as valid scientific evidence. This corresponds to option (D).

Quick Tip:

- Karl Ernst von Baer's careful observations of vertebrate embryology led to the rejection of the "recapitulation theory," establishing that embryonic stages do not recapitulate adult ancestral forms.
- Homology represents common ancestry with divergent functions, while analogy represents separate ancestries with convergent functions.

---

153. The inactive form of Bt toxin is converted to the active form in the insect gut

(A) by nucleases

(B) due to alkaline pH

(C) due to acidic pH

(D) by proteases

Correct Answer: (B) due to alkaline pH

Solution:

Concept:

- *Bacillus thuringiensis* (Bt) is a soil bacterium that synthesizes insecticidal crystalline proteins (Cry proteins) during its sporulation phase.
- These proteins are initially synthesized as inactive **protoxins** inside the bacterium, preventing damage to the bacterial host.
- Activation of the protoxin requires specific physical and chemical conditions inside the gastrointestinal tract of target insect larvae.

Step 1: Identify the biochemical changes occurring inside the insect gut

Upon ingestion by a susceptible insect, the insoluble crystalline protoxins enter the midgut. The midgut environment in lepidopteran, dipteran, and coleopteran insects has a highly alkaline pH.

Step 2: Trace the activation mechanism of the Bt toxin

- The **alkaline pH** of the insect gut facilitates the solubilization of the toxic protein crystals.

- Proteolytic enzymes (proteases) present in the gut then cleave the solubilized protoxin, converting it into its active toxic form.
- Although proteases assist in cleavage, the primary physical-chemical requirement for activating the inactive crystal lattice is its solubilization, which is driven directly by the **alkaline pH**.
- The active toxin then binds to epithelial cells of the midgut, creating pores that disrupt osmotic balance, leading to swelling, lysis, and eventually starvation and death of the insect.

Therefore, the transition from the inactive form to the active form relies on the alkaline pH, which matches option (B).

Quick Tip:

- Bt toxin does not affect mammals (including humans) because the mammalian stomach is highly acidic, preventing the solubilization and activation of the protoxin crystals.
- Transgenic plants (such as Bt Cotton and Bt Brinjal) express these bacterial *cry* genes to provide targeted resistance against specific pests without chemical pesticides.

---

154. Colostrum, secreted by mother during initial days of lactation, is abundant in

(A) IgD

(B) IgG

(C) IgM

(D) IgA

Correct Answer: (D) IgA

Solution:

Concept:

- **Colostrum:** The thick, yellowish-colored fluid secreted by the maternal mammary glands during the final stage of pregnancy and the initial days of lactation following parturition (childbirth).
- **Biological Role:** It acts as a concentrated source of nutrients and essential protective

compounds, ensuring the transfer of passive immunity to the newborn infant whose active immune system is not yet fully developed.

- **Antibodies (Immunoglobulins):** These proteins identify and neutralize foreign agents. Secretory fluids in the human body are rich in specific classes of immunoglobulins.

Step 1: Analyze the distribution of immunoglobulin classes

There are five main classes of human immunoglobulins: IgA, IgD, IgE, IgG, and IgM.

- **IgA:** The primary antibody found in external secretions (such as tears, saliva, colostrum, and gastrointestinal secretions), offering mucosal immunity.
- **IgG:** The most abundant antibody in circulating blood plasma, which can cross the placental barrier.
- **IgM:** The first antibody produced during a primary immune response, primarily located in blood and lymph.
- **IgD:** Primarily functions as an antigen receptor on the surface of B lymphocytes.

Step 2: Relate the antibody type to colostrum

Since colostrum is a specialized maternal secretion, it contains highly concentrated levels of secretory IgA. This antibody coats the infant's intestinal tract, protecting against potential pathogens. This matches option (D).

Quick Tip:

- **Passive vs. Active Immunity:** Colostrum provides *passive immunity* because pre-formed antibodies (IgA) are transferred to the host, rather than the infant's body producing them.
- **Placental antibody:** Remember that **IgG** is the only antibody class capable of passing through the human placenta to provide prenatal protection.

---

155. Which of the following in female gametophyte of an angiosperm helps in guiding the pollen tube for fertilizing the eggs ?

(A) Polar nucleus

(B) Antipodals

(C) Synergids

(D) Central cells

Correct Answer: (C) Synergids

Solution:

Concept:

- The mature female gametophyte of an angiosperm (embryo sac) typically exhibits a 7-celled, 8-nucleate structure:
  - **Egg Apparatus (Micropylar end):** Contains one egg cell and two flanking **synergids**.
  - **Central Cell:** Contains two polar nuclei.
  - **Antipodals (Chalazal end):** Three cells located at the chalazal pole.
- Synergids possess specialized cellular structures at their micropylar tip known as the **filiform apparatus**.

Step 1: Understand the fertilization pathway in angiosperms

Upon reaching the stigma, the pollen grain germinates to produce a pollen tube, which grows down through the style toward the ovary. The pollen tube enters the ovule through the micropylar opening.

Step 2: Examine the role of the filiform apparatus and synergids

As the pollen tube approaches the embryo sac, it must find the precise path to deliver male gametes to the egg cell. The filiform apparatus, which consists of prominent finger-like projections on the synergid cell walls, secretes chemical signals (chemotropic substances). These chemical secretions guide the pollen tube's growth into one of the synergids, facilitating the fertilization process.

Step 3: Confirm the correct cellular structure

The cells responsible for this chemotropic guidance are the synergids, which contains the filiform apparatus. This matches option (C).

Quick Tip:

- The **filiform apparatus** is located at the micropylar end of the synergids.
- Once the pollen tube enters a synergid, the synergid degenerates, releasing the two male gametes to carry out double fertilization (one fuses with the egg cell, and the other fuses with the polar nuclei of the central cell).

---

156. Which of the following disease is not sexually transmitted ?

(A) Genital warts

(B) Syphilis

(C) Tuberculosis

(D) Gonorrhoea

Correct Answer: (C) Tuberculosis

Solution:

Concept:

- **Sexually Transmitted Infections (STIs):** Also known as Venereal Diseases (VD), these are infections or diseases transmitted primarily through intimate sexual contact with an infected partner.
- **Systemic and Respiratory Infections:** Diseases that spread through pathways such as airborne droplets, contaminated food or water, or direct contact, rather than primarily via sexual intercourse.

Step 1: Analyze the transmission pathway of the listed diseases

- **Genital warts (Option A):** Caused by the Human Papillomavirus (HPV). It is a well-established viral STI spread primarily through sexual contact.
- **Syphilis (Option B):** Caused by the spirochete bacterium *Treponema pallidum*. It is a chronic infection transmitted through sexual contact with active lesions.
- **Gonorrhoea (Option D):** Caused by the bacterium *Neisseria gonorrhoeae*. It is a common bacterial STI affecting the mucosal surfaces of the urogenital tract.

Step 2: Analyze the transmission pathway of Tuberculosis

Tuberculosis (Option C): Caused by the bacterium *Mycobacterium tuberculosis*. It is primarily a pulmonary (lung) disease that spreads through airborne droplet transmission when an infected individual coughs, sneezes, or talks. It is not classified as a sexually transmitted infection. This corresponds to option (C).

Quick Tip:

- **Bacterial STIs:** Gonorrhoea, Syphilis, Chlamydiasis.
- **Viral STIs:** Genital herpes, Genital warts, Hepatitis-B, HIV/AIDS.
- Early detection and complete treatment are vital for STIs to prevent long-term complications like Pelvic Inflammatory Disease (PID) or infertility.

---

157. Which of the following statements about lac-operon is correct ?

(A) Galactose can act as an inducer of lac operon

(B) Gene i is constitutively expressed

(C) Lactose activates repressor to bind to the operator

(D) Genes i, z, y and a share single common promoter

Correct Answer: (B) Gene i is constitutively expressed

Solution:

Concept:

- The *lac* operon (lactose operon) is a polycistronic gene regulation system in *Escherichia coli* that regulates the transport and metabolism of lactose.
- Its key components include:
  - **Regulatory gene (i gene):** Codes for the repressor protein.
  - **Promoter (p):** Binding site for RNA polymerase.
  - **Operator (o):** Binding site for the repressor protein.
  - **Structural genes (z, y, a):** Code for metabolic enzymes.

Step 1: Evaluate each statement individually for accuracy

- **Option (A):** Galactose is a monosaccharide product of lactose hydrolysis, but it cannot bind to the repressor protein to initiate operon transcription; only lactose (or its isomer allolactose) functions as the inducer. Thus, this statement is incorrect.
- **Option (B):** The regulatory i gene is transcribed and translated at a continuous, baseline level regardless of the presence of lactose, which is known as *constitutive expression*. This ensures repressor protein is always present in the cell to regulate the system. This statement is correct.
- **Option (C):** When lactose enters the cell, it binds to the repressor and causes a conformational change that *inactivates* the repressor. This prevents the repressor from binding to the operator, allowing transcription. Thus, this statement is incorrect.
- **Option (D):** The regulator gene (i gene) has its own independent promoter, while the structural genes (z, y, a) share a single, separate promoter. Thus, this statement is incorrect.

Step 2: Identify the correct option

Based on the evaluations, only statement (B) is biologically accurate.

Quick Tip:

- **Constitutive expression** means that the gene is continuously expressed to maintain basic cellular functions, independent of external environmental triggers.
- The structural genes of the lac operon and their corresponding proteins are:
  - z gene → β-galactosidase (hydrolyzes lactose)
  - y gene → permease (increases permeability of the cell to β-galactosides)
  - a gene → transacetylase (transfers an acetyl group to β-galactosides)

---

158. Match List-I with List-II.

List-I	List-II
A. Transformation	I. Restriction enzyme
B. Cloning site	II. Transfer DNA to host bacteria
C. Selection	IV. Antibiotic
D. Ori	III. Replication

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (B) A-II, B-I, C-IV, D-III

Solution:

Concept:

- Recombinant DNA technology uses biological elements to clone genes of interest inside host cells.
- Key processes and genetic tools include:
  - **Transformation:** Introducing foreign genetic material directly into a recipient bacterium.
  - **Cloning Sites:** Specific locations on a vector recognized by restriction endonucleases where foreign DNA is inserted.
  - **Selectable Markers:** Genes (such as those providing resistance to antibiotics) used to select recombinant host cells and eliminate non-recombinants.
  - **Origin of Replication (Ori):** A DNA sequence that initiates DNA replication inside host cells.

Step 1: Establish the matches between List-I and List-II

- **A. Transformation:** Represents the process used to **II. Transfer DNA to host bacteria**.
- **B. Cloning site:** The physical region in a cloning vector cleaved by a specific **I. Restriction enzyme** to insert foreign DNA.

- **C. Selection:** The process of identifying transformed cells, often using an **IV. Antibiotic** resistance gene as a selectable marker.
- **D. Ori:** The sequence responsible for initiating DNA **III. Replication** and controlling the copy number of the plasmid.

Step 2: Match with the given option choices

Combining these correlations, we obtain the pattern: A-II, B-I, C-IV, D-III. This corresponds to option (B).

Quick Tip:

- "**Ori**" is the direct initiator of **Replication**, allowing you to link D with III.
- Commonly used antibiotic resistance genes for selection in *E. coli* vectors include those for ampicillin, chloramphenicol, tetracycline, and kanamycin.

---

159. A population of diploid organisms is at Hardy-Weinberg equilibrium. If the frequency of allele A is 0.1, the frequency of AA is

(A) 0.99

(B) 0.01

(C) 0.02

(D) 0.10

Correct Answer: (B) 0.01

Solution:

Concept:

- The Hardy-Weinberg principle states that allele and genotype frequencies in a population remain constant from generation to generation in the absence of evolutionary influences.
- For a gene locus with two alleles, A (dominant) and a (recessive):
  - Let p be the frequency of allele A.
  - Let q be the frequency of allele a.
  - Thus, $p + q = 1$.

- The expected genotype frequencies in the population are given by:

$$p^2 + 2pq + q^2 = 1$$

where:

  - p^2 is the frequency of homozygous dominant individuals (AA).
  - $2pq$ is the frequency of heterozygous individuals (Aa).
  - q^2 is the frequency of homozygous recessive individuals (aa).

Step 1: Identify the given values from the problem statement

The problem states that the population is in Hardy-Weinberg equilibrium, and the frequency of the allele A (represented as p) is:

$$p = 0.1$$

Step 2: Calculate the frequency of genotype AA

The frequency of the homozygous dominant genotype AA is represented mathematically by p^2:

$$\text{Frequency of } AA = p^2$$

$$\text{Frequency of } AA = (0.1)^2 = 0.01$$

Thus, the expected frequency of the genotype AA in the population is 0.01, which corresponds to option (B).

Quick Tip:

- Always pay close attention to whether the question asks for an **allele frequency** (p or q) or a **genotype/phenotype frequency** (p^2, $2pq$, or q^2).
- To find the other allele's frequency: $q = 1 - p = 1 - 0.1 = 0.9$.
- The heterozygous frequency (Aa) would be $2pq = 2 \times 0.1 \times 0.9 = 0.18$.

---

160. Sperm motility is due to _____.

(A) muscular movement

(B) flagellar movement

(C) ciliary movement

(D) amoeboid movement

Correct Answer: (B) flagellar movement

Solution:

Concept:

- Specialized cells in eukaryotic multicellular organisms exhibit distinct types of movement:
  - **Amoeboid Movement:** Movement accomplished by pseudopodia, seen in specialized immune cells like macrophages and neutrophils.
  - **Ciliary Movement:** Coordinated movement driven by hair-like cilia, seen in respiratory tract linings (trachea) and the fallopian tubes.
  - **Flagellar Movement:** Movement driven by a whip-like flagellum, seen in specific free-swimming unicellular structures or gametes.
  - **Muscular Movement:** Contractile movement of muscle fibers, utilized for skeletal locomotion, heart beating, and peristalsis.

Step 1: Analyze the structure and locomotion of human sperm

A mature sperm cell (spermatozoon) is structurally divided into a head, neck, middle piece, and a tail.

- The sperm tail is a specialized **flagellum** containing an axoneme with a characteristic $9+2$ arrangement of microtubules.
- The coordinated, undulating lashing of this tail propels the sperm cell through fluid environments to reach the ovum.

Step 2: Identify the correct classification of movement

Since the propulsion of sperm relies directly on the wave-like beating of its tail, this motion represents flagellar movement. This corresponds to option (B).

Quick Tip:

- The energy required for flagellar movement is provided by ATP generated in the mitochondria concentrated within the sperm's middle piece.
- Both cilia and flagella are extensions of the cell membrane that originate from basal bodies, which are structurally similar to centrioles.

---

161. Consider a population of 10 million cells. Given the per-capita birth rate of 0.002 (per unit time) and the per-capita death rate of 0.002 (per unit time), the expected number of cells after 10 generations is _____.

(A) 100 million

(B) 1 million

(C) 5 million

(D) 10 million

Correct Answer: (D) 10 million

Solution:

Concept:

- Population growth rate over time can be mathematically expressed by the exponential growth equation:

$$\frac{dN}{dt} = rN$$

where:

  - N is the population size.
  - r is the intrinsic rate of natural increase, calculated as the difference between the per-capita birth rate (b) and the per-capita death rate (d):

$$r = b - d$$

- If the growth rate r is zero, the population size does not undergo any net change over time, regardless of the time intervals or generations elapsed.

Step 1: Calculate the intrinsic rate of natural increase (r)

Using the values provided:

- Per-capita birth rate $(b) = 0.002$
- Per-capita death rate $(d) = 0.002$

Calculate r:

$$r = b - d = 0.002 - 0.002 = 0$$

Step 2: Calculate the expected population size after 10 generations

The mathematical relationship for population size is:

$$N_t = N_0 e^{rt}$$

Substituting $r = 0$ into the equation:

$$N_t = N_0 e^{(0 \times t)}$$

$$N_t = N_0 e^0$$

$$N_t = N_0 \times 1$$

$$N_t = 10 \text{ million}$$

Because the birth rate equals the death rate, the population remains stable at 10 million cells. This corresponds to option (D).

Quick Tip:

- When the per-capita birth rate matches the per-capita death rate, the population achieves a state of dynamic equilibrium.
- Under these conditions, elapsed time and generations have no net effect on the total population size.

---

162. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: Forelimbs of human and bats are homologous.

Reason R: Forelimbs of humans and bats have similar anatomical structure.

In the light of the above statements, choose the most appropriate answer from the options

given below:

(A) A is false but R is true

(B) Both A and R are correct and R is the correct explanation of A

(C) Both A and R are true, but R is not the correct explanation of A

(D) A is true but R is false

Correct Answer: (B) Both A and R are correct and R is the correct explanation of A

Solution:

Concept:

- **Homology:** The relationship between structures derived from a common evolutionary ancestor.
- Homologous structures share a similar basic anatomical plan and embryonic development, though they may perform different functions.
- Examples include the forelimbs of humans, cheetahs, whales, and bats, which all consist of humerus, radius, ulna, carpals, metacarpals, and phalanges.
- Homology indicates divergent evolution.

Step 1: Evaluate Assertion A

Assertion A states that the forelimbs of humans and bats are homologous.

This is true, as they are derived from a common mammalian ancestor.

Step 2: Evaluate Reason R

Reason R states that the forelimbs of humans and bats have a similar anatomical structure.

This is also true, as they share the same arrangement of bones.

Step 3: Determine if R is the correct explanation of A

Homology, by definition, is based on structural and anatomical similarity.

Because their forelimbs share the same fundamental anatomical structure, they are classified as homologous organs.

Thus, R is the correct explanation of A.

Quick Tip:

Homology → Similar anatomy, different functions → Divergent evolution.

Analogy → Different anatomy, similar functions → Convergent evolution (e.g., wings of butterfly and bird).

---

163. Muscle contraction is initiated by a signal sent by the central nervous system by the release of _____.

(A) cyclic adenine monophosphate

(B) acetyl choline

(C) acetyl coenzyme A

(D) cyclic guanine monophosphate

Correct Answer: (B) acetyl choline

Solution:

Concept:

- **Somatic Motor Signaling:** Skeletal muscles are under voluntary control, with contraction initiated by neural signals generated in the Central Nervous System (CNS) and transmitted along somatic motor neurons.
- **The Motor Unit:** A single motor neuron and the group of skeletal muscle fibers it innervates function together as a unified motor unit.
- **Neuromuscular Junction (NMJ):** The specialized chemical synapse between the terminal end of a motor neuron and the motor end-plate region of the muscle fiber's sarcolemma (plasma membrane).
- **Synaptic Transmission:** At the NMJ, electrical action potentials are converted into chemical signals through the release of a specific neurotransmitter into the synaptic cleft.

Step 1: Trace the chemical sequence at the neuromuscular junction

When an action potential reaches the presynaptic axon terminal of the motor neuron:

- Voltage-gated calcium channels open, allowing calcium ions (Ca^{2+}) to enter the axon terminal.

- This influx triggers the fusion of synaptic vesicles with the presynaptic membrane, releasing **acetylcholine** (ACh) into the synaptic cleft via exocytosis.
- ACh molecules diffuse across the cleft and bind to ligand-gated nicotinic acetylcholine receptors on the sarcolemma.

Step 2: Evaluate the options against the mechanism of action

- **(A) cyclic adenine monophosphate (cAMP):** An intracellular second messenger involved in signal transduction cascades, not a primary synaptic neurotransmitter.
- **(B) acetyl choline:** The primary neurotransmitter released at somatic motor synapses that depolarizes the sarcolemma to trigger skeletal muscle contraction.
- **(C) acetyl coenzyme A (acetyl-CoA):** A key biochemical intermediate in cellular respiration (Krebs cycle) and lipid metabolism, rather than a neural signaling molecule.
- **(D) cyclic guanine monophosphate (cGMP):** An intracellular second messenger that regulates cellular pathways, such as smooth muscle relaxation, but is not responsible for initiating skeletal muscle contraction at the NMJ.

Thus, acetylcholine is the neurotransmitter responsible for initiating the process, corresponding to option (B).

Quick Tip:

- **Somatic Neurotransmitter:** Acetylcholine is the universal neurotransmitter utilized by somatic motor neurons to activate skeletal muscle contraction.
- **Signal Termination:** To ensure that the muscle does not remain in a state of continuous contraction, the enzyme **acetylcholinesterase** (AChE) rapidly hydrolyzes acetylcholine in the synaptic cleft into acetic acid and choline, allowing the muscle fiber to repolarize and relax.

164. Which of the following hormone is not secreted by human placenta ?

(A) LH

(B) hCG

(C) Estrogen

(D) Progesterone

Correct Answer: (A) LH

Solution:

Concept:

- **Endocrine Role of the Placenta:** During human gestation, the placenta acts as a temporary, highly active endocrine gland. It synthesizes and secretes several hormones that are critical for maintaining the pregnancy, regulating maternal metabolism, and supporting fetal growth.
- **Placental Hormones:** The primary hormones produced by placental tissue (specifically the syncytiotrophoblast layer) include:
  - **hCG** (Human Chorionic Gonadotropin): Maintains the corpus luteum during early pregnancy to ensure continuous progesterone production.
  - **hPL** (Human Placental Lactogen): Regulates maternal glucose and lipid metabolism to support fetal nutrition.
  - **Estrogens (primarily Estriol):** Stimulate uterine growth and ductal development in the mammary glands.
  - **Progesterone:** Maintains the stable, non-contractile state of the uterine endometrium during gestation.
- **Anterior Pituitary Hormones:** Gonadotropic hormones, such as Luteinizing Hormone (LH) and Follicle-Stimulating Hormone (FSH), are synthesized and secreted by gonadotroph cells in the anterior pituitary gland under the regulation of hypothalamic GnRH.

Step 1: Analyze the biological source of the listed hormones

During pregnancy, the levels of estrogen and progesterone rise significantly. These hormones are synthesized directly by the placenta to support the growing fetus. Similarly, hCG is produced by the developing chorion/placenta shortly after implantation.

Step 2: Identify the hormone of non-placental origin

Luteinizing Hormone (LH) is a pituitary gonadotropin. During pregnancy, the extremely high levels of circulating placental estrogen and progesterone exert a strong negative feedback effect on the maternal hypothalamus and anterior pituitary gland. This feedback mechanism suppresses the secretion of LH and FSH to prevent the maturation of new ovarian follicles. Consequently, LH is not secreted by the placenta. This corresponds to option (A).

Quick Tip:

- **Pregnancy-Specific Hormones:** Hormones such as **hCG**, **hPL**, and **relaxin** (which is also secreted by the ovary/placenta later in pregnancy) are produced in women exclusively during gestation.
- **Clinical Application:** Because hCG is produced shortly after the blastocyst implants into the uterine wall, its presence in maternal urine serves as the physiological basis for home pregnancy testing.

---

165. Which of the following statements is correct about *Plasmodium* ?

(A) Fertilization takes place in mosquito gut

(B) Reproduces sexually in liver cells

(C) Reproduces sexually in RBCs

(D) Gametocytes develop in mosquito gut

Correct Answer: (A) Fertilization takes place in mosquito gut

Solution:

Concept:

- *Plasmodium* is a microscopic, single-celled protozoan parasite that causes malaria.
- It has a complex, two-host (digenetic) life cycle:
  - **Asexual cycle (in Humans):** Sporozoites migrate to liver cells and reproduce asexually (schizogony). They then infect red blood cells (RBCs), reproducing asexually to release merozoites.
  - **Sexual stages (Gametocytes):** Form and develop inside human RBCs.
  - **Sexual cycle (in Mosquitoes):** Gametocytes are ingested by the female *Anopheles* mosquito, mature into gametes, and undergo **fertilization** inside the mosquito's gut.

Step 1: Evaluate the statements on sexual vs. asexual phases

Option (A) is correct: Fertilization of male and female microgametes occurs in the intestinal lumen of the mosquito.

Option (B) and (C) are incorrect: *Plasmodium* reproduces asexually in human liver cells and RBCs.

Option (D) is incorrect: Gametocytes are produced and develop in human blood (RBCs), not inside the mosquito.

Quick Tip:

Humans serve as the intermediate host (where asexual reproduction occurs).

Female *Anopheles* mosquitoes serve as the definitive host (where fertilization and sexual reproduction occur).

Sporozoite is the infectious stage of the parasite that is injected into the human body.

---

166. Which of the following are primary consumers in a food chain ?

(A) Carnivores

(B) Parasites

(C) Predators

(D) Herbivores

Correct Answer: (D) Herbivores

Solution:

Concept:

- **Trophic Levels:** The trophic structure of an ecosystem represents the specific feeding positions occupied by different groups of organisms based on their source of nutrition:
  - **Producers (First Trophic Level, T_1):** Autotrophic organisms, primarily green plants, that utilize solar energy to synthesize organic compounds via photosynthesis.
  - **Primary Consumers (Second Trophic Level, T_2):** Heterotrophic organisms that obtain their energy by feeding directly on primary producers.
  - **Secondary Consumers (Third Trophic Level, T_3):** Carnivorous organisms that feed on primary consumers.
  - **Tertiary Consumers (Fourth Trophic Level, T_4):** Top carnivores that feed on secondary consumers.

Step 1: Understand the ecological role of primary consumers

Primary consumers occupy the first heterotrophic level in a food chain. Because their diet

consists exclusively of primary producers (green plants, algae, or phytoplankton), they are biologically classified as **herbivores**. Examples of terrestrial primary consumers include cows, deer, rabbits, and leaf-eating insects. In aquatic ecosystems, small crustaceans and zooplankton serve this role.

Step 2: Evaluate the alternative options

- **(A) Carnivores:** These organisms consume other animals, placing them at the third trophic level (T_3) as secondary consumers, or higher.
- **(B) Parasites:** These organisms live in or on a host organism to obtain nutrients. They do not occupy a single fixed trophic level, as their position depends entirely on the trophic level of their specific host.
- **(C) Predators:** These are active hunters that capture and consume prey animals, placing them as secondary or tertiary consumers.
- **(D) Herbivores:** These are plant-eating animals, which directly corresponds to the definition of primary consumers.

Therefore, option (D) is the correct choice.

Quick Tip:

- **Trophic Level Association:**
  - Producers → Autotrophs (T_1)
  - Primary Consumers → Herbivores (T_2)
  - Secondary Consumers → Primary Carnivores (T_3)
  - Tertiary Consumers → Secondary/Top Carnivores (T_4)
- **10% Law of Energy Transfer:** Only about 10% of the energy available at one trophic level is transferred to the next level. The remaining 90% is lost primarily as metabolic heat during respiration and through waste.

---

167. Which of the following statements about the reabsorption process in Henle's loop are correct ?

(a) The descending limb of Henle's loop is permeable to water but almost impermeable to electrolytes.

(b) Urine gets concentrated in Henle's loop.

(c) Reabsorption of Na^+ and water takes place in Henle's loop.

(d) Active or passive transport of electrolytes occurs in the ascending limb of Henle's loop.

Choose the correct answer from the options given below :

(A) (a), (b) and (d) only

(B) (a) and (b) only

(C) (b), (c) and (d) only

(D) (a), (b) and (c) only

Correct Answer: (A) (a), (b) and (d) only

Solution:

Concept:

- Henle's loop is a hairpin-shaped part of the nephron with two functionally distinct limbs:
  - **Descending limb:** Permeable to water, but nearly impermeable to electrolytes. As filtrate moves down, water is reabsorbed, increasing the concentration of the filtrate.
  - **Ascending limb:** Impermeable to water, but allows transport of electrolytes actively or passively.

Step 1: Analyze the correctness of each statement

Statement (a) is correct: The descending limb allows water to pass through but blocks electrolytes.

Statement (b) is correct: Reabsorption of water in the descending limb concentrates the medullary filtrate.

Statement (c) is incorrect: Reabsorption of water and Na^+ occur in different, separate limbs of Henle's loop, not together in a single step.

Statement (d) is correct: Active or passive transport of electrolytes occurs in the water-impermeable ascending limb.

Step 2: Determine the correct combination

Since statements (a), (b), and (d) are correct, option (1) is the correct choice.

Quick Tip:

The loop of Henle plays a major role in establishing a high osmotic pressure in the kidney medulla.

Remember: Descending limb is for water reabsorption (concentrating the urine); Ascending limb is for salt reabsorption (diluting the urine).

---

168. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: The logistic growth model of populations is considered more realistic than the exponential growth model.

Reason R: Resources are finite.

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) A is not correct but R is correct

(B) Both A and R are correct and R is the correct explanation of A

(C) Both A and R are correct but R is not the correct explanation of A

(D) A is correct but R is not correct

Correct Answer: (B) Both A and R are correct and R is the correct explanation of A

Solution:

Concept:

- **Exponential growth:** Assumes unlimited resources, resulting in a J-shaped curve. This rarely occurs in nature.
- **Logistic growth:** Assumes limited resources, resulting in a Sigmoid (S-shaped) curve.
- The population size levels off as it reaches the carrying capacity (K) of the habitat.

Step 1: Evaluate the truth of the Assertion and Reason

Assertion A is true: The logistic growth model accounts for limiting factors, making it highly realistic.

Reason R is true: Habitats have a finite amount of resources (food, space, nesting sites).

Step 2: Check if R is the correct explanation of A

The logistic growth model is considered more realistic (Assertion) precisely because resources

are limited and finite (Reason) in any natural habitat.

Thus, R is the correct explanation of A.

Quick Tip:

Verhulst-Pearl Logistic Growth is mathematically expressed as: $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$.

When $N = K$, population growth stops, representing the maximum population size that the environment can support.

---

169. Which of the following is the correct order of arrangement of vertebrate column from the head to toe ?

(A) Cervical vertebra, thoracic vertebra, lumbar vertebra, sacrum

(B) Cervical vertebra, thoracic vertebra, sacrum, lumbar vertebra

(C) Sacrum, lumbar vertebra, thoracic vertebra, cervical vertebra

(D) Cervical vertebra, lumbar vertebra, thoracic vertebra, sacrum

Correct Answer: (A) Cervical vertebra, thoracic vertebra, lumbar vertebra, sacrum

Solution:

Concept:

- **Vertebral Column:** The human vertebral column (backbone) is a flexible, mid-dorsal bony structure that extends from the base of the skull to the pelvis, protecting the spinal cord and supporting the trunk.
- **Regional Vertebrae:** In adults, the column consists of 26 serially arranged, articulated units called vertebrae, which are categorized into five distinct anatomical regions:
  - **Cervical Region:** Located in the neck, consisting of 7 individual vertebrae.
  - **Thoracic Region:** Located in the chest/ribcage area, consisting of 12 individual vertebrae.
  - **Lumbar Region:** Located in the lower back, consisting of 5 individual vertebrae.
  - **Sacral Region (Sacrum):** Located in the pelvic girdle, composed of 5 vertebrae that fuse into a single, triangular bone in adults.

– **Coccygeal Region (Coccyx):** Located at the terminal end, composed of 4 small vertebrae fused into a single vestigial tailbone.

Step 1: Trace the craniocaudal (head to toe) sequence of the vertebral column

To establish the correct anatomical order starting from the head (superior) and moving downwards toward the pelvic region (inferior):

- The uppermost vertebrae directly supporting the skull are the **cervical** vertebrae.
- Below the neck, the vertebral column enters the chest region as the **thoracic** vertebrae.
- Below the thoracic cage, the column forms the lower back region with the larger **lumbar** vertebrae.
- Below the lumbar region, the column articulates with the pelvic girdle through the fused **sacrum**.
- The terminal portion of the column is represented by the vestigial **coccyx**.

Therefore, the sequence from superior to inferior is:

$$\text{Cervical} \rightarrow \text{Thoracic} \rightarrow \text{Lumbar} \rightarrow \text{Sacrum} \rightarrow \text{Coccyx}$$

Step 2: Evaluate the options against this anatomical sequence

- **(A) Cervical, thoracic, lumbar, sacrum:** This matches the correct anatomical sequence from head to toe.
- **(B) Cervical, thoracic, sacrum, lumbar:** This is incorrect because the sacrum is placed superior to the lumbar vertebrae.
- **(C) Sacrum, lumbar, thoracic, cervical:** This is incorrect because it presents the reverse (toe to head) sequence.
- **(D) Cervical, lumbar, thoracic, sacrum:** This is incorrect because the lumbar vertebrae are placed superior to the thoracic vertebrae.

Thus, option (A) is the correct choice.

Quick Tip:

- **Sequence Mnemonic (CTLSC):** Remember the vertical order of the vertebral regions using the acronym **CTLSC** (Cervical, Thoracic, Lumbar, Sacrum, Coccygeal).
- **Vertebral Formula:** The standard vertebral distribution in humans is expressed as:

$$C_7T_{12}L_5S_{(5\text{ fused})}Co_{(4\text{ fused})}$$

- Associate the counts of the mobile vertebrae (**7**, **12**, and **5**) with standard daily meal times:
  - Breakfast at **7** AM → **7** Cervical
  - Lunch at **12** PM → **12** Thoracic
  - Dinner at **5** PM → **5** Lumbar

---

170. Match List-I with List-II.

List-I	List-II
A. Both species are harmed	**I. Predation**
B. One species is harmed and the other is benefited	**II. Mutualism**
C. Both species are benefited	**III. Competition**
D. One is benefited while the other has no effect	**IV. Commensalism**

Choose the correct answer from the options given below :

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

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

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

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

Correct Answer: (A) A-III, B-I, C-II, D-IV

Solution:

Concept:

- Biological interactions between populations can be beneficial (+), harmful (−), or neutral (0):
  - **Competition:** (−, −) Both species are negatively affected.
  - **Predation:** (+, −) One species benefits by feeding on the other.

– **Mutualism:** (+, +) Both species benefit.

– **Commensalism:** (+, 0) One species benefits while the other is unaffected.

Step 1: Match each description to its biological interaction term

A. Both species are harmed (−, −) → **III. Competition**

B. One species is harmed and the other is benefited (+, −) → **I. Predation**

C. Both species are benefited (+, +) → **II. Mutualism**

D. One is benefited while the other has no effect (+, 0) → **IV. Commensalism**

Step 2: Identify the correct option matching the list

The sequence is A-III, B-I, C-II, D-IV, which matches option (1).

Quick Tip:

Competition and mutualism are symmetrical interactions (−,− and +,+), while predation and commensalism are asymmetrical.

Spleen-plant relationships and lichen associations are famous examples of mutualistic interactions.

---

171. If the diploid chromosome number of typical angiosperm is 36, what would be the chromosome number in its endosperm ?

(A) 72

(B) 18

(C) 36

(D) 54

Correct Answer: (D) 54

Solution:

Concept:

- In angiosperms, the endosperm is formed as a result of triple fusion (double fertilization).
- Triple fusion involves the fusion of one haploid male gamete (n) with the diploid secondary nucleus ($2n$) inside the embryo sac.
- This results in a triploid cell ($3n$) which develops into the endosperm tissue.
- Somatic cells (vegetative cells) of a typical angiosperm are diploid ($2n$).

Step 1: Find the haploid chromosome number

Given diploid number:

$$2n = 36$$

Therefore, haploid number (n) is:

$$n = \frac{36}{2} = 18$$

Step 2: Calculate the endosperm chromosome number

The endosperm is triploid ($3n$):

$$3n = 3 \times 18 = 54$$

Thus, the chromosome number in its endosperm is 54.

Quick Tip:

Angiosperm endosperm is triploid ($3n$) because of double fertilization.

In contrast, the endosperm in gymnosperms is haploid (n) because it is formed before fertilization.

---

172. Which of the following enzymes synthesizes precursor mRNA ?

(A) DNA polymerase

(B) RNA polymerase I

(C) RNA polymerase II

(D) RNA polymerase III

Correct Answer: (C) RNA polymerase II

Solution:

Concept:

- **Eukaryotic Transcription:** Unlike prokaryotes, which utilize a single RNA polymerase to transcribe all types of RNA, eukaryotic cells exhibit a clear division of labor with three distinct RNA polymerase enzymes in their nucleus:
  - **RNA Polymerase I:** Transcribes ribosomal RNAs (28S, 18S, and 5.8S rRNAs), which are structural and catalytic components of ribosomes.
  - **RNA Polymerase II:** Transcribes protein-coding genes to produce heterogeneous nuclear RNA (**hnRNA**), which serves as the direct precursor of messenger RNA

(mRNA).

- **RNA Polymerase III:** Transcribes transfer RNA (tRNA), 5S rRNA, and other small nuclear RNAs (snRNAs).

Step 1: Understand the nature of precursor mRNA in eukaryotes

In eukaryotic transcription of protein-coding genes, the immediate product is not a fully functional messenger RNA (mRNA). Instead, a primary transcript called heterogeneous nuclear RNA (hnRNA) or precursor mRNA (pre-mRNA) is synthesized. This pre-mRNA contains both coding sequences (exons) and non-coding sequences (introns) and must undergo post-transcriptional processing (capping, tailing, and splicing) to become mature, functional mRNA.

Step 2: Identify the specific transcribing enzyme

Based on the division of labor in eukaryotic nuclei:

- **RNA Polymerase I** is restricted to transcribing ribosomal RNA genes.
- **RNA Polymerase III** is restricted to smaller functional RNA genes, such as tRNAs and the 5S ribosomal subunit.
- **RNA Polymerase II** is responsible for transcribing structural, protein-coding genes into hnRNA (pre-mRNA).

Thus, the enzyme that synthesizes precursor mRNA is RNA Polymerase II, which corresponds to option (C).

Quick Tip:

- **Mnemonic (r-m-t):** To remember the primary products of the three eukaryotic RNA polymerases in sequence, associate Polymerases I, II, and III with the letters **r**, **m**, and **t** respectively:
  - **I** → **r**RNA
  - **II** → **m**RNA precursor (hnRNA)
  - **III** → **t**RNA
- **Prokaryotic Exception:** In prokaryotic organisms, a single DNA-dependent RNA polymerase is responsible for the transcription of all functional classes of RNA (mRNA, tRNA, and rRNA).

---

173. Given below are two statements:

Statement I: Plasmids are autonomously replicating DNA.

Statement II: Plasmids are extrachromosomal DNA.

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) Statement I is incorrect but Statement II is correct

(B) Both Statement I and Statement II are correct

(C) Both Statement I and Statement II are incorrect

(D) Statement I is correct but Statement II is incorrect

Correct Answer: (B) Both Statement I and Statement II are correct

Solution:

Concept:

- **Plasmids:** Small, circular, double-stranded, extrachromosomal DNA molecules found naturally in bacterial cells and some fungi.
- They are physically separate from the host's chromosomal DNA.
- Plasmids possess an origin of replication (*ori*) sequence, enabling them to replicate independently (autonomously) of the host's genomic chromosome.

Step 1: Verify Statement I

Statement I is correct: Plasmids replicate autonomously because they have their own origin of replication.

Step 2: Verify Statement II

Statement II is correct: Plasmids are extrachromosomal, meaning they are located outside and separate from the host's main genome.

Quick Tip:

Plasmids are widely used as vectors in recombinant DNA technology to deliver genes of interest into host bacteria.

Plasmids often carry selectable marker genes, such as those conferring resistance to antibiotics like ampicillin.

---

174. How many theca are present in each lobe of a typical bilobed angiosperm anther?

(A) 12

(B) 2

(C) 6

(D) 8

Correct Answer: (B) 2

Solution:

Concept:

- **Structure of the Anther:** The anther is the fertile, pollen-bearing part of the stamen in angiosperms.
- **Bilobed Arrangement:** A typical angiosperm anther is a bilobed structure, meaning it consists of two distinct lobes joined together by a band of sterile parenchymatous tissue called the connective.
- **Dithecous Lobes:** Internally, each individual lobe of the anther is divided into two separate chambers or pollen sacs, which are anatomically referred to as **theca**.
- Since each lobe possesses two theca, the lobes are described as **dithecous**.
- Consequently, a complete, mature bilobed anther is tetrasporangiate, containing a total of four microsporangia (pollen sacs) distributed across its two lobes.

Step 1: Analyze the spatial structure of the anther

To determine the correct count, we must distinguish between the structure of a single lobe and the structure of the entire anther.

- A typical anther has two lobes in total.
- Each of these lobes is structurally partitioned into two longitudinal cavities (theca).

Step 2: Evaluate the count of theca per individual lobe

The question asks specifically for the number of theca present in **each** lobe. Since each individual lobe is dithecous (possessing two chambers), there are exactly 2 theca per lobe. This corresponds to option (B).

Quick Tip:

- **Key Terminology Distinction:**
  - Number of theca **per lobe** = 2 (dithecous)
  - Number of theca **per entire typical anther** = 4 (tetrathecous / tetrasporangiate)
- A distinct longitudinal groove runs along the outer surface of each anther lobe, marking the internal division between the two corresponding theca.

---

175. Natural selection can lead to

(a) stabilisation

(b) genetic drift

(c) directional change

(d) disruption

Choose the correct answer from the options given below :

(A) (a) and (c) only

(B) (a) only

(C) (a), (c) and (d) only

(D) (a), (b), (c) and (d)

Correct Answer: (C) (a), (c) and (d) only

Solution:

Concept:

- **Natural Selection:** An evolutionary process where environmental pressures favor individuals with advantageous traits, allowing them to reproduce more successfully.
- Based on the phenotypic changes it produces in a population, natural selection works through three distinct modes:
  - **Stabilising selection:** Favors intermediate phenotypes, reducing variation and maintaining status quo (stabilisation).
  - **Directional selection:** Favors one extreme phenotype, shifting the population mean in that direction (directional change).

- **Disruptive selection:** Favors both extremes over the average, splitting the population phenotypic curve (disruption).

- **Genetic Drift:** A separate, non-adaptive evolutionary mechanism caused by random changes in gene pool frequencies.

Step 1: Distinguish the modes of natural selection from other evolutionary factors

Stabilisation (a), directional change (c), and disruption (d) are direct outcomes or types of natural selection.

Genetic drift (b) is an independent evolutionary force driven by random chance events rather than fitness.

Step 2: Identify the correct combination option

The modes of natural selection are (a), (c), and (d). This corresponds to option (3).

Quick Tip:

Stabilising selection narrows the phenotypic distribution curve around the mean.

Directional selection shifts the peak of the curve toward one side.

Disruptive selection produces two distinct peaks at the extreme ends of the phenotypic range, which can lead to speciation.

---

176. Which of the following statements are correct?

(a) Energy flow from producers to consumers is unidirectional

(b) Energy pyramid can never be inverted

(c) Transfer of energy follows the 1% law

Choose the correct answer from the options given below :

(A) (b) and (c) only

(B) (a), (b) and (c)

(C) (a) and (b) only

(D) (a) and (c) only

Correct Answer: (C) (a) and (b) only

Solution:

Concept:

- **Unidirectional Energy Flow:** Energy captured from the sun by producers travels linearly through successive trophic levels. It cannot travel back to previous levels.
- **Pyramid of Energy:** It is universally upright because energy is lost as heat at each trophic level. It can never be inverted.
- **10% Law of Energy (Lindeman):** Only about 10% of the organic energy from one trophic level is stored and passed on to the next.

Step 1: Examine the validity of each statement

Statement (a) is correct: Energy flows in a single direction, from autotrophs to herbivores and then to carnivores.

Statement (b) is correct: The pyramid of energy is always upright because metabolic heat loss at each transfer prevents higher levels from containing more energy.

Statement (c) is incorrect: Energy transfer between successive trophic levels follows the **10% law**, not the 1% law. (The 1% value is the efficiency with which plants convert solar energy into chemical energy during photosynthesis).

Step 2: Identify the correct option

Since only (a) and (b) are correct, option (3) is the correct choice.

Quick Tip:

Pyramids of biomass and numbers can occasionally be inverted (e.g., in deep marine ecosystems or a single-tree ecosystem).

However, the pyramid of energy is strictly upright in all ecosystems due to the laws of thermodynamics.

---

177. Match List-I with List-II.

List-I	List-II
A. Excess growth hormone	I. Reabsorption of water and electrolytes in kidney
B. Luteinizing hormone	II. Contraction of uterus during child birth
C. Vasopressin	III. Acromegaly
D. Oxytocin	IV. Ovulation

Choose the correct answer from the options given below :

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

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

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

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

Correct Answer: (C) A-III, B-IV, C-I, D-II

Solution:

Concept:

- **Growth Hormone (GH):** Hypersecretion of GH in adults causes **Acromegaly**, characterized by the disproportional enlargement of bones in the face, hands, and feet.
- **Luteinizing Hormone (LH):** A pituitary gonadotropin that stimulates follicle maturation and triggers **ovulation** of the mature Graafian follicle.
- **Vasopressin (Antidiuretic Hormone - ADH):** Enhances water and electrolyte permeability in the distal tubules and collecting ducts of **kidneys**, facilitating reabsorption.
- **Oxytocin:** Acts on smooth muscle tissues, causing strong **uterine contractions** during childbirth (parturition).

Step 1: Match hormone items between List-I and List-II

A. Excess growth hormone → **III. Acromegaly**

B. Luteinizing hormone → **IV. Ovulation**

C. Vasopressin → **I. Reabsorption of water and electrolytes in kidney**

D. Oxytocin → **II. Contraction of uterus during child birth**

Step 2: Select the corresponding correct option

The matching sequence is A-III, B-IV, C-I, D-II, which corresponds to option (3).

Quick Tip:

Acromegaly is hard to diagnose in its early stages because the anatomical changes occur very slowly over time.

Oxytocin acts on a positive feedback loop during labor, increasing contraction intensity as labor progresses.

---

178. Which of the following are secondary lymphoid organs?

(a) Bone marrow

(b) Tonsils

(c) Spleen

(d) Thymus

Choose the correct answer from the options given below :

(A) (a) and (d) only

(B) (a) and (b) only

(C) (b) and (c) only

(D) (b) and (d) only

Correct Answer: (C) (b) and (c) only

Solution:

Concept:

- Lymphoid organs are classified into two main types depending on their role in the immune system:
  - **Primary Lymphoid Organs:** Tissues where immature lymphocytes differentiate and mature into antigen-sensitive cells. These are **Bone marrow** and the **Thymus**.
  - **Secondary Lymphoid Organs:** Tissues where mature lymphocytes travel to interact with specific foreign antigens and multiply. These include the **Spleen**, lymph nodes, **tonsils**, Peyer's patches, and appendix.

Step 1: Classify each of the listed lymphoid organs

(a) Bone marrow → Primary lymphoid organ

(b) Tonsils → Secondary lymphoid organ

(c) Spleen → Secondary lymphoid organ

(d) Thymus → Primary lymphoid organ

Step 2: Identify the secondary organs and choose the option

The secondary lymphoid organs are (b) and (c), which is represented by option (3).

Quick Tip:

Bone marrow is the principal site of lymphocyte production, where both B and T cell precursors are generated.

The spleen acts as a main biological filter, trapping blood-borne microorganisms and worn-out erythrocytes.

---

179. During PCR, primers bind to the DNA strands in the _____ step.

(A) ligation

(B) denaturation

(C) extension

(D) annealing

Correct Answer: (D) annealing

Solution:

Concept:

- **Polymerase Chain Reaction (PCR):** An enzymatic, in-vitro technique used to amplify a specific target sequence of DNA into millions of copies.
- A single cycle of PCR involves three distinct temperature-dependent steps:
  - **Denaturation:** The double-stranded template DNA is heated (typically to 94−96°C) to disrupt hydrogen bonds, separating the DNA into single strands.
  - **Annealing:** The temperature is lowered (typically to 50 − 65°C) to allow synthetic oligonucleotide primers to bind (hybridize) to their complementary sequences on the single-stranded template DNA.
  - **Extension:** The temperature is adjusted (typically to 72°C) to allow a thermostable DNA polymerase (such as *Taq* polymerase) to extend the primers by adding complementary deoxynucleotide triphosphates (dNTPs).
- **Ligation:** This is a distinct process of joining DNA fragments catalyzed by DNA ligase, which is not a part of the standard PCR cycle.

Step 1: Analyze the biochemical requirements for primer binding

Primers are short, single-stranded sequences of nucleic acids that serve as starting points for

DNA synthesis. For primers to bind to the template, the double-stranded genomic DNA must first be separated into single strands via heat. Once separated, the temperature of the reaction mixture must be lowered to a point where stable hydrogen bonds can reform specifically between the primers and their complementary regions on the template strands.

Step 2: Evaluate the options against the steps of a PCR cycle

- **(A) Ligation:** This is a cloning step used to seal nicks in the sugar-phosphate backbone, not a component of the standard PCR amplification cycle.
- **(B) Denaturation:** At this high-temperature stage ($\sim 94^\circ$C), single-stranded DNA templates are generated, but the high kinetic energy prevents primers from annealing.
- **(C) Extension:** During this step ($\sim 72^\circ$C), DNA polymerase actively synthesizes the new strand starting from the 3'-hydroxyl end of the already-bound primers.
- **(D) Annealing:** This is the intermediate temperature stage ($\sim 50-60^\circ$C) where the thermal conditions favor the hybridization (binding) of primers to the template DNA.

Step 3: Formulate the final conclusion

The binding of synthetic primers to single-stranded template DNA occurs specifically during the annealing phase. This corresponds to option (D).

Quick Tip:

- **Primer Design:** Primers are designed in pairs (forward and reverse) to flank the region of interest. They are oriented such that DNA synthesis proceeds inward across the target sequence.
- **Thermostability:** *Taq* polymerase is isolated from the hot-spring bacterium *Thermus aquaticus*. This enzyme can withstand the repeated high-temperature denaturation steps without denaturing itself, which is essential for automating the PCR cycle.

180. Given below are two statements:

Statement I: Down's syndrome is caused by the absence of one of the X-chromosomes.

Statement II: Turner's syndrome is caused by the presence of an additional copy of the chromosomes.

In the light of the above statements, choose the correct answer from the options given below:

(A) Statement I is incorrect but Statement II is correct

(B) Both Statement I and Statement II are correct

(C) Both Statement I and Statement II are incorrect

(D) Statement I is correct but Statement II is incorrect

Correct Answer: (C) Both Statement I and Statement II are incorrect

Solution:

Concept:

- Aneuploid disorders are caused by the gain or loss of specific chromosomes due to non-disjunction during cell division.
- **Down's Syndrome:** Caused by the presence of an extra copy of autosome 21 (Trisomy 21). It is an autosomal disorder and does not involve sex chromosomes.
- **Turner's Syndrome:** Caused by the absence of one of the sex chromosomes (X chromosome) in females, leading to an XO karyotype with 45 total chromosomes.

Step 1: Evaluate Statement I

Statement I is incorrect: Down's syndrome involves an additional copy of chromosome 21, not the loss of an X chromosome.

Step 2: Evaluate Statement II

Statement II is incorrect: Turner's syndrome is caused by the absence of a chromosome (monosomy XO), not by an additional copy of a chromosome.

Step 3: Select the corresponding option

Since both Statement I and Statement II are incorrect, option (3) is the correct choice.

Quick Tip:

Down's syndrome results in a total of 47 chromosomes due to autosomal trisomy.

Turner's syndrome results in a total of 45 chromosomes due to sex chromosome monosomy.

Klinefelter's syndrome is another key sex-chromosome aneuploidy, involving an extra X chromosome (XXY, 47 chromosomes).

