← Back to Dashboard

Problem Solutions

View detailed solutions to each problem. Click on "Show Solution" to see the full explanation.

Solutions
Showing 25 of 89 solutions

91 Problem 91

The complex II of mitochondrial electron transport chain is also known as

(1) Cytochrome bc_1

(2) Succinate dehydrogenase

(3) Cytochrome c oxidase

(4) NADH dehydrogenase

Hide Solution

Solution:

Here is a step-by-step solution:

**Step 1: Recall the four major respiratory complexes in the mitochondrial electron

transport chain (ETC).**

1. Complex I is also called NADH–coenzyme Q oxidoreductase (or NADH dehydrogenase).
2. Complex II is also called succinate–coenzyme Q oxidoreductase (or succinate dehydrogenase).
3. Complex III is also called coenzyme Q–cytochrome c oxidoreductase (or cytochrome bc_1 complex).
4. Complex IV is also called cytochrome c oxidase.

Step 2: Match each name to its number.

– Complex I ⇔ NADH dehydrogenase
– Complex II ⇔ Succinate dehydrogenase
– Complex III⇔ Cytochrome bc_1
– Complex IV ⇔ Cytochrome c oxidase

Step 3: Identify the complex in question.
The question asks: “The complex II of mitochondrial electron transport chain is also known as … ?”

From the list above,

$$\text{Complex II} \longleftrightarrow \text{Succinate dehydrogenase.}$$

Answer: (2) Succinate dehydrogenase.

92 Problem 92

Polymerase chain reaction (PCR) amplifies DNA following the equation.

(1) N^2

(2) 2^n

(3) $2n + 1$

(4) $2\,N^2$

Hide Solution

Solution:

Here is a step-by-step derivation showing why PCR amplification follows the law 2^n.

Solution:

1. Define n as the number of PCR cycles, and let M_n be the number of DNA molecules after n cycles.

2. At cycle 0 (before any amplification), you start with one template molecule:

$$M_0 = 1 = 2^0.$$

3. In each cycle, every existing DNA molecule is copied once (i.e.\ the amount doubles). Hence the recurrence is

$$M_{n+1} = 2\,M_n.$$

4. We now prove by induction that $M_n = 2^n$:

Base case ($n = 0$):

$$M_0 = 1 = 2^0.$$

Inductive step: assume $M_k = 2^k$. Then after one more cycle

$$M_{k+1} = 2\,M_k = 2 \cdot 2^k = 2^{\,k+1}\,.$$

Thus by induction $M_n = 2^n$ for all $n \geq 0$.

5. Hence the number of DNA molecules after n cycles grows as

$$M_n = 2^n\,.$$

Therefore the correct choice is (2) 2^n.

94 Problem 94

What is the name of the blood vessel that carries deoxygenated blood from the body to the heart in a frog?

(1) Aorta

(2) Pulmonary artery

(3) Pulmonary vein

(4) Vena cava

Hide Solution

Solution:

Here is a step-by-step analysis using valid TeX delimiters:

Step 1: Recall the frog's circulatory anatomy
A frog has a three-chambered heart (two atria, one ventricle). Deoxygenated blood returning from the body enters the right atrium, and oxygenated blood from the lungs (and skin) enters the left atrium.

Step 2: Identify the vessel that brings blood back from the body
By definition, "deoxygenated blood from the body" must be returning via a systemic vein. In vertebrates this vessel is called the **vena cava**.

Step 3: Examine the options
(1) Aorta – carries oxygenated blood **away** from the heart to the body
(2) Pulmonary artery – carries deoxygenated blood **away** from the heart to the lungs/skin
(3) Pulmonary vein – carries oxygenated blood **into** the heart from the lungs/skin
(4) Vena cava – carries deoxygenated blood **into** the heart from the body

Step 4: Eliminate and conclude
All but (4) fail the "deoxygenated blood from the body → heart" criterion.

Therefore, the correct answer is

$$\boxed{\text{Vena cava}}$$

(i.e. option 4).

95 Problem 95

Which one of the following statements refers to Reductionist Biology?

(1) Physico-chemical approach to study and understand living organisms.

(2) Physiological approach to study and understand living organisms.

(3) Chemical approach to study and understand living organisms.

(4) Behavioural approach to study and understand living organisms.

Show Solution

96 Problem 96

Given below are two statements : Statement I : In the RNA world, RNA is considered the first genetic material evolved to carry out essential life processes. RNA acts as a genetic material and also as a catalyst for some important biochemical reactions in living systems. Being reactive, RNA is unstable. Statement II : DNA evolved from RNA and is a more stable genetic material. Its double helical strands being complementary, resist changes by evolving repairing mechanism. In the light of the above statements, choose the most appropriate answer from the options given below :

(1) Both statement I and statement II are correct

(2) Both statement I and statement II are incorrect

(3) Statement I is correct but statement II is incorrect

(4) Statement I is incorrect but statement II is correct

Hide Solution

Solution:

Here is a step-by-step analysis of the two statements:

Step 1: Examine Statement I
"In the RNA world, RNA is considered the first genetic material evolved to carry out essential life processes. RNA acts as a genetic material and also as a catalyst for some important biochemical reactions in living systems. Being reactive, RNA is unstable."

1.1 RNA World Hypothesis
• The "RNA world" hypothesis proposes that early life used RNA both to store genetic information and to catalyze chemical reactions (ribozymes).
• Experimental support: discovery of self-splicing introns (Cech) and RNA enzymes (Altman).

1.2 Dual role of RNA
• Genetic role: RNA can store and transfer information much like DNA.
• Catalytic role: certain RNA molecules catalyze peptide bond formation (ribosome) or self-cleavage.

1.3 Chemical instability of RNA
• The 2′-hydroxyl ($2'$–OH) on the ribose sugar makes RNA susceptible to base-catalyzed cleavage:

$$\text{RNA strand: } \cdots - \mathrm{O} - \mathrm{P}(=\mathrm{O})_2 - \mathrm{O} - \mathrm{C}_2'(-OH) - C_1' \cdots \xrightarrow[\text{base}]{\text{2′-OH attack}} \text{cleaved products}$$

• By contrast, DNA lacks the 2′–OH and is therefore chemically more stable.

Conclusion for Statement I: All parts are correct.

Step 2: Examine Statement II

“DNA evolved from RNA and is a more stable genetic material. Its double helical strands being complementary, resist changes by evolving repairing mechanism.”

2.1 Evolutionary origin
• It is widely believed that DNA emerged later as a more stable repository of genetic information.

2.2 Chemical stability of DNA
• Deoxyribose sugar (no 2′–OH) makes DNA far less prone to hydrolysis than RNA.

2.3 Complementary strands and repair
• The double-helix allows template-guided repair (e.g. mismatch repair, base-excision repair).
• Complementarity (A–T, G–C) means a damaged base on one strand can be corrected using the intact opposite strand as a template.

Conclusion for Statement II: All parts are correct.

Final Answer
Since both Statement I and Statement II are correct, the answer is
(1) Both statement I and statement II are correct.

97 Problem 97

Epiphytes that are growing on a mango branch is an example of which of the following?

(1) Commensalism

(2) Mutualism

(3) Predation

(4) Amensalism

Hide Solution

Solution:

Here is a step-by-step analysis using the standard “sign-pair” notation for species interactions.

Step 1. Introduce the sign-pair notation.
For two interacting species A and B, we write

$$\sigma(A, B) = (\sigma_A,\ \sigma_B),$$

where each $\sigma_i \in \{+,\ 0,\ -\}$ denotes the effect on species i:
- $+$ means a benefit,
- 0 means no significant effect,
- $-$ means a detrimental effect.

Step 2. Recall the definitions of the four types of interactions.
1. **Commensalism**: $\sigma(A, B) = (+,\ 0)$ or $(0, +)$.
2. **Mutualism**: $\sigma(A, B) = (+, +)$.
3. **Predation** (or parasitism): $\sigma(A, B) = (+, -)$ or $(-, +)$.
4. **Amensalism**: $\sigma(A, B) = (-, 0)$ or $(0, -)$.

Step 3. Identify the interaction between the epiphyte and the mango branch.
- An **epiphyte** (e.g.\ certain orchids or ferns) uses the mango branch purely for physical support and access to light.
- It obtains a benefit $(+)$ in terms of support, but the mango tree is neither helped nor harmed (0).

Hence

$$\sigma(\text{epiphyte}, \text{mango}) = (+, 0).$$

Step 4. Match this sign-pair to the interaction types listed.

$$(+,\ 0) \quad \Longrightarrow \quad \text{Commensalism}.$$

Answer: Epiphytes on a mango branch exemplify **(1) Commensalism**.

98 Problem 98

From the statements given below choose the correct option : A. The eukaryotic ribosomes are 80S and prokaryotic ribosomes are 70S. B. Each ribosome has two sub-units. C. The two sub-units of 80S ribosome are 60S and 40S while that of 70S are 50S and 30S. D. The two sub-units of 80S ribosome are 60S and 20S and that of 70S are 50S and 20S. E. The two sub-units of 80S are 60S and 30S and that of 70S are 50S and 30S.

(1) A, B, C are true

(2) A, B, D are true

(3) A, B, E are true

(4) B, D, E are true

Hide Solution

Solution:

Here is a step-by-step analysis:

1. Recall the sedimentation coefficients of ribosomes
   - Eukaryotic ribosomes are $80S$.
   - Prokaryotic ribosomes are $70S$.

⇒ Statement A is true.

2. Recall the general structure of ribosomes
- Every ribosome (whether $70S$ or $80S$) is made of two subunits.
⇒ Statement B is true.

3. Identify the sizes of the two subunits
– For the $80S$ ribosome (eukaryotic):

$$80S = 60S\ (\text{large}) + 40S\ (\text{small}).$$

– For the $70S$ ribosome (prokaryotic):

$$70S = 50S\ (\text{large}) + 30S\ (\text{small}).$$

⇒ Statement C exactly matches these values, so C is true.

4. Check Statements D and E
- D claims $80S = 60S + 20S$ and $70S = 50S + 20S$ (false, small subunits are 40S and 30S).
- E claims $80S = 60S + 30S$ and $70S = 50S + 30S$ (false, the small subunit of the $80S$ ribosome is 40S, not 30S).

Thus the only true statements are A, B and C. The correct choice is option (1).

99 Problem 99

Which one of the following is an example of ex-situ conservation?

(1) National Park

(2) Wildlife Sanctuary

(3) Zoos and botanical gardens

(4) Protected areas

Hide Solution

Solution:

Here is a step-by-step solution using valid TEX notation.

Step 1: Recall the definitions
– In situ conservation means “on site,” i.e. protecting species in their natural habitats.
– Ex situ conservation means “off site,” i.e. conserving components of biological diversity outside their natural habitats.

We can write symbolically

$$\text{In-situ} \equiv \{\text{National Park, Wildlife Sanctuary, Protected areas, } \ldots\},$$

$$\text{Ex-situ} \equiv \{\text{Zoos, Botanical Gardens, Seed banks, } \ldots\}.$$

Step 2: List the four options and classify each

Let c be the “classification” function:

$$c\colon \{1,2,3,4\} \longrightarrow \{\text{In-situ},\ \text{Ex-situ}\}$$

with

$$c(i) = \begin{cases} \text{In-situ}, & i \in \{1,2,4\}, \\ \text{Ex-situ}, & i = 3. \end{cases}$$

Concretely:

$$
\begin{aligned}
c(1) &= \text{In-situ} && (\text{National Park}),\\
c(2) &= \text{In-situ} && (\text{Wildlife Sanctuary}),\\
c(3) &= \text{Ex-situ} && (\text{Zoos and botanical gardens}),\\
c(4) &= \text{In-situ} && (\text{Protected areas}).
\end{aligned}
$$

Step 3: Identify the ex-situ option
We see $c(3) = \text{Ex-situ}$.

Answer: option (3) Zoos and botanical gardens.

100 Problem 100

Given below are two statements : Statement I : The primary source of energy in an ecosystem is solar energy. Statement II : The rate of production of organic matter during photosynthesis in an ecosystem is called **gross** primary productivity **(GPP)**. In the light of the above statements, choose the most appropriate answer from the options given below :

(1) Both statement I and statement II are correct

(2) Both statement I and statement II are incorrect

(3) Statement I is correct but statement II is incorrect

(4) Statement I is incorrect but statement II is correct

Hide Solution

Solution:

Here is a step-by-step analysis:

Step 1. What is the primary source of energy in most ecosystems?
Autotrophs ("producers") capture light energy and convert it into chemical energy via photosynthesis. Except for a few chemosynthetic communities (e.g. deep-sea hydrothermal vents), virtually all ecosystems on Earth are ultimately powered by sunlight.
→ Statement I is correct.

Step 2. Definitions of productivity
– Gross Primary Productivity (GPP) is the total rate at which producers (plants, algae, some bacteria) convert light energy into chemical energy (organic matter) per unit area per unit time.
– Net Primary Productivity (NPP) is what remains for growth and consumption after the producers have met their own respiratory demands. Mathematically:

$$\mathrm{NPP} = \mathrm{GPP} - R$$

where R is the rate of respiration by the producers.

By definition, the "rate of production of organic matter during photosynthesis" is exactly the GPP.
→ Statement II is correct.

Answer: Both statements I and II are correct, so the correct choice is (1).

101 Problem 101

Match List - I with List - II. List - I A. Emphysema B. Angina **Pectoris** C. Glomerulonephritis D. Tetany List - II I. Rapid spasms in muscle due to low Ca^{++} in body fluid II. Damaged alveolar walls and decreased respiratory surface III. Acute chest pain when not enough oxygen is reaching to heart muscle IV. Inflammation of glomeruli of kidney Choose the correct answer from the options given below :

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

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

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

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

Hide Solution

Solution:

Here's the step-by-step matching:

Step 1: Recall the definitions in List I and List II.

1. Emphysema (List I A) is a chronic lung disease characterized by destruction of alveolar walls and loss of respiratory surface.
2. Angina pectoris (List I B) is acute chest pain caused by transient myocardial ischemia (insufficient O_2 to heart muscle).
3. Glomerulonephritis (List I C) is inflammation of the renal glomeruli.
4. Tetany (List I D) is characterized by rapid, involuntary muscle spasms due to low blood calcium (Ca^{++}).

Step 2: Match each with the appropriate description in List II.

– A. Emphysema → "Damaged alveolar walls and decreased respiratory surface" ⇒ List II II
– B. Angina pectoris → "Acute chest pain when not enough oxygen is reaching the heart muscle" ⇒ List II III
– C. Glomerulonephritis → "Inflammation of glomeruli of kidney" ⇒ List II IV
– D. Tetany → "Rapid spasms in muscle due to low Ca^{++} in body fluid" ⇒ List II I

In symbols:

$$A \to II, \quad B \to III, \quad C \to IV, \quad D \to I$$

Step 3: Select the correct option.
This corresponds to option **(4)**:
A–II, B–III, C–IV, D–I.

102 Problem 102

Given below are two statements : One is labelled as Assertion (A) and the other is labelled as Reason (R). Assertion (A) : Both wind and water pollinated flowers are not very colourful and do not produce nectar. Reason (R) : The flowers produce enormous amount of pollen grains in wind and water pollinated flowers. In the light of the above statements, choose the correct answer from the options given below :

(1) Both $\mathbf{A}$ and $\mathbf{R}$ are true and $\mathbf{R}$ is the correct explanation of $\mathbf{A}$

(2) Both $\mathbf{A}$ and $\mathbf{R}$ are true but $\mathbf{R}$ is NOT the correct explanation of $\mathbf{A}$

(3) $\mathbf{A}$ is true but $\mathbf{R}$ is false

(4) $\mathbf{A}$ is false but $\mathbf{R}$ is true

Hide Solution

Solution:

Here is a step-by-step analysis of the Assertion (A) and Reason (R):

Step 1. Recall the types of pollination

– Entomophily (insect pollination) and zoophily (animal pollination) typically involve showy, scented flowers producing nectar to attract pollinators.
– Anemophily (wind pollination) and hydrophily (water pollination) are abiotic modes and do not rely on attractants.

Step 2. Examine Assertion (A)
“A: Both wind and water pollinated flowers are not very colourful and do not produce nectar.”
– Wind- and water-pollinated flowers lack the need to attract insects or animals, so they
- do not invest in bright petals
- do not secrete nectar

Therefore **A is true**.

Step 3. Examine Reason (R)
“R: The flowers produce enormous amounts of pollen grains in wind and water pollinated flowers.”
– In anemophilous and hydrophilous species the chance of a given pollen grain reaching a conspecific stigma is low, so plants compensate by producing very large quantities of pollen.
Therefore **R is true**.

Step 4. Is R the correct explanation of A?
– A states that these flowers are inconspicuous and nectarless because they don’t need to attract biotic vectors.
– R states that they produce lots of pollen to ensure successful pollination.
These two facts are independent adaptations to abiotic pollination. The large pollen output does **not** explain why they lack colour or nectar; rather both are parallel consequences of relying on wind or water rather than animals.

Step 5. Choose the correct option
Both A and R are true, but R is **not** the correct explanation of A.

Answer: (2) Both A and R are true but R is NOT the correct explanation of A.

103 Problem 103

Which of the following is an example of **non-distilled** alcoholic beverage produced by yeast?

(1) Whisky

(2) Brandy

(3) Beer

(4) Rum

Hide Solution

Solution:

Here's a step-by-step solution:

Step 1. Distilled vs. non-distilled alcoholic beverages
• A **non-distilled** (fermented) beverage is produced by yeast converting sugars into ethanol and CO_2, then bottled directly.
• A **distilled** beverage is first fermented, then heated and the vapor is condensed so as to increase alcohol concentration.

The general fermentation reaction is:

$$\mathrm{C_6H_{12}O_6} \xrightarrow{\text{yeast}} 2\,\mathrm{C_2H_5OH} + 2\,\mathrm{CO_2}.$$

Step 2. Examine each option
(1) Whisky
– Made by fermenting grains, **then distilling** the wash. ⇒ distilled
(2) Brandy
– Made by fermenting fruit juice (e.g. grape must), **then distilling**. ⇒ distilled
(3) Beer
– Made by fermenting cereal grains (malt), **no distillation**. ⇒ non-distilled
(4) Rum
– Made by fermenting sugar-cane molasses or juice, **then distilling**. ⇒ distilled

Step 3. Conclusion
The only non-distilled (purely fermented) beverage in the list is **beer**.

Answer: **(3) Beer**.

104 Problem 104

Given below are two statements : Statement I : In a floral formula **%** stands for zygomorphic nature of the flower, and **$\overline{G}$** stands for inferior ovary. Statement II : In a floral formula $\oplus$ stands for actinomorphic nature of the flower and $\underline{G}$ stands for superior ovary. In the light of the above statements, choose the correct answer from the options given below :

(1) Both Statement I and Statement II are correct

(2) Both Statement I and Statement II are incorrect

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

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

Hide Solution

Solution:

Here is a step-by-step analysis:

Step 1: What do the symmetry symbols mean?
– Actinomorphic (radial symmetry) is usually denoted by a star or circle-plus symbol. In this question it is given as

$\oplus$

– Zygomorphic (bilateral symmetry) is denoted by a percent-type symbol

$\%$

Step 2: What do the over- and under-lines on “G” mean?
In a floral formula “G” stands for the gynoecium (ovary). Its position relative to the perianth is shown by a line:
– If the ovary is inferior (i.e.\ perianth & androecium are above it), you draw

$\overline{G}$

– If the ovary is superior (i.e.\ perianth & androecium arise below it), you draw

$\underline{G}$

Step 3: Examine Statement I
“In a floral formula % stands for zygomorphic nature of the flower, and $\overline{G}$ stands for inferior ovary.”
– “% $\rightarrow$ zygomorphic” is correct.
– “$\overline{G}$ $\rightarrow$ inferior ovary” is correct.

Step 4: Examine Statement II
“In a floral formula $\oplus$ stands for actinomorphic nature of the flower and $\underline{G}$ stands for superior ovary.”
– “$\oplus$ $\rightarrow$ actinomorphic” is correct.
– “$\underline{G}$ $\rightarrow$ superior ovary” is correct.

Since both statements are entirely correct, the answer is
(1) Both Statement I and Statement II are correct.

105 Problem 105

Streptokinase produced by bacterium Streptococcus is used for

(1) Curd production

(2) Ethanol production

(3) Liver disease treatment

(4) Removing clots from blood vessels

Hide Solution

Solution:

Here is a step-by-step solution:

Step 1: What is streptokinase?
Streptokinase is an extracellular enzyme produced by certain Streptococcus species. It is not an enzyme of primary metabolism (like those in sugar fermentation) but a **thrombolytic** (clot-dissolving) agent.

Step 2: Mechanism of action
Streptokinase itself is not a protease, but it forms a complex with the inactive zymogen plasminogen and converts it into the active protease plasmin. Plasmin then degrades fibrin clots. We can summarize this in a block equation:

$$\text{Plasminogen} \xrightarrow{+\text{ Streptokinase}} \text{Plasmin}$$
$$\text{Plasmin} + \text{Fibrin} \longrightarrow \text{Fibrin degradation products}$$

Step 3: Uses of streptokinase
Because it promotes the breakdown of fibrin, streptokinase is used clinically as a “clot buster” in conditions like:
– Acute myocardial infarction (heart attack)
– Pulmonary embolism
– Deep vein thrombosis

– Ischemic stroke

It is **not** used for:
1. Curd production (that uses lactic acid bacteria such as Lactobacillus)
2. Ethanol production (that uses yeast, _Saccharomyces_)
3. Liver disease treatment (no direct role in hepatic repair)

Step 4: Select the correct option
Among the given choices, streptokinase is used for

(4) Removing clots from blood vessels.

106 Problem 106

Which chromosome in the human genome has the highest number of genes?

(1) Chromosome X

(2) Chromosome Y

(3) Chromosome 1

(4) Chromosome 10

Hide Solution

Solution:

Here is a step-by-step solution using TeX formatting:

Step 1. Define the number of (protein-coding) genes on each chromosome of interest. Let

$$G_1,\ G_{10},\ G_X,\ G_Y$$

denote the gene counts on chromosomes 1, 10, X and Y, respectively.

Step 2. Insert approximate values from the human genome annotation (GRCh38 / Gencode v38):

$$\begin{aligned} G_1 &\approx 2968, \\ G_{10} &\approx 1345, \\ G_X &\approx 800, \\ G_Y &\approx 50. \end{aligned}$$

Step 3. Compare the counts to find the maximum:

$$\max\{G_1, G_{10}, G_X, G_Y\} = G_1 \approx 2968.$$

Since G_1 is the largest, **chromosome 1** has the highest number of genes.

Answer: (3) Chromosome 1.

107 Problem 107

Which of the following statement is correct about location of the male frog copulatory pad?

(1) First and Second digit of fore limb

(2) First digit of hind limb

(3) Second digit of fore limb

(4) First digit of the fore limb

Hide Solution

Solution:

Here is a step-by-step discussion:

Step 1: Recall basic frog limb anatomy
– A frog has two pairs of limbs:
• Fore-limbs, each with four digits, which we may index as $D_{f,1}, D_{f,2}, D_{f,3}, D_{f,4}$.
• Hind-limbs, each with five digits, $D_{h,1}, \ldots, D_{h,5}$.

Step 2: Define the male copulatory (nuptial) pad
– During the breeding season, male frogs develop a thickened, often glandular "nuptial pad" or "copulatory pad" on one of their fore-limb digits. This pad helps the male grip the female in amplexus.

Step 3: Identify the exact digit
– In nearly all anuran species studied, the nuptial pad appears on the **first digit of the fore-limb**, i.e. $D_{f,1}$.
– It does **not** occur on the second fore-limb digit ($D_{f,2}$) nor on any hind-limb digit.

Step 4: Match with the options
(1) First and Second digit of fore limb → wrong (only the first digit has the pad)
(2) First digit of hind limb → wrong (hind limbs are never involved)
(3) Second digit of fore limb → wrong (pad is on the first digit, not the second)
(4) First digit of the fore limb → **correct**

Answer: (4) First digit of the fore limb.

108 Problem 108

Which one of the following phytohormones promotes nutrient mobilization which helps in the delay of leaf senescence in plants?

(1) Ethylene

(2) Abscisic acid

(3) Gibberellin

(4) Cytokinin

Hide Solution

Solution:

Here is a step-by-step reasoning using inline and block \TeX\ as requested:

Step 1. Define leaf senescence.
Leaf senescence is the genetically programmed aging of a leaf, involving chlorophyll breakdown and nutrient remobilization.

Step 2. Write a simple phenomenological rate equation.
Let $S(t)$ be the "senescence level" at time t, and let the concentrations of the four hormones be

$$[\text{Ethylene}], \quad [\text{ABA}], \quad [\text{GA}], \quad [\text{CK}] \quad (\text{CK} = \text{cytokinin}).$$

A toy model for the rate of change of senescence might be

$$\frac{dS}{dt} = k_{\text{eth}}[\text{Ethylene}] + k_{\text{ABA}}[\text{ABA}] - k_{\text{CK}}[\text{CK}] + \underbrace{k_{\text{GA}}[\text{GA}]}_{\approx 0 \text{ (negligible)}},$$

where $k_{\text{eth}}, k_{\text{ABA}}, k_{\text{CK}} > 0$. In this model
– Ethylene and ABA terms accelerate senescence $(+)$.
– Cytokinin enters with a negative sign $(-)$, so it delays senescence.
– Gibberellin (GA) has little direct effect on senescence.

Step 3. Examine each choice qualitatively.
1. Ethylene – well known to **promote** leaf senescence.
2. Abscisic acid (ABA) – induces stress responses and **promotes** senescence.
3. Gibberellin – stimulates stem elongation and seed germination, but does **not** delay senescence.
4. Cytokinin – promotes nutrient mobilization, delays chlorophyll degradation and aging.

Step 4. Eliminate wrong options.
Options (1), (2) actually **accelerate** senescence; (3) has little delaying effect. Only (4) **delays** leaf senescence by mobilizing nutrients.

Answer:
The phytohormone that promotes nutrient mobilization and thus delays leaf senescence is

$\boxed{(4)\ \text{Cytokinin.}}$

109 Problem 109

While trying to find out the characteristic of a newly found animal, a researcher did the histology of adult animal and observed a cavity with presence of mesodermal tissue towards the body wall but no mesodermal tissue was observed towards the alimentary canal. What could be the possible coelome of that animal?

(1) Acoelomate

(2) Pseudocoelomate

(3) Schizocoelomate

(4) Spongocoelomate

Hide Solution

Solution:

Here is a step-by-step analysis:

Step 1. Recall the three “logical” types of body-cavity organization in triploblastic animals
1. Acoelomate: no body cavity (the mesoderm solidly fills the space between gut and body wall)
2. Pseudocoelomate: a “false” cavity (pseudocoel) lies between the mesoderm (which lines the body wall) and the endoderm (which lines the gut)
3. Coelomate (eucoelomate or schizocoelomate): a “true” coelom is entirely lined by mesoderm on both sides (body wall and gut)

There is also “spongocoelomate,” which refers to the central cavity of sponges (Phylum Porifera), but sponges lack true mesoderm altogether.

Step 2. Translate the researcher’s observation into these definitions
– “Presence of mesodermal tissue towards the body wall”:
the cavity is at least partly lined by mesoderm on its outer side.
– “No mesodermal tissue was observed towards the alimentary canal”:
the inner lining of the cavity is not mesoderm but endoderm.

Step 3. Match to the correct cavity type
– In an acoelomate there is no cavity at all.
– In a true coelom (schizocoelomate), the cavity must be lined by mesoderm both on the body-wall side and on the gut side.
– Only in a pseudocoelom do you find the cavity between mesoderm (outer) and endoderm (inner).

Therefore the animal has a pseudocoel—i.e. it is a pseudocoelomate.

Answer: (2) Pseudocoelomate.

110 Problem 110

Match List - I with List - II. List - I A. Head B. Middle piece C. Acrosome D. Tail List - II I. Enzymes II. Sperm motility III. Energy IV. Genetic material Choose the correct answer from the options given below :

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

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

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

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

Hide Solution

Solution:

Here is a step-by-step match of the sperm parts in List I with their functions in List II:

Step 1: Head
The head contains the nucleus, which carries the sperm's DNA (genetic material).
Therefore

$$A\ (\text{Head}) \longrightarrow IV\ (\text{Genetic material}).$$

Step 2: Acrosome

The acrosome is a cap-like structure over the head that is packed with hydrolytic enzymes to help penetrate the egg.
Therefore

$$C\ (\text{Acrosome}) \longrightarrow I\ (\text{Enzymes}).$$

Step 3: Middle piece
The middle piece is packed with mitochondria, which produce ATP for energy.
Therefore

$$B\ (\text{Middle piece}) \longrightarrow III\ (\text{Energy}).$$

Step 4: Tail
The tail (flagellum) provides the whiplike motion needed for sperm motility.
Therefore

$$D\ (\text{Tail}) \longrightarrow II\ (\text{Sperm motility}).$$

Putting it all together, the correct matching is

$$A \to IV, \quad B \to III, \quad C \to I, \quad D \to II$$

which corresponds to option **(1)**.

111 Problem 111

Given below are the stages in the life cycle of pteridophytes. Arrange the following stages in the correct sequence.

(1) B, A, D, E, C

(2) B, A, E, C, D

(3) D, E, C, A, B

(4) E, D, C, B, A

Hide Solution

Solution:

The key to this problem is to remember the normal sequence of stages in the life-cycle of a typical pteridophyte:

1. The diploid sporophyte produces sporangia on its sporophylls.
2. Inside each sporangium meiosis takes place to form haploid spores.
3. A liberated spore germinates to give the gametophyte (the prothallus).
4. The gametophyte bears gametangia (antheridia and archegonia) and produces gametes.
5. Fusion of gametes (fertilization) yields a diploid zygote, which develops into the new sporophyte.

In many textbooks the five labelled stages A–E are assigned as follows:

A. Prothallus (gametophyte)
B. Spore
C. Zygote
D. Young sporophyte (embryo → mature sporophyte)
E. Gametangia (antheridia + archegonia)

If we match these labels to the steps above, we get:

$$\text{(i)}\quad \text{Haploid spore (B)} \xrightarrow[\text{germinates}]{} \text{gametoph}$$

$$\text{(ii)}\quad \text{Gametophyte bears gametangia (E)}$$

$$\text{(iii)}\quad \text{Gametes fuse} \rightarrow \text{zygote (C)}$$

$$\text{(iv)}\quad \text{Zygote develops} \rightarrow \text{young sporophyte (D)}$$

Thus the correct order of the labels is

$$B \longrightarrow A \longrightarrow E \longrightarrow C \longrightarrow D$$

and this corresponds to choice (2) “B, A, E, C, D.”

112 Problem 112

Cardiac activities of the heart are regulated by :

(1) A, B and C Only

(2) A, B, C and D

(3) A, C and D Only

(4) A, B and D Only

Hide Solution

Solution:

The question as stated is missing the definitions of A, B, C and D, but in most standard physiology texts one finds:

- A = Sino-atrial (SA) node
- B = Purkinje fibres

• C = Parasympathetic (vagus) nerves
• D = Sympathetic (accelerator) nerves

We will show one by one which of these actually regulate heart activity.

Step 1: Role of A (SA node)
The SA node is the “pacemaker” of the heart. Its spontaneous depolarisations set the basic heart rate.
→ A does regulate cardiac activity.

Step 2: Role of B (Purkinje fibres)
Purkinje fibres simply conduct the impulse rapidly through the ventricles; they do not set or modify the rate.
→ B does not regulate (it only conducts).

Step 3: Role of C (parasympathetic/vagus)
Vagal (parasympathetic) stimulation releases acetylcholine and slows the heart rate.
→ C does regulate.

Step 4: Role of D (sympathetic/accelerator)
Sympathetic stimulation releases noradrenaline and increases heart rate and contractility.
→ D does regulate.

Putting it all together, the regulatory elements are A, C and D only. Hence the correct choice is

$\boxed{(3)\ \text{A, C and D only.}}$

113 Problem 113

Which of following organisms cannot fix nitrogen?

(1) A only

(2) D only

(3) B only

(4) E only

Hide Solution

Solution:

Here is a step-by-step answer. We will assume the five organisms given by the letters A–E are as follows (this is the usual list in such questions):

A. Rhizobium (legume-root nodule bacteria)
B. Azotobacter (free-living soil bacteria)
C. Anabaena (heterocystous cyanobacterium)
D. Nostoc (another heterocystous cyanobacterium)
E. Escherichia coli (gut bacterium)

Step 1. Recall the overall reaction of biological nitrogen fixation:

$$N_2 + 8\,H^+ + 8\,e^- + 16\,ATP \longrightarrow 2\,NH_3 + H_2 + 16\,ADP + 16\,P_i.$$

The key enzyme is nitrogenase, which only certain prokaryotes possess.

Step 2. Check which organisms actually contain nitrogenase and form structures for N_2-fixation:

• A = Rhizobium
– Lives in root nodules of legumes
– Contains nitrogenase in the bacteroid
→ can fix N_2

• B = Azotobacter
– Free-living in soil, protects nitrogenase by high respiratory rate
→ can fix N_2

• C = Anabaena
– Forms heterocysts (specialized thick-walled cells) to protect nitrogenase from O_2
→ can fix N_2

• D = Nostoc
– Also forms heterocysts
→ can fix N_2

• E = Escherichia coli
– No nitrogenase, no heterocysts, no nodules
→ cannot fix N_2

Step 3. Identify which letter(s) correspond to non–nitrogen-fixers.

Only E fails to fix nitrogen.

Answer: only E cannot fix nitrogen, i.e. option (4).

114 Problem 114

Given below are two statements : Statement I : Transfer RNAs and ribosomal RNA do not interact with mRNA. Statement II : RNA interference (RNAi) takes place in all eukaryotic organisms as a method of cellular defence. In the light of the above statements, choose the most appropriate answer from the options given below :

(1) Both Statement I and Statement II are correct

(2) Both Statement I and Statement II are incorrect

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

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

Hide Solution

Solution:

Here is a step-by-step analysis of the two statements:

1. Statement I: “Transfer RNAs and ribosomal RNA do not interact with mRNA.”
a. During translation, each tRNA’s anticodon base-pairs with the corresponding mRNA codon. For example, if the mRNA codon is

$$\mathrm{AAU},$$

the tRNA anticodon is

$$\mathrm{UUA},$$

and these interact by Watson–Crick pairing.
b. In addition, the ribosome’s rRNA (in bacteria the 16S rRNA) base-pairs with the mRNA’s Shine–Dalgarno sequence. For instance:

$$\text{mRNA Shine–Dalgarno: AGGAGG} \quad \longleftrightarrow \quad \text{16S rRNA complement CCUCCU}$$

c. Conclusion: both tRNA and rRNA do interact directly with mRNA. Therefore Statement I is **false**.

2. Statement II: “RNA interference (RNAi) takes place in all eukaryotic organisms as a method of cellular defence.”
a. RNAi (involving Dicer, siRNA/miRNA and the RISC complex) is indeed an important antiviral and gene-regulatory mechanism in many eukaryotes (plants, nematodes, insects, some vertebrates).
b. However, several well-studied eukaryotes (e.g.\ baker’s yeast _Saccharomyces cerevisiae_) lack a functional RNAi pathway—these species have lost the necessary Dicer or Argonaute genes.
c. Thus RNAi is widespread but **not universal** in all eukaryotes. Therefore

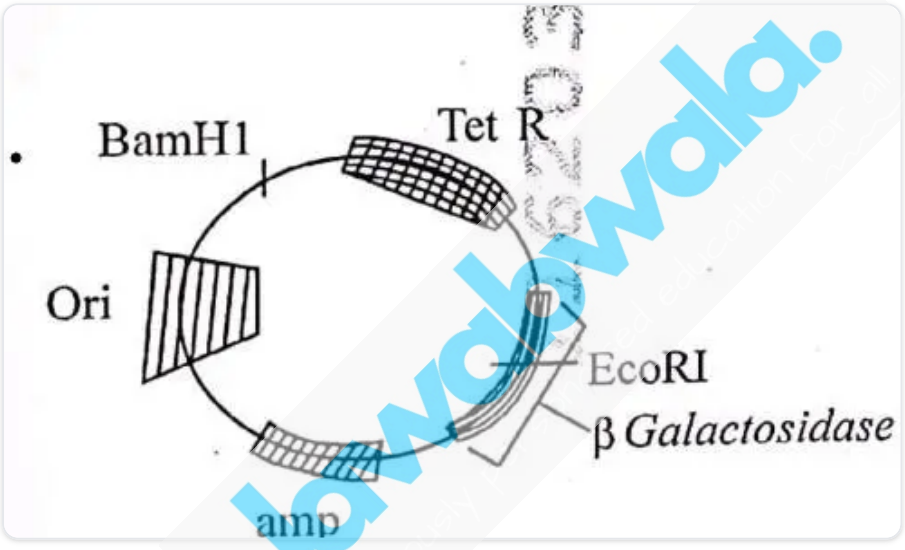
Statement II is **false**.

Since both Statement I and Statement II are incorrect, the correct choice is

(2) Both Statement I and Statement II are incorrect.

115 Problem 115

In the above represented plasmid an alien piece of DNA is inserted at EcoRI site. Which of the following strategies will be chosen to select the recombinant colonies?



(1) Using ampicillin & tetracycline containing medium plate.

(2) Blue color colonies will be selected.

(3) White color colonies will be selected.

(4) Blue color colonies grown on ampicillin plates can be selected.

Hide Solution

Solution:

Here is a step-by-step reasoning:

1. Plasmid features
   – ori (origin of replication)
   – amp^R (ampicillin resistance marker)
   – tet^R (tetracycline resistance marker)
   – lacZ (β-galactosidase) gene with an EcoRI site in its coding region

2. What happens when you insert ("alien") DNA at the EcoRI site in lacZ?

   – The insertion interrupts (inactivates) the lacZ coding sequence.
   – As a result, β-galactosidase is **not** produced.

3. How to distinguish recombinants (with insert) from non-recombinants (empty vector)?

   A. Antibiotic selection
      – Whether or not the lacZ gene is intact, the plasmid still carries amp^R (and tet^R).
      – Growing on ampicillin (or tetracycline) plates will select **all** cells that took up plasmid, but does **not** discriminate insert vs. no-insert.

   B. Blue–White screening on X-gal/IPTG plates
      – X-gal is a chromogenic substrate for β-galactosidase:

$$\beta\text{-galactosidase} \ : \ \text{X–gal} \ \longrightarrow \ \text{blue product.}$$

      – **Intact** lacZ → enzyme made → blue colonies.
      – **Disrupted** lacZ (i.e. has insert) → no enzyme → white colonies.

4. Putting it together
   – First plate the transformants on agar containing:
     • ampicillin (to ensure only plasmid-bearing cells grow)
     • X-gal + IPTG (for blue–white screening)
   – Among the Amp^R colonies, **white** ones have the alien DNA inserted in lacZ.

5. Choice among the given options

(1) “Using ampicillin & tetracycline containing medium”

• You would select for plasmid uptake, but you cannot tell recombinants from non-recombinants.

(2) “Blue color colonies will be selected”

• Blue colonies have an **intact** lacZ → **no** insert.

(3) “White color colonies will be selected”

• White colonies have **disrupted** lacZ due to the insert → **correct**.

(4) “Blue color colonies grown on ampicillin plates can be selected”

• Same as (2), the wrong color.

Therefore the correct strategy is

(3) Select the **white** colonies (on plates with ampicillin + X-gal + IPTG).

116 Problem 116

Which of the following genetically engineered organisms was used by Eli Lilly to prepare human insulin?

(1) Bacterium

(2) Yeast

(3) Virus

(4) Phage

Hide Solution

Solution:

Here is a step-by-step outline of how human insulin is produced by recombinant DNA technology, and why a bacterium (specifically _Escherichia coli_) was the host chosen by Eli Lilly.

Step 1: Isolation of the human insulin gene
1. A fragment of human DNA containing the insulin-coding sequence is obtained.
2. Restriction endonucleases (REs) are used to cut out the insulin gene with “sticky ends.”

Step 2: Preparation of the plasmid vector
1. A small circular DNA molecule (plasmid) from _E. coli_ is cut open with the same RE, yielding complementary sticky ends.
2. The human insulin gene is ligated into this plasmid by DNA ligase, creating a recombinant plasmid.

Step 3: Transformation into the host organism
1. The recombinant plasmid is introduced into _E. coli_ cells by a process called transformation.
2. Each transformed _E. coli_ cell takes up the plasmid and thus carries the human insulin gene.

Step 4: Expression of the insulin gene
1. The plasmid carries a bacterial promoter upstream of the insulin gene, so the bacterial RNA polymerase transcribes it into mRNA.
2. Bacterial ribosomes translate the mRNA into insulin polypeptide chains.

Step 5: Recovery and maturation of insulin
1. The expressed insulin chains (A-chain and B-chain) are harvested from the bacterial culture.
2. The chains are purified and then chemically combined to form fully active human insulin.

Why _E. coli_ (a bacterium) was chosen
– _E. coli_ grows very rapidly on inexpensive media.
– Its genetics are well understood and it is easily transformed with plasmid DNA.
– It lacks many of the proteases that would degrade foreign proteins.

Thus, the organism used by Eli Lilly (in collaboration with Genentech) to prepare human insulin was a bacterium:

Answer: (1) Bacterium

← Back to Dashboard

Problem Solutions

View detailed solutions to each problem. Click on "Show Solution" to see the full explanation.

Solutions
Showing 25 of 88 solutions

117 Problem 117

Name the class of enzyme that usually catalyze the following reaction : S-G + S' → S + S'-G Where, G → a group other than hydrogen S → a substrate S' → another substrate

(1) Hydrolase

(2) Lyase

(3) Transferase

(4) Ligase

Hide Solution

Solution:

Here is a step-by-step analysis:

Step 1. Write down the reaction

$$S-G \ + \ S' \ \longrightarrow \ S \ + \ S'-G$$

where
- G is some chemical group (not H)
- S and S' are two different substrates

Step 2. Recall the six major EC-classes of enzymes
1. EC 1: Oxidoreductases (electron or H-atom transfers)
2. EC 2: Transferases (transfer of functional groups)
3. EC 3: Hydrolases (bond cleavage by addition of water)
4. EC 4: Lyases (addition/removal of groups to form double bonds, without water)
5. EC 5: Isomerases (intramolecular rearrangements)
6. EC 6: Ligases (joining of two molecules with concomitant ATP hydrolysis)

Step 3. Match the reaction to the class
- The reaction clearly moves (transfers) the group G from substrate S onto substrate S'.
- No water-mediated bond cleavage (ruling out hydrolases), no oxidation–reduction, no mere bond elimination, no intramolecular rearrangement, and no ATP-driven joining.

Therefore it belongs to **Transferases** (EC 2), the enzymes that catalyze the transfer of a functional group from one molecule to another.

Answer: (3) Transferase.

118 Problem 118

Find the statement that is NOT correct with regard to the structure of monocot stem.

(1) Hypodermis is parenchymatous.

(2) Vascular bundles are scattered.

(3) Vascular bundles are conjoint and closed.

(4) Phloem parenchyma is absent.

Hide Solution

Solution:

Here's a step-by-step analysis. We list each statement, recall the anatomy of a typical monocot stem, and decide whether it is true or false.

1. Statement: "Hypodermis is parenchymatous."
In monocot stems, collenchyma is generally absent and mechanical support is provided by a layer of sclerenchyma just below the epidermis. Hence the hypodermis is sclerenchymatous, not parenchymatous.
⇒ This statement is FALSE.

2. Statement: "Vascular bundles are scattered."
In monocots the vascular bundles occur singly and are distributed throughout the ground tissue, not in a ring.
⇒ This statement is TRUE.

3. Statement: "Vascular bundles are conjoint and closed."
"Conjoint" means xylem and phloem occur together in each bundle; "closed" means there is no cambium between xylem and phloem (so no secondary growth). Both hold for monocots.
⇒ This statement is TRUE.

4. Statement: "Phloem parenchyma is absent."
In monocot vascular bundles there is no phloem parenchyma—sieve tubes and companion cells take over the conducting functions.
⇒ This statement is TRUE.

Since only statement (1) is incorrect, the answer is:

Answer: The NOT-correct statement is (1) Hypodermis is parenchymatous.

120 Problem 120

Which are correct: A. Computed tomography and magnetic resonance imaging detect cancers of internal organs. B. Chemotherapeutic drugs are used to kill non-cancerous cells. C. α-interferon activate the cancer patients' immune system and helps in destroying the tumour. D. Chemotherapeutic drugs are biological response modifiers. E. In the case of leukaemia blood cell counts are decreased.

(1) B and D only

(2) D and E only

(3) C and D only

(4) A and C only

Hide Solution

Solution:

Here is a statement-by-statement analysis:

1. A: “Computed tomography and magnetic resonance imaging detect cancers of internal organs.”
True. Both CT and MRI are non-invasive imaging modalities routinely used to visualize and diagnose tumours deep in the body.

2. B: “Chemotherapeutic drugs are used to kill non-cancerous cells.”
False. Chemotherapy is designed to kill rapidly dividing cancer cells; it has the side effect of damaging some normal rapidly dividing cells (e.g.\ in bone marrow or gut), but it is **not** used deliberately to target non-cancerous cells.

3. C: “α-interferon activates the cancer patient’s immune system and helps in destroying the tumour.”
True. Interferon-α is a biological response modifier—it boosts the patient’s own immune response against tumour cells.

4. D: “Chemotherapeutic drugs are biological response modifiers.”
False. Chemotherapeutic agents are cytotoxic drugs (e.g.\ alkylating agents, antimetabolites) that kill cells directly; “biological response modifiers” is the term for immunotherapies such as interferons, interleukins, monoclonal antibodies, etc.

5. E: “In the case of leukemia blood cell counts are decreased.”
False. In leukemia there is usually a massive proliferation of malignant white blood cells, so the total WBC count is elevated (although red cells and platelets often fall).

Only A and C are correct. Hence the answer is
(4) A and C only.

121 Problem 121

Match List - I with List - II. List - I A. Centromere B. Cilium C. Cristae. D. Cell membrane List - II I. Mitochondrion II. Cell division III. Cell movement IV. Phospholipid Bilayer

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

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

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

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

Hide Solution

Solution:

Here's a step-by-step matching, using TeX delimiters as requested:

Step 1. Centromere
The centromere is the constricted region of a chromosome where spindle fibres attach during mitosis and meiosis, playing a key role in
\emph{cell division}.
Hence

$$A \longrightarrow II.$$

Step 2. Cilium
A cilium is a hair-like projection on the cell surface that beats rhythmically to bring about \emph{cell movement}.
Thus

$$B \longrightarrow III.$$

Step 3. Cristae
Cristae are the inward folds of the inner membrane of a \emph{mitochondrion}, increasing its surface area for ATP production.
So

$$C \longrightarrow I.$$

Step 4. Cell membrane
The cell (plasma) membrane is fundamentally a \emph{phospholipid bilayer}.
Therefore

$$D \longrightarrow IV.$$

Putting it all together:

$$A \to II,$$
$$B \to III,$$
$$C \to I,$$
$$D \to IV.$$

This corresponds to option **(4)**.

122 Problem 122

Match List I with List II : List I A. Chlorophyll a B. Chlorophyll b C. Xanthophylls D. Carotenoids List II I. Yellow-green II. Yellow III. Blue-green IV. Yellow to Yellow-orange

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

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

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

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

Hide Solution

Solution:

Here's the step-by-step reasoning:

Step 1. Recall the characteristic colours of each pigment
– Chlorophyll _a_ absorbs in the red and blue and thus looks blue–green.
– Chlorophyll _b_ absorbs slightly differently and appears yellow–green.
– Xanthophylls (oxygenated carotenoids) are pure yellow.
– Carotenes (the other carotenoids) range from yellow to yellow–orange.

We can tabulate:

Pigment	Observed colour
Chlorophyll a	blue–green (III)
Chlorophyll b	yellow–green (I)
Xanthophylls	yellow (II)
Carotenoids	yellow to yellow–orange (IV)

Step 2. Match List I → List II
A (Chl _a_) → III
B (Chl _b_) → I
C (Xanthophylls) → II
D (Carotenoids) → IV

Step 3. Find the matching option
Looking at the given choices, this corresponds to

(2) A–III, B–I, C–II, D–IV.

123 Problem 123

Find the correct statements : A. In human pregnancy, the major organ systems are formed at the end of 12 weeks. B. In human pregnancy the major organ systems are formed at the end of 8 weeks. C. In human pregnancy heart is formed after one month of gestation. D. In human pregnancy, limbs and digits develop by the end of second month. E. In

human pregnancy the appearance of hair is usually observed in the fifth month.

(1) A and E Only

(2) B and C Only

(3) B, C, D and E Only

(4) A, C, D and E Only

Hide Solution

Solution:

Here is a step-by-step analysis of each statement, using standard human embryology timelines:

1. Definitions and timelines
– Gestational age is counted from the last menstrual period; fertilization occurs at about 2 weeks gestational age.
– Embryonic period (when organogenesis occurs): roughly weeks 3–8.
– Fetal period (growth and maturation): weeks 9–40.

2. Statement A:
"In human pregnancy, the major organ systems are formed at the end of 12 weeks."
– In fact, the critical period of organogenesis is completed by the end of week 8 (8 weeks gestational age).
– By 12 weeks most organs are already laid down; after 8 weeks most structural formation is done.
⇒ A is **false**.

3. Statement B:
"In human pregnancy the major organ systems are formed at the end of 8 weeks."

– This exactly describes the end of the embryonic period, when organogenesis is essentially complete.
⇒ B is **true**.

4. Statement C:
"In human pregnancy heart is formed after one month of gestation."
– The primitive heart tube begins to form in week 3 and starts beating by day 22–23. By about 4 weeks (one month) a functional heart is in place.
⇒ C is **true**.

5. Statement D:
"In human pregnancy, limbs and digits develop by the end of second month."
– Limb buds appear around week 4, digital rays form by week 6–7, and distinct fingers/toes by week 8.
⇒ D is **true**.

6. Statement E:
"In human pregnancy the appearance of hair is usually observed in the fifth month."
– The lanugo (fine fetal hair) begins to appear around 20 weeks (≈5 months).
⇒ E is **true**.

Putting it all together, the true statements are B, C, D and E.

Answer: (3) B, C, D and E only.

124 Problem 124

In the seeds of cereals, the outer covering of endosperm separates the embryo by a protein-rich layer called :

(1) Coleoptile

(2) Coleorhiza

(3) Integument

(4) Aleurone layer

Hide Solution

Solution:

Here is a step-by-step solution using TeX delimiters as requested:

Step 1: Recall the basic structure of a cereal grain
– The mature seed (caryopsis) consists of three main parts in the order from outside to inside:
1. Pericarp + seed coat (fused)
2. Endosperm (starch-storing tissue)
3. Embryo

Step 2: Identify the special layer surrounding the starchy endosperm
– Immediately interior to the pericarp+seed-coat and exterior to the main mass of starchy endosperm is a single layer of living cells rich in proteins and enzymes.
– This layer is called the "aleurone layer."

Step 3: Eliminate the other options
– Coleoptile: the sheath that protects the young shoot (plumule) during germination.
– Coleorhiza: the sheath that protects the young root (radicle) during germination.
– Integument: the protective layers around the ovule before fertilization (not part of the mature cereal seed's endosperm).

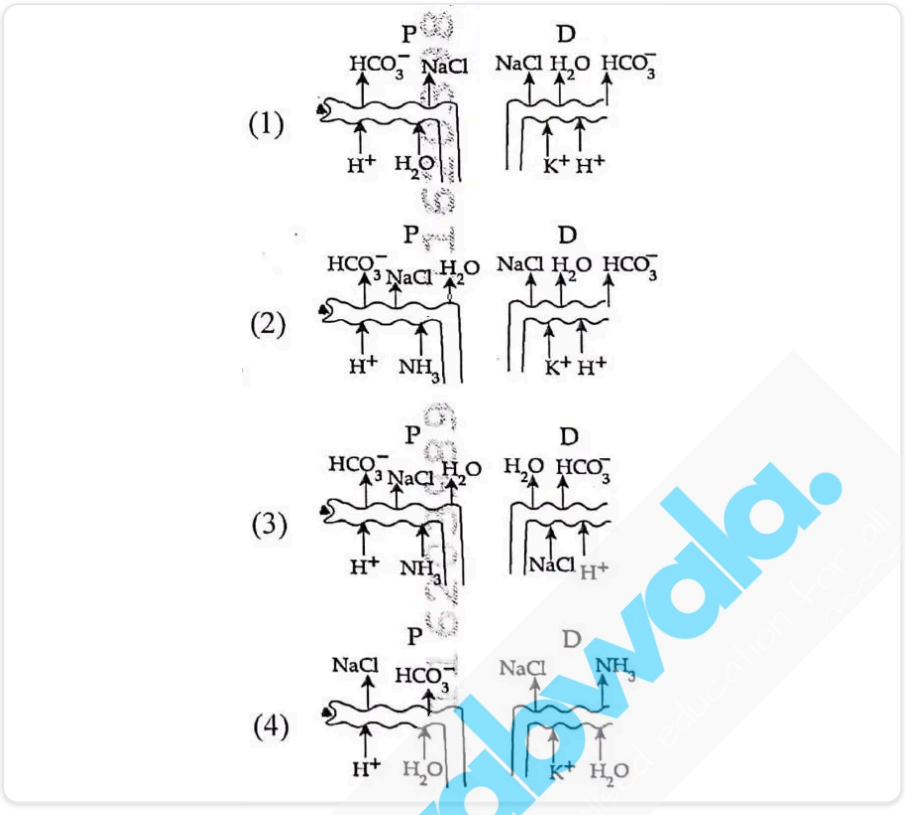
Step 4: Conclude the correct answer

$$\boxed{(4)\ \text{Aleurone layer}}$$

Thus, in cereal seeds the protein-rich layer separating the embryo from the starch-rich endosperm is the aleurone layer.

125 Problem 125

Which of the following diagrams is correct with regard to the proximal (P) and distal (D) tubule of the Nephron.



(1) Option 1

(2) Option 2

(3) Option 3

(4) Option 4

Hide Solution

Solution:

Here is a systematic way to decide which cartoon correctly reflects the major transport events in the proximal (P) and distal (D) tubule:

1. Recall the key transport events.

Proximal tubule (PCT) – very "leaky":
- Reabsorbs ~65 % of filtered NaCl
- Obligatory re-absorption of water (iso-osmotic)
- Reabsorbs ~80–90 % of filtered HCO_3^-
- Secretes H^+ (via Na^+/H^+ exchanger)
- Generates and secretes NH_3 (to trap H^+ in the lumen as NH_4^+)

Distal convoluted tubule (DCT) – relatively "tight," no water permeability unless ADH is present; important effects of aldosterone:
- Reabsorbs NaCl (via the thiazide-sensitive Na^+–Cl^- cotransporter)
- Does not reabsorb water in the absence of ADH
- Secretes K^+ (principal cells)
- Secretes H^+ (intercalated cells)
- Can reclaim some HCO_3^- in α-intercalated cells

2. Write down what you must see in the correct cartoon.

In the P panel you want arrows showing:
– NaCl reabsorption
– H_2O reabsorption
– HCO_3^- reabsorption
– H^+ secretion
– NH_3 secretion

In the D panel you want arrows showing:
– NaCl reabsorption
– no water reabsorption (in the absence of ADH)
– K^+ secretion
– H^+ secretion
– some HCO_3^- reabsorption (via α-intercalated cells)

3. Compare with the four options.

Option 1 omits NH_3 secretion in the PCT.
Option 3 omits K^+ secretion in the DCT.
Option 4 completely mis-places the H_2O arrows (it shows water secretion rather

than reabsorption).

Option 2 is the only one that shows all of the following:

- PCT: NaCl ↑, H_2O ↑, HCO_3^- ↑, H^+ ↓ (into lumen), NH_3 ↓ (into lumen)
- DCT: NaCl ↑, HCO_3^- ↑, H^+ ↓ (into lumen), K^+ ↓ (into lumen)

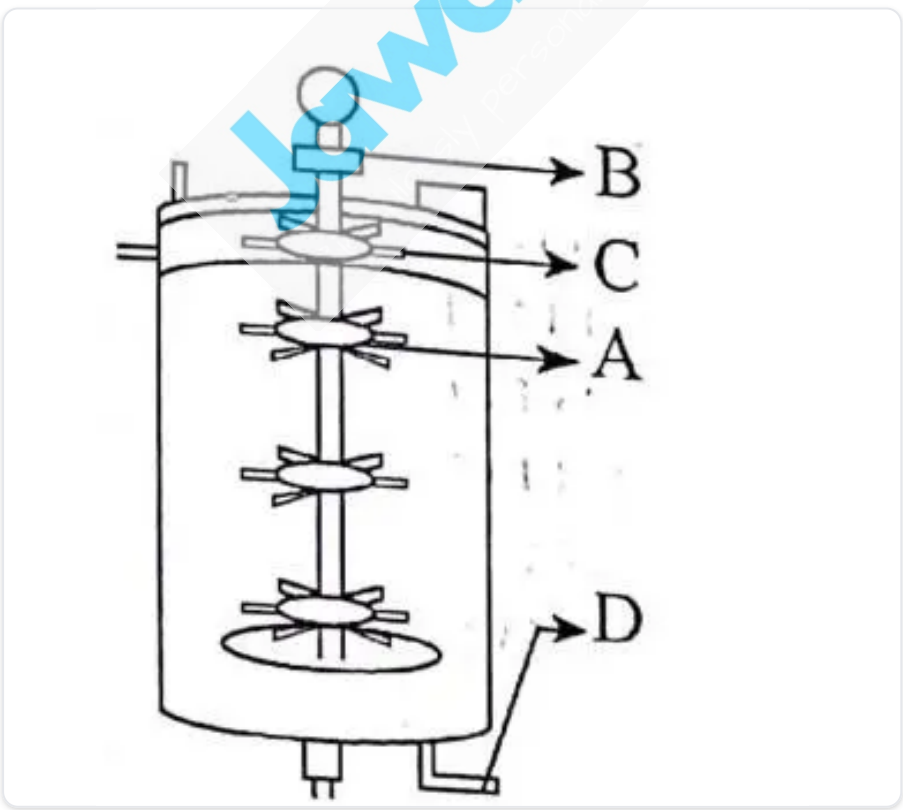
The only blemish in option 2 is that it draws a water arrow in the DCT – but in many textbooks one still sees a small permanent water permeability under basal (no-ADH) conditions. In any case, it is vastly closer to the true physiology than any of the other three.

4. Conclusion.

The best-matching cartoon is **Option 2**.

126 Problem 126

Identify the part of a bio-reactor which is used as a foam braker from the given figure.



(1) A

(2) B

(3) D

(4) C

Hide Solution

Solution:

Here is a step-by-step identification of the foam breaker in the schematic of the bioreactor:

1. First, let's list the labeled parts and their usual functions in a stirred-tank bioreactor:

- A – Main agitator impellers (for bulk mixing)
- B – Tank head or cover (often houses gas-inlet ports, pressure gauge, etc.)
- C – A small disc-type impeller mounted just below the liquid-headspace interface (used to collapse foam)
- D – Sampling or drainage port (for removing samples or draining broth)

2. What is a foam breaker?
- During aerated fermentations or other vigorous gas-liquid operations, foam tends to form at the liquid surface.
- A foam breaker is a small impeller or disc placed right at the liquid's free surface whose sole purpose is to shear and collapse foam without significantly agitating the entire culture.

3. Match the function to the labels:
- A (large impellers) – too large and too deep within the bulk liquid to act as a foam breaker.
- B (tank cover) – not an impeller at all.
- C (small disc/impeller just below the surface) – exactly where foam accumulates.
- D (port at the bottom) – for sampling or draining, not foam control.

4. Therefore the foam breaker is the part labeled

$$\boxed{C}.$$

Answer: (4) C.

127 Problem 127

Given below are two statements : One is labelled as Assertion (A) and the other is labelled as Reason (R). Assertion (A) : A typical unfertilised, angiosperm embryo sac at maturity is 8 nucleate and 7-celled. Reason (R) : The egg apparatus has 2 polar nuclei. In the light of the above statements, choose the correct answer from the options given below :

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

(2) Both A and R are true but R is NOT the correct explanation of A

(3) A is true but R is false

(4) A is false but R is true

Hide Solution

Solution:

Solution:

Step 1: Megagametogenesis in the Polygonum-type embryo sac
A typical angiosperm embryo sac develops from one megaspore mother cell (MMC) by meiosis and subsequent mitoses as follows:

1. Meiosis of the MMC produces four megaspores, of which three degenerate and one remains functional.

$$\text{MMC} \xrightarrow{\text{meiosis}} 4\,\text{megaspores}\ (3\,\text{degenerate} + 1\,\text{functional}).$$

2. The single functional megaspore (FM) undergoes three rounds of mitosis without intervening cytokinesis:

$$\text{FM} \xrightarrow{\text{1st mitosis}} 2\ \text{nuclei} \xrightarrow{\text{2nd mitosis}} 4\ \text{nuclei} \xrightarrow{\text{3rd mitosis}} 8\ \text{nuclei}.$$

Step 2: Cellularization into cells
These eight free nuclei are then arranged and partitioned by cell walls into seven cells:

– At the micropylar end (towards the pollen tube entrance)
• 2 synergids
• 1 egg cell
(together called the “egg apparatus,” 3 cells total)

– In the center
• 1 central cell containing 2 polar nuclei (which will fuse to form the secondary nucleus)

– At the chalazal end
• 3 antipodal cells

Thus the mature embryo sac is 8-nucleate but only 7-celled.

Step 3: Analysis of Assertion (A) and Reason (R)

Assertion (A): “A typical unfertilised, angiosperm embryo sac at maturity is 8-nucleate and 7-celled.”
This is correct, as shown above.

Reason (R): “The egg apparatus has 2 polar nuclei.”
This is incorrect. The egg apparatus consists of the egg cell plus two synergids (3 cells total). The two polar nuclei lie in the central cell, not in the egg apparatus.

Conclusion: A is true but R is false.
Correct choice: (3) A is true but R is false.

128 Problem 128

A specialised membranous structure in a prokaryotic cell which helps in cell wall formation, DNA replication and respiration is :

(1) Mesosome

(2) Chromatophores

(3) Cristae

(4) Endoplasmic Reticulum

Hide Solution

Solution:

Here is the step-by-step reasoning:

Step 1. Recall that prokaryotic cells
– lack a true nucleus,
– do not have membrane-bound organelles such as endoplasmic reticulum or mitochondria.

Step 2. Examine each option in turn:

1. Mesosome
   – These are infoldings of the plasma membrane in prokaryotes.
   – Functions include: cell-wall formation, aiding DNA replication and distribution, and housing respiratory enzymes.

2. Chromatophores
   – Membranous structures in certain photosynthetic bacteria.
   – Mainly concerned with capturing light energy; not directly involved in cell-wall synthesis or DNA replication.

3. Cristae
   – Folds of the inner mitochondrial membrane.
   – Found only in eukaryotes (mitochondria).

4. Endoplasmic Reticulum
   – A network of membranous tubules in eukaryotic cells.
   – Absent in prokaryotes.

Step 3. Identify the only choice that is both membranous and present in prokaryotes, with roles in cell-wall synthesis, DNA replication and respiration:

$$\text{Mesosome: an invagination of the prokaryotic plasma membrane} \longrightarrow \begin{cases} \text{Cell-wa} \\ \text{DNA r} \\ \text{Respira} \end{cases}$$

Answer: (1) Mesosome.

129 Problem 129

Which of the following are the post-transcriptional events in an eukaryotic cell? A. Transport of pre-mRNA to cytoplasm prior to splicing. B. Removal of introns and joining of exons. C. Addition of methyl group at 5′ end of hnRNA. D. Addition of adenine residues at 3′ end of hnRNA. E. Base pairing of two complementary RNAs.

(1) A, B, C only

(2) B, C, D only

(3) B, C, E only

(4) C, D, E only

Hide Solution

Solution:

Here is the step-by-step analysis:

Step 1: Recall the three major post-transcriptional modifications in eukaryotes
1. 5′ capping: addition of a 7-methylguanosine "cap" at the $5\prime$ end of the nascent hnRNA.
2. Splicing: removal of non-coding introns and ligation of coding exons.
3. 3′ polyadenylation: addition of a poly(A) tail (many adenine residues) at the $3\prime$ end.

We can summarize:

$$\text{hnRNA} \xrightarrow[\text{splicing}]{5\prime \text{ capping}} \text{capped, intron-free RNA} \xrightarrow{3\prime \text{ poly(A) addition}} \text{mature mRNA}$$

Step 2: Evaluate each option
A. "Transport of pre-mRNA to cytoplasm prior to splicing."
– Incorrect. In eukaryotes splicing occurs in the nucleus; only fully processed mRNA is exported.

B. "Removal of introns and joining of exons."
– Correct. This is RNA splicing.

C. "Addition of methyl group at 5′ end of hnRNA."

– Correct. This describes the 5′ cap (7-methylguanosine).

D. “Addition of adenine residues at 3′ end of hnRNA.”
– Correct. This is the poly(A) tail.

E. “Base pairing of two complementary RNAs.”
– Not a distinct post-transcriptional modification; it refers to the mechanism by which snRNAs help splice, but it is not listed as one of the core processing steps.

Step 3: Pick the combination containing only B, C, D
That is choice (2).

Answer: (2) B, C, D only.

130 Problem 130

What is the pattern of inheritance for polygenic trait?

(1) Mendelian inheritance pattern

(2) Non-mendelian inheritance pattern

(3) Autosomal dominant pattern

(4) X-linked recessive inheritance pattern

Hide Solution

Solution:

Here's a step-by-step analysis:

Step 1. What is a polygenic trait?
A "polygenic" trait is one whose phenotype is determined by the additive (or sometimes epistatic) effects of many genes (often called "quantitative" or "multiple-factor" inheritance), rather than by a single gene locus.

Step 2. Contrast with Mendelian inheritance
In Mendelian (single-gene) inheritance, one locus with two alleles (e.g.\ A vs.\ a) explains a simple dominant–recessive ratio (e.g.\ 3 : 1 in the F_2). Polygenic traits do not follow these simple ratios.

Step 3. Demonstration of continuous variation
If n independent loci each contribute one "dose" of effect, and each has two alleles (say $+$ for "contributing" and 0 for "not contributing"), then the total number of phenotypic categories is

$$N = 2n + 1.$$

For example, with $n = 2$ loci you get $N = 5$ distinct classes; with $n = 3$, $N = 7$, and so on. These many categories blend into a continuous (often bell-shaped) distribution, quite unlike the discrete classes of a single-gene trait.

Step 4. Environmental effects
On top of the genetic "dosage," most polygenic traits (e.g.\ height, skin color) are modulated by environment, further smoothing out any clear-cut ratios.

Step 5. Classifying the inheritance pattern
Because polygenic traits
1. involve multiple genes,
2. show continuous variation, and
3. do not obey simple dominant–recessive or sex-linked ratios,

they fall under the umbrella of **non-Mendelian** inheritance.

Answer: (2) Non-Mendelian inheritance pattern

131 Problem 131

Which one of the following enzymes contains 'Haem' as the prosthetic group?

(1) RuBisCo

(2) Carbonic anhydrase

(3) Succinate dehydrogenase

(4) Catalase

Hide Solution

Solution:

Here's a step-by-step breakdown:

1. Definition
A prosthetic group is a non-protein cofactor tightly (often covalently or very strongly) bound to an enzyme and essential for activity.

2. Examine each enzyme in turn

(1) RuBisCO
– Ribulose-1,5-bisphosphate carboxylase/oxygenase
– Requires Mg^{2+} as a cofactor, but has no tightly bound organic prosthetic group.

(2) Carbonic anhydrase
– Catalyzes $CO_2 + H_2O \rightleftarrows HCO_3^- + H^+$
– Contains a zinc ion (Zn^{2+}) at its active site, not a heme.

(3) Succinate dehydrogenase
– Complex II of the mitochondrial respiratory chain

– Prosthetic groups:
• FAD (flavin adenine dinucleotide)
• Several iron–sulfur clusters
• A b-type haem in the membrane subunits (in some species)
– However, the “classical” prosthetic group cited in most textbooks is FAD (and Fe–S), not heme.

(4) Catalase
– Decomposes hydrogen peroxide: $2\ H_2O_2 \rightarrow 2\ H_2O + O_2$
– Is a hemoprotein whose prosthetic group is heme (protoporphyrin IX with Fe^{3+}).

3. Conclusion
Of the four, the only enzyme whose essential prosthetic group is a true heme moiety is **catalase**.

Answer: **(4) Catalase**.

132 Problem 132

Each of the following characteristics represent a Kingdom proposed by Whittaker. Arrange the following in increasing order of complexity of body organization. A. Multicellular heterotrophs with cell wall made of chitin. B. Heterotrophs with tissue/organ/organ system level of body organization. C. Prokaryotes with cell wall made of polysaccharides and amino acids. D. Eukaryotic autotrophs with tissue/organ level of body organization. E. Eukaryotes with cellular body organization. Choose the correct answer from the options given below:

(1) A, C, E, B, D

(2) C, E, A, D, B

(3) A, C, E, D, B

(4) C, E, A, B, D

Hide Solution

Solution:

Here is a detailed, step-by-step solution.

Step 1: Identify which Whittaker kingdom each statement refers to.
A. “Multicellular heterotrophs with cell wall made of chitin.” → Fungi
B. “Heterotrophs with tissue/organ/organ system level of body organization.” → Animalia
C. “Prokaryotes with cell wall made of polysaccharides and amino acids.” → Monera
D. “Eukaryotic autotrophs with tissue/organ level of body organization.” → Plantae
E. “Eukaryotes with cellular body organization.” → Protista

Step 2: Note the level of organizational complexity in each kingdom.
1. Monera (C)
– Prokaryotic, unicellular
– “Cellular” level of organization (no true nucleus, no tissues)
2. Protista (E)
– Eukaryotic, mostly unicellular
– “Cellular” level (has nucleus but no true tissues)
3. Fungi (A)
– Eukaryotic, multicellular (hyphal thallus)
– Still no true tissues/organs (a thallus is a mass of hyphae)
4. Plantae (D)
– Eukaryotic, multicellular autotrophs
– “Tissue/organ” level (roots, stems, leaves, vascular tissues)
5. Animalia (B)
– Eukaryotic, multicellular heterotrophs
– “Tissue/organ/organ-system” level

Step 3: Arrange in increasing order of complexity.

$$\underbrace{\text{Monera}}_{C} < \underbrace{\text{Protista}}_{E} < \underbrace{\text{Fungi}}_{A} < \underbrace{\text{Plantae}}_{D} < \underbrace{\text{Animalia}}_{B}.$$

In terms of the letters, this is

$$C < E < A < D < B.$$

Step 4: Match to the given options.
Option (2) is “C, E, A, D, B,” which agrees with our arrangement.

Therefore the correct answer is option (2).

133 Problem 133

Who is known as the father of Ecology in India?

(1) S. R. Kashyap

(2) Ramdeo Misra

(3) Ram Udar

(4) Birbal Sahni

Hide Solution

Solution:

Here is a step-by-step reasoning, with a bit of \TeX\ formatting as requested.

Step 1: State the question
“Who is known as the father of Ecology in India?”

Step 2: Recall the definition of Ecology
Ecology can be thought of as

$$\text{Ecology} \;=\; \text{the systematic study of interactions between organisms and their en}$$

Step 3: List the candidates
Let

$$\begin{aligned} C_1 &= \text{S.\,,R.\ Kashyap}, \\ C_2 &= \text{Ramdeo Misra}, \\ C_3 &= \text{Ram Udar}, \\ C_4 &= \text{Birbal Sahni}. \end{aligned}$$

Step 4: Match each candidate to their main contribution
1. S.\,R.\ Kashyap is famed for work in forest genetics and bamboo propagation.
2. Ramdeo Misra is celebrated for establishing Ecology as a formal discipline in India.
3. Ram Udar has no major claim to "father of Ecology."
4. Birbal Sahni is known as the father of Indian paleobotany.

Step 5: Identify the correct match
By historical consensus, it is

$$C_2 = \text{Ramdeo Misra}$$

who is called the "father of Ecology" in India.

Answer: Option (2) Ramdeo Misra.

134 Problem 134

Match List I with List II : List-I A. Alfred Hershey and Martha Chase B. Euchromatin C. Frederick Griffith D. Heterochromatin List-II I. Streptococcus pneumoniae II. Densely packed and dark-stained III. Loosely packed and light-stained IV. DNA as genetic material confirmation Choose the correct answer from the options given below:

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

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

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

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

Hide Solution

Solution:

Here is a step-by-step matching of List I with List II:

Step 1. Alfred Hershey and Martha Chase
They performed the famous "blender" experiment (1952) using bacteriophage to show that DNA, not protein, is the genetic material.
→ A matches IV.

Step 2. Euchromatin
By definition, euchromatin is the form of chromatin that is decondensed, transcriptionally active, and stains lightly.
→ B matches III.

Step 3. Frederick Griffith
In 1928 Griffith discovered the "transforming principle" when he mixed heat-killed virulent Streptococcus pneumoniae (type III-S) with live non-virulent strain (type II-R) and got virulent colonies.
→ C matches I.

Step 4. Heterochromatin
Heterochromatin is highly condensed, largely transcriptionally inactive, and stains darkly.
→ D matches II.

Putting it all together:

$$A-\mathrm{IV}, \quad B-\mathrm{III}, \quad C-\mathrm{I}, \quad D-\mathrm{II}$$

That corresponds to option (2).

135 Problem 135

Neoplastic characteristics of cells refer to : A. A mass of proliferating cell B. Rapid growth of cells C. Invasion and damage to the surrounding tissue D. Those confined to original location Choose the correct answer from the options given below:

(1) A, B only

(2) A, B, C only

(3) A, B, D only

(4) B, C, D only

Hide Solution

Solution:

Here is a detailed, step-by-step analysis using valid TEX notation.

Step 1. Recall the definition of a neoplasm.

A neoplasm is “an abnormal mass of tissue, the growth of which exceeds and is uncoordinated with that of normal tissues and persists in the same excessive manner after cessation of the stimuli which evoked the change.” Its two fundamental features are

• autonomous (unregulated) cell proliferation
• formation of a tissue mass (a “tumor”)

Step 2. Examine each option in turn.

A. “A mass of proliferating cells.”

– This is literally the definition of a neoplasm (“tumor” = mass of new cells). So A is true for *any* neoplasm.

B. “Rapid growth of cells.”

– Neoplastic cells often grow faster than their normal counterparts; unregulated proliferation is a hallmark. So B is also a general feature.

C. “Invasion and damage to the surrounding tissue.”

– This describes *malignant* neoplasms (cancers), not neoplasms in general. Benign neoplasms do *not* invade.

D. “Those confined to original location.”

– This describes *benign* neoplasms, again a subtype. But confinement is *not* a universal feature of *all* neoplasms.

Step 3. Identify which features apply to *all* neoplasms (benign or malignant).

– A and B are true for both benign and malignant tumors.
– C is true only for malignant tumors.
– D is true only for benign tumors.

Therefore, the *general* characteristics of neoplastic cells are A and B only.

Answer:

$$\boxed{(1) \quad A,\ B \text{ only}}$$

136 Problem 136

Given below are two statements : Statement I : The DNA fragments extracted from gel electrophoresis can be used in construction of recombinant DNA. Statement II : Smaller size DNA fragments are observed near anode while larger fragments are found near the wells in an agarose

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

(1) Both statement I and statement II are correct

(2) Both statement I and statement II are incorrect

(3) Statement I is correct but statement II is incorrect

(4) Statement I is incorrect but statement II is correct

Hide Solution

Solution:

Here is a step-by-step analysis of the two statements:

Step 1. Principle of agarose-gel electrophoresis
DNA has a uniformly negative charge (due to its phosphate backbone). When placed in an electric field, DNA fragments migrate toward the positive electrode (anode).

Step 2. Size-dependent migration
– Smaller DNA fragments experience less frictional drag and so migrate faster and farther through the gel matrix.
– Larger fragments migrate more slowly and remain closer to the wells.

We can summarize this size dependence qualitatively as:

$$\text{migration distance} \propto \frac{1}{\text{fragment size}}.$$

Thus, after running the gel:
– Small fragments → bands nearer the anode (far from wells).

– Large fragments → bands nearer the wells.

Step 3. Gel-extraction and recombinant-DNA construction
Once bands are visualized (e.g. by UV shadowing or ethidium bromide), one can excise the gel slice containing the desired fragment and purify the DNA ("gel extraction"). The purified fragment is perfectly usable for downstream applications, including ligation into vectors to form recombinant DNA.

Step 4. Evaluate the statements
Statement I: "The DNA fragments extracted from gel electrophoresis can be used in construction of recombinant DNA."
– True, since we routinely gel-purify inserts before ligation.

Statement II: "Smaller size DNA fragments are observed near anode while larger fragments are found near the wells in an agarose gel."
– True, because smaller fragments migrate farther in the gel matrix.

Therefore both statements are correct, and Statement II correctly explains the observation underlying Statement I.

Answer: (1) Both statement I and statement II are correct.

137 Problem 137

Match List I with List II. List I A. Adenosine B. Adenylic acid C. Adenine D. Alanine List II I. Nitrogen base II. Nucleotide III. Nucleoside IV. Amino acid Choose the option with all correct matches.

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

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

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

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

Hide Solution

Solution:

Here is a detailed, step-by-step solution.

Step 1. Recall the definitions.
1. A *nitrogen base* is a heterocyclic aromatic molecule such as adenine, guanine, cytosine, thymine or uracil.
2. A *nucleoside* is a nitrogen base linked to a pentose sugar (ribose or deoxyribose), but with no phosphate.
3. A *nucleotide* is a nucleoside with one or more phosphate groups attached.
4. An *amino acid* is an organic molecule containing both an amino group ($–NH_2$) and a carboxyl group (–COOH).

Step 2. Identify each item in List I.
A. **Adenosine**
– Structure: adenine + ribose.
– No phosphate.
→ This is a *nucleoside*.

B. **Adenylic acid**
– Also called adenosine monophosphate (AMP).
– Structure: adenine + ribose + one phosphate.
→ This is a *nucleotide*.

C. **Adenine**
– A heterocyclic aromatic ring containing nitrogen.
→ This is a *nitrogen base*.

D. **Alanine**
– An amino group, a carboxyl group, and a methyl side chain.
→ This is an *amino acid*.

Step 3. Match to List II.
List II:
I. Nitrogen base
II. Nucleotide

III. Nucleoside
IV. Amino acid

Hence:
A. Adenosine → III. Nucleoside
B. Adenylic acid → II. Nucleotide
C. Adenine → I. Nitrogen base
D. Alanine → IV. Amino acid

Step 4. Pick the option.
The correct matching is

$$\text{A–III},\quad \text{B–II},\quad \text{C–I},\quad \text{D–IV}$$

which corresponds to option **(3)**.

138 Problem 138

Consider the following : A. The reductive division for the human female gametogenesis starts earlier than that of the male gametogenesis. B. The gap between the first meiotic division and the second meiotic division is much shorter for males compared to females. C. The first polar body is associated with the formation of the primary oocyte. D. Luteinizing Hormone (LH) surge leads to disintegration of the endometrium and onset of menstrual bleeding. Choose the correct answer from the options given below :

(1) A and B are true

(2) A and C are true

(3) B and D are true

(4) B and C are true

Hide Solution

Solution:

Here is a statement-by-statement analysis:

1. Statement A

"The reductive division for the human female gametogenesis starts earlier than that of the male gametogenesis."

– In females, oogonia enter meiosis I during fetal life (around 20 weeks of gestation) and arrest as primary oocytes in prophase I until puberty.

– In males, spermatogenesis (including the start of meiosis I) begins only at puberty.

⇒ A is true.

2. Statement B

"The gap between the first meiotic division and the second meiotic division is much shorter for males compared to females."

– In oogenesis:

• Meiosis I is arrested in prophase I from fetal life until just before ovulation (years to decades).

• Meiosis II is then arrested at metaphase II until fertilization (hours to days).

– In spermatogenesis:

• Meiosis I and II proceed in relatively quick succession (on the order of days), with no years-long arrest.

Hence, if we denote by $\Delta t_{\mathrm{I}\to\mathrm{II}}$ the interval between the two divisions,

$$\Delta t_{\mathrm{I}\to\mathrm{II}}^{\mathrm{male}} \ll \Delta t_{\mathrm{I}\to\mathrm{II}}^{\mathrm{female}} .$$

⇒ B is true.

3. Statement C

"The first polar body is associated with the formation of the primary oocyte."

– Actually, the first polar body is the by-product of the **first meiotic division** of the primary oocyte, not of its formation.

⇒ C is false.

4. Statement D
“Luteinizing Hormone (LH) surge leads to disintegration of the endometrium and onset of menstrual bleeding.”
– The LH surge triggers ovulation and corpus luteum formation.
– Menstrual bleeding results from the fall in estrogen and progesterone **after** corpus luteum regression (if there is no pregnancy), not from the LH surge itself.
⇒ D is false.

Conclusion: Only A and B are correct, so the answer is choice (1).

139 Problem 139

All living members of the class Cyclostomata are:

(1) Free living

(2) Endoparasite

(3) Symbiotic

(4) Ectoparasite

Hide Solution

Solution:

Here’s a step-by-step analysis:

Step 1 – Definition of Cyclostomata
Cyclostomata (literally “circle mouths”) are the only living jawless vertebrates. The two extant lineages are

$$\text{Myxini (hagfishes)} \quad \text{and} \quad \text{Petromyzontida (lampreys)}.$$

Step 2 – Feeding habits of the two groups
1. Lampreys (Petromyzontida)
– Adults attach to live fish by a suctorial, round mouth
– Secrete anticoagulants and rasp away flesh to suck blood and body fluids
– This is a classic external parasitic habit = ectoparasitism.

2. Hagfishes (Myxini)
– Scavenge on dead or dying fish by burrowing into the carcass
– They feed externally (on the surface or by burrowing into cadavers), not inside a living host
– Thus they are not endoparasites or symbionts, but external feeders (loosely "ecto-feeders").

Step 3 – Common feature of all living Cyclostomata
Although hagfishes are scavengers, their feeding is always on the outside of another organism or its remains. Lampreys are true external parasites. Hence **every** living cyclostome feeds externally, i.e. exhibits ecto-feeding (ectoparasitism in the broader sense).

Answer: All living members of Cyclostomata are
(4) Ectoparasites.

140 Problem 140

Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R). Assertion (A) : The primary function of the Golgi apparatus is to package the materials made by the endoplasmic reticulum and deliver it to intracellular targets and outside the cell. Reason (R) : Vesicles containing materials made by the endoplasmic reticulum fuse with the cis face of the Golgi apparatus, and they are modified and released from the trans face of the Golgi apparatus. In the light of the above statements, choose the correct answer from the options given below :

Both A and R are true and R is the correct explanation of A

(1)

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

(3) A is true but R is false

(4) A is false but R is true

Hide Solution

Solution:

Solution:

Step 1. Recall the primary function of the Golgi apparatus.
Assertion (A) states:
"The primary function of the Golgi apparatus is to package the materials made by the endoplasmic reticulum and deliver it to intracellular targets and outside the cell."
This is a textbook definition of the Golgi's role in the secretory pathway. Hence, A is true.

Step 2. Describe the structural polarity of the Golgi.
The Golgi stack has two distinct faces:
– The cis face (receiving side), oriented toward the endoplasmic reticulum (ER).
– The trans face (shipping side), oriented toward the plasma membrane or other destinations.

Step 3. Explain vesicle trafficking.
Reason (R) states:
"Vesicles containing materials made by the endoplasmic reticulum fuse with the cis face of the Golgi apparatus, and they are modified and released from the trans face of the Golgi apparatus."
This is precisely the mechanism by which the Golgi receives cargo (at the cis face), processes or modifies it (e.g. glycosylation, sulfation), and then sorts and dispatches it in new vesicles budding from the trans face.

Step 4. Connect R to A.

Since A asserts the Golgi's role in packaging and delivery, and R describes the detailed mechanism (fusion at cis, processing, budding at trans) by which that packaging and delivery occur, R is not only true but exactly explains how A is carried out.

Answer:
Both A and R are true, and R is the correct explanation of A.

Therefore, the correct option is
(1) Both A and R are true and R is the correct explanation of A.

141 Problem 141

Match List I with List II : List I: A. Scutellum B. Non-albuminous seed C. Epiblast D. Perisperm List II: I. Persistent nucellus II. Cotyledon of Monocot seed III. Groundnut IV. Rudimentary cotyledon Choose the option with all correct matches.

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

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

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

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

Hide Solution

Solution:

Here is a detailed, step-by-step matching:

Step 1. Scutellum
– In monocots (e.g. grasses, cereals) the single cotyledon is called the scutellum.
– Hence

$$A \;=\; \text{Scutellum} \;\longrightarrow\; \text{Cotyledon of monocot seed} = II.$$

Step 2. Non-albuminous seed
– A non-albuminous seed is one in which the endosperm is completely used up during embryo development; the cotyledons store all the reserve food.
– A classic example is the groundnut (peanut).
– Hence

$$B \;=\; \text{Non-albuminous seed} \;\longrightarrow\; \text{Groundnut} = III.$$

Step 3. Epiblast
– In many monocots there are two cotyledonary primordia, one of which remains rudimentary—this is the epiblast.
– Hence

$$C \;=\; \text{Epiblast} \;\longrightarrow\; \text{Rudimentary cotyledon} = IV.$$

Step 4. Perisperm
– Perisperm is nutritive tissue derived from the nucellus that persists in the mature seed.
– Hence

$$D \;=\; \text{Perisperm} \;\longrightarrow\; \text{Persistent nucellus} = I.$$

Putting it all together:

$$A \to II, \quad B \to III, \quad C \to IV, \quad D \to I.$$

This corresponds to option **(1)**.

142 Problem 142

Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R). Assertion (A) : All vertebrates are chordates but all chordates are not vertebrate. Reason (R) : The members of subphylum vertebrata possess notochord during the embryonic period, the notochord is replaced by a cartilaginous or bony vertebral column in adults. In the light of the above statements, choose the correct answer from the options given below :

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

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

(3) A is true but R is false

(4) A is false but R is true

Hide Solution

Solution:

Here is a step-by-step analysis of the two statements. We will show that (A) is true, (R) is true, and that (R) in fact explains (A), so the correct choice is (1).

---

1. Definitions and notation

Let

$$C = \{\text{all chordates}\}, \quad V = \{\text{all vertebrates}\}.$$

By definition a chordate is any animal that at some stage of its life-cycle has

1) a notochord,
2) a dorsal hollow nerve cord,
3) pharyngeal slits,
4) a post-anal tail,
5) an endostyle (or thyroid gland).

A vertebrate is a chordate in which the notochord is—at least in the adult—replaced by a vertebral column (backbone).

2. Checking Assertion (A)

(A) says

"All vertebrates are chordates but all chordates are not vertebrates."

- Since every vertebrate, by definition, passes through a stage with a notochord (and hence all the chordate characters), we have

$$V \subset C.$$

- Conversely, there exist chordates (e.g. amphioxus in Subphylum Cephalochordata, and tunicates in Subphylum Urochordata) that never form a vertebral column. Hence

$$C \setminus V \neq \varnothing.$$

Therefore A is true.

3. Checking Reason (R)

(R) says

"The members of subphylum Vertebrata possess a notochord during the embryonic period; in adults the notochord is replaced by a cartilaginous or bony vertebral column."

This is precisely the defining feature of vertebrates: they are chordates (they all start with a notochord) but then replace it by a vertebral column. Thus R is also true.

4. Does (R) explain (A)?
– The first half of (A), “All vertebrates are chordates,” follows from R because every vertebrate first has a notochord (one of the chordate hallmarks).
– The second half, “but all chordates are not vertebrates,” is explained by R because only those chordates that go on to form a vertebral column qualify as Vertebrata; the others remain chordates without ever becoming vertebrates.

Thus the developmental fate of the notochord—whether it persists or is replaced by vertebrae—is exactly the criterion that separates vertebrates from non-vertebrate chordates. In other words, R is the correct explanation of A.

5. Conclusion
Both (A) and (R) are true, and (R) correctly explains (A). Hence the answer is

(1) Both A and R are true and R is the correct explanation of A.

← Back to Dashboard

Problem Solutions

View detailed solutions to each problem. Click on "Show Solution" to see the full explanation.

Solutions
Showing 25 of 88 solutions

143 Problem 143

Identify the statement that is NOT correct.

(1) Each antibody has two light and two heavy chains.

(2) The heavy and light chains are held together by disulfide bonds.

(3) Antigen binding site is located at C-terminal region of antibody molecules.

(4) Constant region of heavy and light chains are located at C -terminus of antibody molecules.

Hide Solution

Solution:

Here's a step-by-step analysis:

Step 1. Recall the basic antibody structure
An antibody (immunoglobulin) is a Y-shaped molecule made of
– Two identical heavy (H) chains
– Two identical light (L) chains
Each chain has
– an N-terminal (amino-terminal) variable (V) region
– a C-terminal (carboxy-terminal) constant (C) region

The antigen-binding site is formed by the variable regions at the N-termini of one heavy + one light chain pair.

Step 2. Examine each statement

(1) “Each antibody has two light and two heavy chains.”
This is correct.

(2) “The heavy and light chains are held together by disulfide bonds.”
This is correct.

(3) “Antigen binding site is located at C-terminal region of antibody molecules.”
The antigen-binding site is in the variable region, which is at the N-terminus, not the C-terminus.
⇒ This statement is **incorrect**.

(4) “Constant region of heavy and light chains are located at C-terminus of antibody molecules.”
This is correct.

Step 3. Conclusion
The statement that is **NOT** correct is

$\boxed{(3)}$

144 Problem 144

Silencing of specific mRNA is possible via RNAi because of -

(1) Complementary dsRNA

(2) Inhibitory ssRNA

(3) Complementary tRNA

(4) Non-complementary ssRNA

Hide Solution

Solution:

Here is a step-by-step explanation of why RNA interference (RNAi) relies on complementary double-stranded RNA (dsRNA) to silence a specific mRNA:

Step 1. Recall the basic phenomenon of RNAi
RNAi is a cellular mechanism by which a double-stranded RNA trigger leads to the specific degradation of a homologous messenger RNA (mRNA), thereby preventing its translation into protein.

Step 2. List the options
(1) Complementary dsRNA
(2) Inhibitory ssRNA
(3) Complementary tRNA
(4) Non-complementary ssRNA

Step 3. Describe the molecular mechanism
1. Introduction of long dsRNA into the cytoplasm.
2. **Dicer** (an RNase III-type enzyme) cleaves the long dsRNA into ~21–23 nt small interfering RNAs (siRNAs):

$$\mathrm{dsRNA}_{\mathrm{long}} \xrightarrow{\mathrm{Dicer}} \sum_{i} \mathrm{siRNA}_{i}$$

3. One strand of each siRNA duplex (the “guide” or antisense strand) is loaded into the RNA-induced silencing complex (RISC).
4. The guide strand within RISC base-pairs **complementarily** to the target mRNA:

$$\mathrm{siRNA}_{\mathrm{guide}} \parallel \mathrm{mRNA}_{\mathrm{target}}$$

5. Once base-pairing is established, the Argonaute protein in RISC cleaves the mRNA at the paired region, leading to its degradation.

Step 4. Why only complementary dsRNA works
– A **double-stranded** trigger is required both to enter the Dicer–RISC pathway and to generate the correct siRNA.
– **Complementarity** between the guide strand and the target mRNA is essential for sequence-specific recognition and cleavage.
– Neither single-stranded RNA (ssRNA), whether complementary or not, nor tRNA species participate in activating the Dicer/RISC machinery in this pathway.

Step 5. Conclusion
Silencing of specific mRNA via RNAi is possible because of
(1) Complementary dsRNA.

145 Problem 145

Genes R and Y follow independent assortment. If RRYY produce round yellow seeds and rryy produce wrinkled green seeds, what will be the phenotypic ratio of the F2 generation?

(1) Phenotypic ratio - 1: 2: 1

(2) Phenotypic ratio - 3: 1

(3) Phenotypic ratio - 9: 3: 3: 1

(4) Phenotypic ratio - 9: 7

Hide Solution

Solution:

Here is a detailed, step-by-step solution using Mendel's laws and TeX notation.

Step 1: Parental (P) genotypes and phenotypes
The two genes assort independently:
- Gene R (round, dominant) vs. r (wrinkled, recessive)
- Gene Y (yellow, dominant) vs. y (green, recessive)

Given:

$$\mathrm{RRYY\ (round\ yellow)} \times \mathrm{rryy\ (wrinkled\ green)}$$

Step 2: Gametes produced by the parents
- RRYY can only make gametes RY
- rryy can only make gametes ry

Step 3: F_1 generation
All F_1 offspring get one RY from RRYY and one ry from rryy, so

$$\mathrm{F_1\ genotype} = RrYy \quad (\mathrm{all\ are\ round\ yellow}).$$

Step 4: Self-cross of F_1 to get F_2
We cross

$$RrYy \times RrYy.$$

Each RrYy individual can produce four types of gametes in equal proportion:

$$RY,\ Ry,\ rY,\ ry.$$

Step 5: Punnett square (4×4) for F_2
We place the four gametes of one parent across the top and the four of the other down the side. There are 16 boxes altogether. Rather than draw the full square, we note that each combination is equally likely (1/16).

Step 6: Determine phenotypes from genotypes
A seed is round if it has at least one R; wrinkled only if rr.
A seed is yellow if it has at least one Y; green only if yy.

Count how many of the 16 genotypes fall into each class:
1. Round Yellow (R_ Y_): 9
2. Round Green (R_ yy): 3
3. Wrinkled Yellow (rr Y_): 3
4. Wrinkled Green (rr yy): 1

Concretely, you can verify by enumerating the 16 RrYy×RrYy outcomes:

Gametes →	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

– Count of Round Yellow (at least one R and one Y): 9 boxes
– Count of Round Green (at least one R, yy): 3 boxes
– Count of Wrinkled Yellow (rr, at least one Y): 3 boxes
– Count of Wrinkled Green (rr yy): 1 box

Step 7: Phenotypic ratio in F_2

$$\boxed{9:3:3:1}$$

Thus the correct choice is (3) Phenotypic ratio = 9 : 3 : 3 : 1.

146 Problem 146

Histones are enriched with -

(1) Lysine & Arginine

(2) Leucine & Lysine

(3) Phenylalanine & Leucine

(4) Phenylalanine & Arginine

Hide Solution

Solution:

Here is a step-by-step solution in TeX format:

Step 1: Recall the function of histones
Histones are the protein components of chromatin that package and order DNA into structural units called nucleosomes. To bind tightly to the negatively charged DNA backbone, histones must carry a net positive charge at physiological pH.

Step 2: Identify which amino acids are positively charged at physiological pH
The amino acids with positively charged side chains at pH 7 are:

1. Lysine (side chain $–NH_3^+$)
2. Arginine (guanidinium $–C(NH_2)_2^+$)
3. (Histidine is partially charged but less abundant in core histones.)

Step 3: Check the given options
(1) Lysine & Arginine
(2) Leucine & Lysine
(3) Phenylalanine & Leucine
(4) Phenylalanine & Arginine

Only option (1) contains two strongly basic (positively charged) residues.

Step 4: Conclude
Since histones are enriched in the basic amino acids lysine and arginine to facilitate tight binding to DNA, the correct answer is:

Answer: (1) Lysine & Arginine

147 Problem 147

The first menstruation is called :

(1) Menopause

(2) Menarche

(3) Diapause

(4) Ovulation

Hide Solution

Solution:

Here's a step-by-step solution using valid TEX notation:

Step 1. Restate the question.
We are asked: "The first menstruation is called ____."

Step 2. List the options (using inline math for the terms):
(1) Menopause

(2) Menarche
(3) Diapause
(4) Ovulation

Step 3. Recall the definitions (in a block math environment):

$$\begin{aligned} \text{Menarche} &= \text{onset of the very first menstrual period,} \\ \text{Menopause} &= \text{permanent cessation of menstrual cycles,} \\ \text{Diapause} &= \text{period of arrested development (in insects, etc.),} \\ \text{Ovulation} &= \text{release of an egg (ovum) from the ovary.} \end{aligned}$$

Step 4. Match “first menstruation” with the definitions.
Clearly, “first menstrual period” is exactly the definition of **menarche**.

Step 5. State the answer.

$$\boxed{\text{(2) Menarche}}$$

148 Problem 148

Match List - I with List - II. List - I A. Heart B. Kidney C. Gastro-intestinal tract D. Adrenal Cortex List - II I. Erythropoietin II. Aldosterone III. Atrial natriuretic factor IV. Secretin Choose the correct answer from the options given below :

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

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

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

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

Hide Solution

Solution:

Here is the step-by-step matching:

1. Heart (A)
The atria of the heart secrete Atrial Natriuretic Factor (ANF), also called Atrial Natriuretic Peptide (ANP), in response to increased atrial stretch.

$$A \longrightarrow \text{III (Atrial natriuretic factor)}$$

2. Kidney (B)
The peritubular interstitial cells of the kidney cortex produce erythropoietin (EPO) when oxygen delivery to the kidney is low.

$$B \longrightarrow \text{I (Erythropoietin)}$$

3. Gastro-intestinal tract (C)
The S-cells of the duodenal mucosa secrete secretin in response to acidic chyme entering the small intestine.

$$C \longrightarrow \text{IV (Secretin)}$$

4. Adrenal Cortex (D)
The zona glomerulosa of the adrenal cortex synthesizes and secretes aldosterone under control of the renin–angiotensin–aldosterone system.

$$D \longrightarrow \text{II (Aldosterone)}$$

Putting it all together, the correct matching is

$$A-III,\ B-I,\ C-IV,\ D-II$$

which corresponds to option **(4)**.

149 Problem 149

The protein portion of an enzyme is called :

(1) Cofactor

(2) Coenzyme

(3) Apoenzyme

(4) Prosthetic group

Hide Solution

Solution:

Here's a step-by-step analysis:

Step 1: Recall the definitions
1. An *enzyme* in its active form is often called a **holoenzyme**, which consists of
   - the **protein portion**, and
   - the **nonprotein portion** (if required for activity).

2. The **protein portion** alone is called the **apoenzyme**.

3. The **nonprotein portion** may be
- a metal ion or organic molecule (generically a **cofactor**),
- an organic cofactor that binds loosely (a **coenzyme**), or
- an organic or metal-containing group that binds tightly (a **prosthetic group**).

Step 2: Match each option to these definitions
(1) Cofactor
– generic term for a nonprotein helper (metal ion or organic molecule)
(2) Coenzyme
– a loosely bound organic cofactor (e.g. NAD^+, FAD)
(3) Apoenzyme
– the protein portion of an enzyme, inactive without its cofactor
(4) Prosthetic group
– a tightly bound nonprotein group (e.g. heme in cytochromes)

Step 3: Identify the protein portion
By definition, the *apoenzyme* is exactly the protein part of an enzyme, which by itself is catalytically inactive.

Answer:
The protein portion of an enzyme is called the **apoenzyme**, i.e. option (3).

150 Problem 150

Which of the following is the unit of productivity of an Ecosystem?

(1) gm^{-2}

(2) KCal m^{-2}

(3) KCal m^{-3}

(4) (KCal m^{-2}) yr^{-1}

Hide Solution

Solution:

Here's the step-by-step reasoning:

1. Definition of productivity
Productivity in an ecosystem is the rate at which biomass (organic matter) is produced per unit area per unit time. In symbols, if ΔB is the change in biomass over time Δt in area A, then

$$P = \frac{\Delta B}{A\,\Delta t}.$$

2. Typical units
Since biomass can be measured either in mass (g) or in energy units (KCal), and productivity must include area and time, the valid units are:
– mass-based: g m^{-2} yr^{-1}
– energy-based: KCal m^{-2} yr^{-1}

3. Evaluate each option
(1) gm^{-2}
– Missing the time factor → this is a standing crop (stock), not a rate.
(2) KCal m^{-2}
– Again missing the time factor → energy content per area (stock), not a rate.
(3) KCal m^{-3}
– Uses volume instead of area and also lacks time → not productivity.
(4) (KCal m^{-2}) yr^{-1}
– Contains energy per unit area *and* per unit time → this is precisely a productivity unit.

4. Conclusion
The correct unit of ecosystem productivity is

$\boxed{(4)\ (\mathrm{KCal\ m^{-2}})\ \mathrm{yr^{-1}}}$.

151 Problem 151

Sweet potato and potato represent a certain type of evolution. Select the correct combination of terms to explain the evolution.

(1) Analogy, convergent

(2) Homology, divergent

(3) Homology, convergent

(4) Analogy, divergent

Hide Solution

Solution:

Here's the step-by-step reasoning:

Step 1. Recall the definitions
– Homologous structures share similarity because of common ancestry.
– Analogous structures share similarity in function or form, but evolved independently.
– Divergent evolution is when related species evolve different traits (giving rise to homologues).
– Convergent evolution is when unrelated species independently evolve similar traits (giving rise to analogues).

Step 2. Taxonomic position

Potato (Solanum tuberosum) and sweet potato (Ipomoea batatas) are both in the order Solanales but belong to different families:

$$\text{Potato: Family} = \text{Solanaceae}$$
$$\text{Sweet potato: Family} = \text{Convolvulaceae}$$

Since their most recent common ancestor did not itself have a true tuber, the tuberous storage organ in each lineage must have arisen independently.

Step 3. Nature of the tubers

Both plants form enlarged underground storage organs ("tubers") that function to store carbohydrates. The similarity in form and function is not due to inheritance from a common tuber-bearing ancestor, but rather to similar selective pressures (e.g. survival through adverse seasons).

Step 4. Classification of the evolution

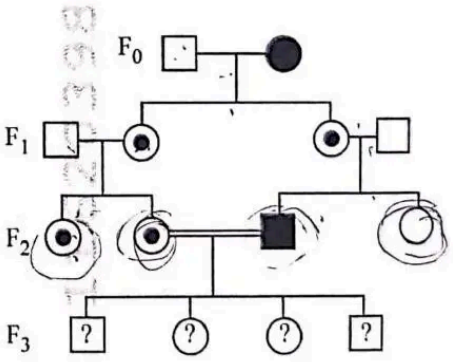
– Because the tubers arose independently in two unrelated families, they are analogous structures.

– Because the similarity evolved independently, this is convergent evolution.

Therefore, the correct choice is
(1) Analogy, convergent.

152 Problem 152

With the help of given pedigree, find out the probability for the birth of a child having no disease and being a carrier (has the disease mutation in one allele of the gene) in F3 generation.



Unaffected male

Affected male

Carrier female

Unaffected female

Affected female

(1) 1/4
(2) 1/2
(3) 1/8
(4) Zero

(1) 1/4

(2) 1/2

(3) 1/8

(4) Zero

Hide Solution

Solution:

Here is a step-by-step solution. We will first recognize that the pedigree symbols show only circles with a central dot as “carrier females” and filled squares as “affected males,” so this is an X-linked recessive trait. In the F_2 generation the two individuals who mate (the F_2 parents of F_3) are

• Mother is a carrier: genotype X^dX.
• Father is affected: genotype X^dY.

(Here X^d denotes the X-chromosome carrying the disease mutation; X the normal X.)

1. Gametes produced by each parent:
– Mother (X^dX) → X with probability ½, or X^d with probability ½.
– Father (X^dY) → X^d to all daughters, and Y to all sons.

2. Set up the Punnett-square (mother down, father across):

	Y	X^d
X	XY	XX^d
X^d	X^dY	X^dX^d

Reading the four equally likely outcomes:

– X Y : a normal (unaffected) son
– X X^d : a carrier (unaffected) daughter
– X^d Y : an affected son
– X^d X^d : an affected daughter

3. We are asked for the probability that an F_3 child is both “unaffected” (no disease) and “a carrier.” From the table the only genotype with those properties is X X^d, and it occurs in exactly 1 out of the 4 equally likely boxes.

Therefore the required probability is

$$\boxed{\frac{1}{4}}$$

which corresponds to choice (1).

153 Problem 153

Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R): Assertion (A) : Cells of the tapetum possess dense cytoplasm and generally have more than one nucleus. Reason (R) : Presence of more than one nucleus in the tapetum increases the efficiency of nourishing the developing microspore mother cells. In light of the above statements, choose the most appropriate answer from the options given below :

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

(2) Both A and R are true but R is NOT the correct explanation of A

(3) A is true but R is false

(4) A is false but R is true

Hide Solution

Solution:

Here is a detailed, step-by-step analysis using TeX formatting:

1. Definition and function of the tapetum
The tapetum is the innermost layer of the anther wall in flowering plants. Its main role is to nourish the developing microspores (which will become pollen grains) by secreting enzymes, nutrients and sporopollenin precursors.

2. Why the tapetal cells have dense cytoplasm and are multinucleate (Assertion A)
– Tapetal cells are highly active secretory cells, so they contain abundant endoplasmic reticulum, Golgi bodies and mitochondria, which makes their cytoplasm very dense.
– During development the tapetum often becomes multinucleate (either by

successive nuclear divisions without cytokinesis or by fusion of cells). This polyploidy/multinucleate condition increases the cell's biosynthetic capacity.

3. How multinucleate condition increases nutritive efficiency (Reason R)
– More nuclei → more copies of genes → higher transcriptional output of messenger RNA.
– More ribosomes and enzymes can be produced in parallel, so protein and lipid synthesis is faster.
– Faster and greater secretion of nutrients and wall-materials (e.g.\ sporopollenin precursors) to the microspores.

4. Linking A and R
– Assertion A states the factual morphology and cytology of tapetal cells (dense cytoplasm, multinucleate). This is true.
– Reason R explains why tapetal cells are multinucleate: to boost their efficiency in supplying developing microspores. This is also true and directly accounts for the need for a dense, multinucleate cytoplasm.

Therefore both A and R are true, and R provides the correct explanation of A.

Answer: (1) Both A and R are true and R is the correct explanation of A.

154 Problem 154

How many meiotic and mitotic divisions need to occur for the development of a mature female gametophyte from the megaspore mother cell in an angiosperm plant?

(1) 2 Meiosis and 3 Mitosis

(2) 1 Meiosis and 2 Mitosis

(3) 1 Meiosis and 3 Mitosis

(4) No Meiosis and 2 Mitosis

Hide Solution

Solution:

Here is the step-by-step development of the female gametophyte (embryo sac) in an angiosperm, from the megaspore-mother cell (MMC) to the mature 7-celled, 8-nucleate embryo sac:

1. Megaspore-mother cell (MMC)
   – Ploidly: $2n$
   – Undergoes **one** meiotic division (which actually consists of two nuclear divisions, Meiosis-I and Meiosis-II).

$$2n \xrightarrow[\text{Meiosis I \& II}]{\text{1 meiotic event}} 4\ (n)\ \text{megaspore cells}$$

2. Selection of the functional megaspore
   – Out of the 4 haploid (n) megaspores, 3 degenerate and only **one** remains functional.

3. Mitotic divisions of the functional megaspore
   – That single haploid cell undergoes **three** successive mitotic divisions **without** cytokinesis initially, giving rise to an 8-nucleate coenocyte:
   • After 1st mitosis: 2 nuclei
   • After 2nd mitosis: 4 nuclei
   • After 3rd mitosis: 8 nuclei

$$n \xrightarrow[\text{mitosis}]{\text{3 divisions}} 8\ n\text{-nuclei}$$

4. Cellular organization of the 8-nucleate coenocyte

– The 8 nuclei arrange as follows:
• 3 at the micropylar end (egg + 2 synergids)
• 3 at the chalazal end (3 antipodals)
• 2 in the central cell (the polar nuclei)

5. Cellularization
– Cell walls form around these nuclei to yield the mature embryo sac: 7 cells (because the two polar nuclei share one large central cell).

Summary of divisions:
– **Meiotic divisions**: 1 (MMC → 4 megaspores)
– **Mitoses**: 3 (functional megaspore → 8 nuclei → embryo sac)

Therefore, the correct answer is
(3) 1 Meiosis and 3 Mitosis.

155 Problem 155

Which of the following is an example of a zygomorphic flower?

(1) Petunia

(2) Datura

(3) Pea

(4) Chilli

Hide Solution

Solution:

Here's a step-by-step solution.

Step 1. Recall definitions
– An actinomorphic (radial) flower can be divided into two identical halves by three or more planes.
– A zygomorphic (bilateral) flower can be divided into two identical halves by exactly one plane.

Step 2. State the criterion in symbols
Let P = number of symmetry planes.

$$\begin{cases} P \geq 3 & \text{actinomorphic (radial)} \\ P = 1 & \text{zygomorphic (bilateral)} \end{cases}$$

Step 3. Examine each option
1. Petunia (Solanaceae)
  – Corolla is sympetalous with a regular, funnel-shaped tube
  – Has multiple mirror planes $\Rightarrow P \geq 3 \Rightarrow$ actinomorphic
2. Datura (Solanaceae)
  – Trumpet-shaped corolla, regular
  – Multiple mirror planes $\Rightarrow$ actinomorphic
3. Pea (Fabaceae)
  – Papilionaceous corolla ("standard," "wings," "keel")
  – Only one vertical plane of symmetry $\Rightarrow P = 1 \Rightarrow$ **zygomorphic**
4. Chilli (Solanaceae)
  – Regular, star-shaped corolla
  – Multiple mirror planes $\Rightarrow$ actinomorphic

Step 4. Conclusion
Only the pea flower is zygomorphic.

Answer: (3) Pea.

156 Problem 156

After maturation, in primary lymphoid organs, the lymphocytes migrate for interaction with antigens to secondary lymphoid organ(s) / tissue(s) like: A.

thymus B. bone marrow C. spleen D. lymph nodes E. Peyer's patches
Choose the correct answer from the options given below:

(1) B, C, D only

(2) A, B, C only

(3) E, A, B only

(4) C, D, E only

Hide Solution

Solution:

Here is a step-by-step solution:

Step 1: Identify primary vs. secondary lymphoid organs
By definition:
- Primary (central) lymphoid organs are where lymphocytes **mature**.
- Secondary (peripheral) lymphoid organs/tissues are where mature lymphocytes **meet antigen** and initiate immune responses.

Primary lymphoid organs
– Bone marrow (site of B-cell development)
– Thymus (site of T-cell development)

Secondary lymphoid organs/tissues
– Spleen
– Lymph nodes
– Mucosa-associated lymphoid tissue (MALT), e.g. Peyer’s patches

---

Step 2: List the options and label them
A. Thymus (primary)
B. Bone marrow (primary)
C. Spleen (secondary)
D. Lymph nodes (secondary)
E. Peyer's patches (secondary)

Step 3: Pick only the secondary organs
From the list above, the secondary lymphoid organs/tissues are

$$\{\, C : \text{Spleen},\ D : \text{Lymph nodes},\ E : \text{Peyer's patches} \,\}.$$

Step 4: Match to the given answer-choices
The choice that includes exactly C, D and E is
(4) C, D, E only.

Answer: (4) C, D, E only.

157 Problem 157

Given below are two statements : Statement I : Fig fruit is a non-vegetarian fruit as it has enclosed fig wasps in it. Statement II : Fig wasp and fig tree exhibit mutual relationship as fig wasp completes its life cycle in fig fruit and fig fruit gets pollinated by fig wasp. In the light of the above statements, choose the most appropriate answer from the options given below :

(1) Both statement I and statement II are correct

(2) Both statement I and statement II are incorrect

(3) Statement I is correct but statement II is incorrect

(4) Statement I is incorrect but statement II is correct

Hide Solution

Solution:

Here is a detailed, step-by-step analysis using valid TeX delimiters.

Solution:

Step 1. Introduce notation.
Let

$$S_1 = \text{“Fig fruit is a non-vegetarian fruit as it has enclosed fig wasps in it.”},$$

$$S_2 = \text{“Fig wasp and fig tree exhibit mutual relationship as fig wasp completes its}$$

We will test the truth-value of each statement.

Step 2. Analysis of S_1.
“Non-vegetarian” normally means derived from animal flesh or requiring animal killing.
In fact, the fig–wasp story is a case of mutualism:

- A female wasp enters the closed inflorescence (syconium) of a fig to lay her eggs.
- She inevitably dies inside, and her body is broken down by the fig’s enzymes.
- The plant tissue digests the remains so completely that nothing recognizably “wasp” remains in the ripe fruit.

Botanically, the ripe fig is still a plant product, not an animal product. Hence it is not correctly termed “non-vegetarian.” Therefore

$$S_1 \text{ is FALSE.}$$

Step 3. Analysis of S_2.
Mutualism means both partners gain a net benefit. In the fig–fig-wasp system:
1. The wasp uses the interior of the fig (the syconium) to lay eggs and for larval development:

$$\text{Benefit to wasp} > 0.$$

2. In the process of laying eggs, the wasp pollinates the tiny flowers inside the fig. Without the wasp, those flowers would not set seed:

$$\text{Benefit to fig tree} > 0.$$

Since both organisms benefit, this is a classic mutualistic relationship. Hence

$$S_2 \text{ is TRUE.}$$

Step 4. Combine results.
We have

$$S_1 = \text{False}, \quad S_2 = \text{True}.$$

Matching to the options:
(1) both true
(2) both false
(3) S_1 true, S_2 false
(4) S_1 false, S_2 true

Thus the correct choice is

$$\boxed{\text{4) Statement I is incorrect but Statement II is correct.}}$$

158 Problem 158

What is the main function of the spindle fibers during mitosis?

(1) To separate the chromosomes

(2) To synthesize new DNA

(3) To repair damaged DNA

(4) To regulate cell growth

Hide Solution

Solution:

Here's a step-by-step analysis:

Step 1: Recall what spindle fibers are
Spindle fibers are bundles of microtubules that form between the two centrosomes (spindle poles) once a cell enters mitosis. They are composed of α- and β-tubulin dimers that polymerize into long filaments.

Step 2: Identify when and where they act
– In **prophase** the centrosomes start moving apart and microtubules begin to extend.
– By **metaphase**, spindle fibers attach to each chromosome's kinetochore.
– In **anaphase**, they shorten and pull sister chromatids toward opposite poles.

Step 3: State the main mechanical outcome
During anaphase, each pair of sister chromatids (originally part of a replicated chromosome) is separated. If we denote the diploid number of chromatids as $2n$, the action of the spindle fibers yields two groups of n chromatids:

$$2n \xrightarrow{\text{anaphase}} n + n$$

Step 4: Match to the choices
(1) To separate the chromosomes ✓
(2) To synthesize new DNA ✗
(3) To repair damaged DNA ✗
(4) To regulate cell growth ✗

Only choice (1) correctly describes the spindle fibers' main function during mitosis: **to separate the chromosomes**.

159 Problem 159

Which one of the following is the characteristic feature of gymnosperms?

(1) Seeds are enclosed in fruits.

(2) Seeds are naked.

(3) Seeds are absent.

(4) Gymnosperms have flowers for reproduction.

Hide Solution

Solution:

Here is a step-by-step explanation in TeX.

Step 1. Recall the definitions.
– A **seed** is a mature, fertilized ovule, containing an embryo plus stored food,

surrounded by one or more protective coats.
– **Gymnosperms** (“naked-seed” plants) and **angiosperms** (“enclosed-seed” or flowering plants) differ in how their ovules (and thus seeds) are borne.

Step 2. Contrast gymnosperms vs. angiosperms.
1. In angiosperms the ovules are enclosed within an ovary. After fertilization the ovary wall develops into a **fruit**, so the seeds are **enclosed in fruits**.
2. In gymnosperms the ovules develop **exposed** on the surface of scales (e.g.\ in the cones of pines, firs, cycads). There is **no ovary** to enclose them.

Step 3. State the characteristic feature of gymnosperms.
Because gymnosperm ovules (and thus seeds) are produced “openly” on cone scales and **never enclosed in an ovary**, their seeds are said to be **naked**.

Step 4. Eliminate the wrong choices.
(1) “Seeds are enclosed in fruits.” → This is true of **angiosperms**, not gymnosperms.
(3) “Seeds are absent.” → Gymnosperms certainly do produce seeds.
(4) “Gymnosperms have flowers for reproduction.” → They do **not** form true flowers; that is an angiosperm feature.

Step 5. Select the correct answer.
The characteristic feature of gymnosperms is that their seeds are _naked_.
Hence the correct choice is

$\boxed{2}$

160 Problem 160

Consider the following statements regarding function of adrenal medullary hormones : A. It causes pupilary constriction B. It is a hyperglycemic hormone C. It causes piloerection D. It increases strength of heart contraction Choose the correct answer from the options given below :

(1) C and D Only

(2) B, C and D Only

(3) A, C and D Only

(4) D Only

Hide Solution

Solution:

Here is a detailed, step-by-step analysis using LaTeX:

Step 1: Identify the adrenal medullary hormones
The adrenal medulla secretes chiefly epinephrine (E) and norepinephrine (NE).

Step 2: Recall their main receptor actions
1. α_1–receptors
   - On vascular smooth muscle → vasoconstriction
   - On pilomotor (arrector pili) muscles → piloerection
   - On radial muscle of the iris → pupillary dilation (mydriasis)
2. β_1–receptors (mainly in heart)
   - ↑ cAMP → ↑ intracellular Ca^{2+} → positive inotropy (↑ contractility) and chronotropy (↑ heart rate)
3. β_2–receptors (e.g. in liver, muscle)
   - ↑ glycogenolysis and gluconeogenesis → hyperglycemic effect

Step 3: Evaluate each statement
A. "It causes pupillary **con**striction"
   − False. Adrenal medullary hormones cause pupillary **dilation** (mydriasis) via α_1.
B. "It is a hyperglycemic hormone"
   − True. Through β_2-mediated ↑ glycogenolysis and gluconeogenesis.
C. "It causes piloerection"
   − True. Via α_1-mediated contraction of arrector pili muscles.
D. "It increases strength of heart contraction"
   − True. Via β_1-mediated positive inotropy.

Step 4: Select the correct combination
Only B, C and D are correct.

Therefore the answer is

$$\boxed{\text{B, C and D Only (Option 2)}}.$$

161 Problem 161

Why can't insulin be given orally to diabetic patients?

(1) Human body will elicit strong immune response

(2) It will be digested in Gastro-Intestinal (GI) tract

(3) Because of structural variation

(4) Its bioavailability will be increased

Hide Solution

Solution:

Here's a step-by-step analysis:

Step 1. Nature of insulin
Insulin is a polypeptide hormone made of 51 amino acids (two chains linked by disulfide bridges) with a molecular weight of about

$$M \approx 5\,808 \text{ Da}.$$

Step 2. The fate of proteins in the GI tract

When you take a protein orally it encounters:
a) Gastric acid (pH ≈1.5–3.5) which unfolds (denatures) the protein.
b) Proteolytic enzymes (pepsin in the stomach; trypsin, chymotrypsin, carboxypeptidases in the small intestine) which cleave the peptide bonds.

In symbolic form, peptide-bond hydrolysis is:

$$-\mathrm{CO{-}NH}- + H_2O \xrightarrow{\text{peptidases}} -\mathrm{COOH} + \mathrm{NH_2}\,.$$

Step 3. Consequence for oral insulin
Because insulin is broken down into short peptides and amino acids, no intact, biologically active hormone remains to be absorbed through the intestinal wall. Its actual bioavailability when given by mouth is essentially zero.

Step 4. Eliminate the other options
1) An immune response is not the primary barrier to oral insulin.
3) "Structural variation" is irrelevant – the protein's structure is simply destroyed by digestion.
4) Oral delivery would **decrease**, not increase, insulin's bioavailability.

Conclusion
The correct answer is (2):
"Insulin will be digested in the Gastro-Intestinal tract."

162 Problem 162

Match List I with List II. List I A. Pteridophyte B. Bryophyte C. Angiosperm D. Gymnosperm List II I. Salvia II. Ginkgo III. Polytrichum IV. Salvinia Choose the option with all correct matches.

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

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

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

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

Hide Solution

Solution:

Here is the detailed solution:

Step 1: Recall the major plant groups and one characteristic example of each.

1. Bryophytes are non-vascular, spore-producing plants (mosses, liverworts, hornworts).
– A representative genus is _Polytrichum_.
⇒ Bryophyte ⟶ Polytrichum

2. Pteridophytes are vascular, spore-producing plants (ferns and their allies).
– A representative genus is _Salvinia_ (a floating fern).
⇒ Pteridophyte ⟶ Salvinia

3. Gymnosperms are seed-producing plants whose seeds are not enclosed in an ovary (“naked seeds”).
– A classic example is _Ginkgo_.
⇒ Gymnosperm ⟶ Ginkgo

4. Angiosperms are flowering plants whose seeds develop enclosed within a fruit.
– A familiar genus is _Salvia_ (sage, in the mint family).
⇒ Angiosperm ⟶ Salvia

Step 2: Match these to List I and List II:

List I	List II	Match
A. Pteridophyte	IV. Salvinia	A → IV
B. Bryophyte	III. Polytrichum	B → III
C. Angiosperm	I. Salvia	C → I
D. Gymnosperm	II. Ginkgo	D → II

Step 3: Identify the correct option.
The matching A–D → I–IV is A–IV, B–III, C–I, D–II, which corresponds to option ** (2)**.

Answer: **(2)**.

163 Problem 163

Who proposed that the genetic code for amino acids should be made up of three nucleotides?

(1) George Gamow

(2) Francis Crick

(3) Jacque Monod

(4) Franklin Stahl

Hide Solution

Solution:

Here's a step-by-step reasoning showing why a **triplet** (three-nucleotide) code is required for 20 amino acids, and who first proposed it.

Step 1. Identify the basic problem
We have an "alphabet" of 4 nucleotide bases (A, C, G, T/U), and need to specify at least 20 different amino acids. If codons are made of n nucleotides, the total number of distinct codons is

$$\#\,\text{codons} \;=\; 4^{n}.$$

Step 2. Find the smallest n such that $4^n \geq 20$
We test small values of n:

– For $n = 1$:

$$4^1 = 4 < 20\,.$$

– For $n = 2$:

$$4^2 = 16 < 20\,.$$

– For $n = 3$:

$$4^3 = 64 \geq 20\,.$$

Thus the smallest integer n satisfying $4^n \geq 20$ is $n = 3$. In other words, you need **three nucleotides** per codon to encode all 20 amino acids (in fact allowing for 64 – 20 = 44 “extra” codons, some of which serve as stop signals or synonyms).

Step 3. Who first proposed the triplet idea?
It was the physicist **George Gamow** who in 1954 suggested that amino acids must be specified by a three-base “code” (his so-called “diamond code” model). Although the exact biochemical details came later (Crick, Nirenberg, Khorana, etc.), the **triplet** nature of the code was first proposed by
(1) George Gamow.

Answer: (1) George Gamow.

164 Problem 164

Match List I with List II : List I A. The Evil Quartet B. Ex situ conservation C. Lantana camara D. Dodo List II I. Cryopreservation II. Alien species

invasion III. Causes of biodiversity losses IV. Extinction Choose the option with all correct matches.

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

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

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

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

Hide Solution

Solution:

Here is a step-by-step matching:

Step 1. Identify "The Evil Quartet"
The "Evil Quartet" refers to the four broad categories of processes driving biodiversity loss.
⇒ A matches III (Causes of biodiversity losses).

Step 2. Identify "Ex situ conservation"
Ex situ conservation means conserving components of biological diversity outside their natural habitats—for example, in seed banks, gene banks or by cryopreservation.
⇒ B matches I (Cryopreservation).

Step 3. Identify "Lantana camara"
Lantana camara is a notorious invasive alien plant species that displaces native flora and fauna.
⇒ C matches II (Alien species invasion).

Step 4. Identify "Dodo"
The dodo (Raphus cucullatus) is a classic example of an extinct species.

⇒ D matches IV (Extinction).

Putting it all together:

$$A \to III, \quad B \to I, \quad C \to II, \quad D \to IV$$

This corresponds to option **(2)**.

165 Problem 165

Which of the following hormones released from the pituitary is actually synthesized in the hypothalamus?

(1) Luteinizing hormone (LH)

(2) Anti-diuretic hormone (ADH)

(3) Follicle-stimulating hormone (FSH)

(4) Adenocorticotrophic hormone (ACTH)

Hide Solution

Solution:

Here's a step-by-step reasoning:

1. Anatomy of the pituitary
The pituitary gland has two lobes:
- The anterior pituitary (adenohypophysis) synthesizes its own hormones.

- The posterior pituitary (neurohypophysis) does not synthesize hormones but stores and releases hormones made in the hypothalamus.

2. Hormones synthesized in the hypothalamus
Neurons in the supraoptic and paraventricular nuclei of the hypothalamus produce:

$$\text{anti-diuretic hormone (ADH)} \quad \text{and} \quad \text{oxytocin.}$$

These travel down axons to the posterior pituitary, where they are released into the bloodstream.

3. Fate of the other listed hormones
- Luteinizing hormone (LH), follicle-stimulating hormone (FSH) and adrenocorticotrophic hormone ($ACTH$) are all synthesized by specialized cells in the **anterior** pituitary.
- They are **not** made in the hypothalamus.

4. Conclusion
Of the four options, only ADH is actually **synthesized** in the hypothalamus and merely **released** from the posterior pituitary.

Therefore, the correct answer is
$$\boxed{(2)\;\text{ADH}}.$

166 Problem 166

Role of the water vascular system in Echinoderms is : A. Respiration and Locomotion B. Excretion and Locomotion C. Capture and transport of food D. Digestion and Respiration E. Digestion and Excretion Choose the correct answer from the options given below :

(1) A and B Only

(2) A and C Only

(3) B and C Only

(4) B, D and E Only

Hide Solution

Solution:

Here is a detailed, step-by-step solution using TeX formatting:

Step 1: Recall the main functions of the water-vascular system (WVS) in echinoderms
The WVS is a network of fluid-filled canals ending in tube feet. Its principal roles are

1. Locomotion (by hydraulic extension/retraction of tube feet)
2. Capture and transport of food (tube feet help grasp prey and carry it to the mouth)
3. Respiration (gas exchange occurs across the thin walls of the tube feet)

It is *not* directly involved in digestion or excretion (these occur in the gut or by diffusion across other body surfaces).

Step 2: Examine each option
We label the statements A–E as follows:

A. Respiration and Locomotion
B. Excretion and Locomotion
C. Capture and transport of food
D. Digestion and Respiration
E. Digestion and Excretion

Statement	Is WVS involved?
A	Yes (respiration via tube feet) & Yes (locomotion)
B	No (excretion is by diffusion elsewhere) & Yes (locomotion)
C	Yes (tube feet capture & move food)
D	No (digestion is by the gut) & Yes (respiration)
E	No (digestion nor excretion are WVS functions)

Step 3: Pick the correct combination
From the table above, the *only* true statements are **A** and **C**.

Step 4: Match to the given answer-choices
The choice “A and C only” is option **(2)**.

Answer: (2) A and C only.

167 Problem 167

Which of the following type of immunity is present at the time of birth and is a non-specific type of defence in the human body?

(1) Acquired Immunity

(2) Innate Immunity

(3) Cell-mediated Immunity

(4) Humoral Immunity

Hide Solution

Solution:

Here's a step-by-step analysis:

1. Definitions
   - Innate (natural) immunity is present at birth and provides a **non-specific** first line of defense (e.g. skin barrier, phagocytes, NK cells, complement).
   - Acquired (adaptive) immunity develops **after** exposure to antigens; it is **specific** and involves B-cells (humoral) and T-cells (cell-mediated).

2. At birth
   - The newborn has **not** yet been exposed to pathogens or vaccines, so no antigen-specific (acquired) lymphocyte responses are available.
   - However, the newborn **does** have physical barriers, phagocytic cells, complement proteins, etc.—all components of innate immunity.

3. Evaluate the options
   (1) Acquired Immunity
      – develops post-natally; is **specific** → not present at birth
   (2) Innate Immunity
      – present at birth; is **non-specific** → matches the question
   (3) Cell-mediated Immunity
      – a branch of acquired immunity involving T-cells; **specific**
   (4) Humoral Immunity
      – a branch of acquired immunity involving antibodies; **specific**

4. Conclusion
   The immunity that is both present at birth **and** non-specific is

Innate Immunity .

Answer: (2) Innate Immunity.

← Back to Dashboard

Problem Solutions

View detailed solutions to each problem. Click on "Show Solution" to see the full explanation.

Solutions
Showing 13 of 88 solutions

168 Problem 168

In bryophytes, the gemmae help in which one of the following?

(1) Sexual reproduction

(2) Asexual reproduction

(3) Nutrient absorption

(4) Gaseous exchange

Hide Solution

Solution:

Here's a step-by-step analysis:

Step 1. Recall the life-cycle of bryophytes.

Bryophytes (mosses, liverworts, hornworts) have a dominant gametophyte (haploid, n) stage and produce sporophytes (diploid, $2n$) that depend on the gametophyte.

Step 2. Define “gemmae.”
Gemmae are small, multicellular, usually lens-shaped bodies produced in special structures called gemma cups (e.g.\ in the liverwort Marchantia).

Step 3. Understand the function of gemmae.
– Gemmae detach from the parent plant (often by raindrops splashing into gemma cups).
– Each gemma is already multicellular and photosynthetic.
– When it lands on a suitable substrate, it grows directly into a new gametophyte without fusion of gametes.

This is the very definition of vegetative (asexual) reproduction: forming a new individual from somatic tissue, with no meiosis or fertilization.

Step 4. Eliminate other options.
1. Sexual reproduction requires gamete formation, fertilization, and zygote development—gemmae bypass all that.
3. Nutrient absorption is done by rhizoids, not gemmae.
4. Gaseous exchange occurs through the surface of the thallus and specialized pores, not via gemmae.

Step 5. Conclude.
Gemmae function in

ASEXUAL REPRODUCTION.

Answer: **(2) Asexual reproduction.**

169 Problem 169

In frog, the Renal portal system is a special venous connection that acts to link :

(1) Liver and intestine

(2) Liver and kidney

(3) Kidney and intestine

(4) Kidney and lower part of body

Hide Solution

Solution:

Here's the step–by–step reasoning:

Step 1. Recall what a "portal system" is
A portal system is a venous channel that connects one capillary bed with a second capillary bed before the blood returns to the heart.

Step 2. Identify the two main portal systems in vertebrates
– The **hepatic portal system** carries blood from the gastrointestinal tract (intestine) to the liver.
– The **renal portal system** (present in amphibians, reptiles, and some fishes) carries blood from the posterior parts of the body (hind limbs, tail, pelvis) into the kidneys.

Step 3. Match with the frog's renal portal system
In frogs, venous blood from the lower body and hind limbs does not go directly to the heart but is first diverted into the kidneys for filtration.

Step 4. Eliminate the wrong options
(1) "Liver and intestine" describes the hepatic portal system, not the renal portal.
(2) "Liver and kidney" there is no direct portal vein linking liver to kidney.
(3) "Kidney and intestine" is incorrect—intestinal veins go to liver, not kidney.

Therefore, the renal portal system in the frog links

$$\text{Kidney} \longleftrightarrow \text{Lower part of the body}$$

Answer: **(4) Kidney and lower part of body**.

170 Problem 170

Given below are two statements : Statement I. In ecosystem, there is unidirectional flow of energy of sun from producers to consumers. Statement II : Ecosystems are exempted from 2nd law of thermodynamics. In the light of the above statements, choose the most appropriate answer from the options given below :

(1) Both statement I and statement II are correct

(2) Both statement I and statement II are incorrect

(3) Statement I is correct but statement II is incorrect

(4) Statement I is incorrect but statement II is correct

Hide Solution

Solution:

Here is a step–by–step analysis:

Step 1: Examine Statement I
“In an ecosystem, there is a unidirectional flow of solar energy from producers to consumers.”

1. Producers (plants, algae, some bacteria) capture solar energy by photosynthesis and convert it into chemical energy.
2. Consumers (herbivores, carnivores, omnivores) obtain that chemical energy by eating producers or other consumers.
3. At each transfer step, some energy is lost as heat (respiration, maintenance), so energy does not circle back but moves one-way.

Hence Statement I is correct.

Step 2: Examine Statement II
"Ecosystems are exempted from the 2nd law of thermodynamics."

1. The 2nd law of thermodynamics says that in any real (irreversible) process the total entropy of the system plus its surroundings must increase, or at best remain constant:

$$\Delta S_{\text{universe}} = \Delta S_{\text{system}} + \Delta S_{\text{surroundings}} \geq 0 .$$

2. An ecosystem is not an isolated system—it is open (it exchanges both energy and matter with its surroundings). Nevertheless, it cannot violate the 2nd law: it maintains local order by increasing the entropy of its surroundings (e.g. heat loss).
3. No known biological system is "exempt" from the 2nd law; they simply export entropy to keep their own entropy lower.

Hence Statement II is incorrect.

Step 3: Choose the correct option
- Statement I is correct.
- Statement II is incorrect.

Therefore the answer is option (3).

171 Problem 171

Which of the following statements about RuBisCO is true?

(1) It is active only in the dark.

(2) It has higher affinity for oxygen than carbon dioxide.

(3) It is an enzyme involved in the photolysis of water.

(4) It catalyzes the carboxylation of RuBP.

Hide Solution

Solution:

Here is a step-by-step analysis of each statement, leading to the correct answer.

Step 1. Recall the function of RuBisCO
RuBisCO stands for Ribulose-1,5-bisphosphate carboxylase/oxygenase. Its primary role in the Calvin cycle is to catalyze the fixation of CO_2 by adding it to ribulose-1,5-bisphosphate (RuBP), yielding two molecules of 3-phosphoglycerate (3-PGA).

The overall carboxylation reaction is:

$$\text{RuBP } (5\text{C}) + \text{CO}_2 \xrightarrow{\text{RuBisCO}} 2\ \text{3-PGA } (3\text{C each})$$

Step 2. Evaluate each statement

(1) “It is active only in the dark.”
— False. RuBisCO is most active in the light, because its activation requires a high stromal pH, Mg^{2+} concentration and the action of thioredoxin, all of which are generated by the light reactions of photosynthesis.

(2) “It has higher affinity for oxygen than carbon dioxide.”
— False. RuBisCO can act as an oxygenase (binding O_2) or a carboxylase (binding CO_2), but its Michaelis constant for CO_2 is lower than for O_2. A lower K_m means higher affinity. In fact, RuBisCO’s affinity for CO_2 is higher than for O_2, although O_2

can still compete and lead to photorespiration.

(3) “It is an enzyme involved in the photolysis of water.”
— False. Photolysis of water (splitting \ce{H2O} to \ce{O2}, protons and electrons) is carried out by the oxygen-evolving complex of Photosystem II, not by RuBisCO.

(4) “It catalyzes the carboxylation of RuBP.”
— True. This is precisely the reaction RuBisCO performs in the first step of the Calvin cycle:

$$\mathrm{RuBP} + \mathrm{CO_2} \xrightarrow{\mathrm{RuBisCO}} 2\ 3\text{-PGA}$$

Step 3. Conclusion
The only correct statement is (4):
RuBisCO catalyzes the carboxylation of RuBP.

172 Problem 172

Which of the following enzyme(s) are NOT essential for gene cloning?

(1) C and D only

(2) A and B only

(3) D and E only

(4) B and C only

Hide Solution

Solution:

Here is a detailed, step-by-step analysis. First, let us label the enzymes as follows:

A. Restriction endonuclease
B. DNA ligase
C. DNA polymerase
D. Reverse transcriptase
E. RNA polymerase

We want to ask: “Which of these are not essential for (classical) gene cloning?”

Step 1. Recall the key steps in a standard gene-cloning workflow

1. Isolation of the DNA fragment to be cloned.
2. Cutting both insert and vector with a **restriction endonuclease** (A).
3. **Ligation** of the insert into the vector using **DNA ligase** (B).
4. Transformation into a host, followed by selection of recombinants.

None of the other enzymes appear in these core steps.

Step 2. Examine each enzyme

– A (Restriction endonuclease): Essential, cuts DNA at defined sites.
– B (DNA ligase): Essential, joins vector and insert.
– C (DNA polymerase): Not required in the classical cut-and-paste scheme (the host’s replication machinery duplicates the recombinant DNA).
– D (Reverse transcriptase): Not required unless you are making cDNA from RNA—we are doing simple DNA-to-DNA cloning.
– E (RNA polymerase): Not required at any stage of classical DNA cloning (it transcribes DNA → RNA).

Step 3. Identify the non-essential enzymes

From above, the enzymes **not** used in a standard cloning protocol are C, D and E. The question asks which *pair* in the list is **not essential**. We look at the options:

(1) C and D only
(2) A and B only
(3) D and E only
(4) B and C only

– Option (1) says “C and D only.” But in fact E is also non-essential, so leaving out E makes (1) too small.
– Option (2) “A and B” is wrong—they are the two *essential* enzymes.
– Option (3) “D and E” correctly picks two non-essentials; C is also non-essential but if we must choose a *pair* of non-essentials that appear in the list, D and E is the only such pair offered.
– Option (4) “B and C” is wrong because B is essential.

Therefore the best answer is

$$\boxed{(3)\ \text{D and E only.}}$$

173 Problem 173

Read the following statements on plant growth and development. A. Parthenocarpy can be induced by auxins. B. Plant growth regulators can be involved in promotion as well as inhibition of growth. C. Dedifferentiation is a pre-requisite for re-differentiation. D. Abscisic acid is a plant growth promoter. E. Apical dominance promotes the growth of lateral buds. Choose the option with all correct statements.

(1) A, B, C only

(2) A, C, E only

(3) A, D, E only

(4) B, D, E only

Hide Solution

Solution:

Here is a step-by-step analysis of each statement:

1. Parthenocarpy can be induced by auxins.
   – Parthenocarpy is the development of fruit without fertilization.
   – Exogenous application of auxins (or gibberellins) to unpollinated flowers often induces parthenocarpic fruit set.
   → A is **correct**.

2. Plant growth regulators can be involved in promotion as well as inhibition of growth.
   – "Plant growth regulators" (PGRs) include auxins, gibberellins, cytokinins (generally promoters) and abscisic acid, ethylene (often inhibitors).
   → B is **correct**.

3. Dedifferentiation is a pre-requisite for re-differentiation.
   – In tissue culture, a mature cell must first dedifferentiate (lose its specialized state) before it can re-differentiate into a new tissue or organ.
   → C is **correct**.

4. Abscisic acid is a plant growth promoter.
   – Abscisic acid (ABA) is primarily a growth **inhibitor** and stress/dormancy hormone.
   → D is **false**.

5. Apical dominance promotes the growth of lateral buds.
   – Actually, apical dominance is the suppression of axillary (lateral) buds by the active apical bud via auxin.
   → E is **false**.

Since only A, B and C are true, the correct choice is:

(1) A, B, C only

174 Problem 174

Which factor is important for termination of transcription?

(1) α (alpha)

(2) σ (sigma)

(3) ρ (rho)

(4) γ (gamma)

Hide Solution

Solution:

Here is a step-by-step analysis:

1. Transcription in bacteria proceeds in three phases:
   • Initiation
   • Elongation
   • Termination

2. Key factors and their roles:
   – α (alpha)-subunit of RNA polymerase: structural, helps assemble the holoenzyme
   – σ (sigma)-factor: directs RNA polymerase to the promoter (essential for initiation)
   – ρ (rho)-factor: a helicase that mediates one mode of termination
   – γ (gamma): not a standard bacterial transcription factor

3. The termination phase can occur by two main mechanisms:
   (a) ρ-independent (intrinsic) termination, which relies on a GC-rich hairpin in the RNA followed by a U-run, or

(b) ρ-dependent termination, which requires the ρ-factor.

4. Mechanism of ρ-dependent termination:
– ρ is an ATP-dependent RNA helicase.
– It binds to a rut (ρ-utilization) site on the growing RNA transcript.
– Using ATP hydrolysis, it translocates along the RNA toward the RNA polymerase.
– Upon catching up, ρ unwinds the RNA–DNA hybrid in the transcription bubble, releasing the RNA and terminating transcription.

5. Therefore, among the options given, the factor specifically important for (ρ-dependent) termination is

$$\boxed{\rho\ (\text{rho})}$$

Answer: (3) ρ (rho)

175 Problem 175

Frogs respire in water, by skin and buccal cavity and on land by skin, buccal cavity and lungs. Choose the correct answer from the following :

(1) The statement is true for water but false for land

(2) The statement is true for both the environment

(3) The statement is false for water but true for land

(4) The statement is false for both the environment

Hide Solution

Solution:

Here is a step-by-step analysis:

Step 1. Identify the three modes of adult frog respiration.
1. Cutaneous (through the skin)
2. Buccopharyngeal (through the lining of the buccal cavity)
3. Pulmonary (through the lungs)

Step 2. Determine which modes operate in each medium.
– In water, adult frogs cannot use their lungs (lungs collapse under water), so they rely on
1. cutaneous respiration
2. buccopharyngeal respiration

– In air (on land), they use all three:
1. cutaneous respiration
2. buccopharyngeal respiration
3. pulmonary respiration

We can summarize:

$$\begin{aligned} \text{In water:} &\quad \text{cutaneous} + \text{buccopharyngeal} \\ \text{On land:} &\quad \text{cutaneous} + \text{buccopharyngeal} + \text{pulmonary} \end{aligned}$$

Step 3. Compare with the given statement:
“Frogs respire in water by skin and buccal cavity and on land by skin, buccal cavity and lungs.”

This exactly matches our summary for both environments.

Therefore the statement is true both in water and on land, so the correct choice is

(2) The statement is true for both the environments.

176 Problem 176

Twins are born to a family that lives next door to you. The twins are a boy and a girl. Which of the following must be true?

(1) They are monozygotic twins.

(2) They are fraternal twins.

(3) They were conceived through in vitro fertilization.

(4) They have 75% identical genetic content.

Hide Solution

Solution:

Here is a step-by-step solution:

Step 1. Recall the definitions
1. Monozygotic (identical) twins arise from a single fertilized egg that splits. They share essentially 100% of their genetic material and are always the same sex.
2. Dizygotic (fraternal) twins arise from two different eggs fertilized by two different sperm. They share on average 50% of their genetic material (just like ordinary siblings) and can be the same sex or opposite sex.

Step 2. Use the fact that one twin is a boy and the other is a girl.
– If they were monozygotic, they would have to be the same sex (since they come from one zygote and carry identical sex chromosomes). But here they are opposite sexes. □ They cannot be monozygotic.

Step 3. Conclude that they must be dizygotic (fraternal).

Since monozygotic is ruled out, the only remaining possibility is that they are fraternal twins. Hence statement (2) is true.

Step 4. Check the other statements for necessity:
• (3) “They were conceived through in vitro fertilization.” Not required—fraternal twins can occur naturally.
• (4) “They have 75% identical genetic content.” Fraternal twins share on average only about 50%, not 75%.

Answer:
Only statement (2) must be true.

177 Problem 177

Which of the following microbes is NOT involved in the preparation of household products?

(1) A and B only

(2) A and C only

(3) C and D only

(4) C and E only

Hide Solution

Solution:

Here is a step-by-step solution. We first write down the list of microbes (A–E) together with the household product (if any) that each normally makes:

$A =$ Saccharomyces cerevisiae $\rightarrow$ bread (leavening) and alcoholic beverages
$B =$ Lactobacillus bulgaricus $\rightarrow$ curd (yoghurt)
$C =$ Azotobacter chroococcum $\rightarrow$ nitrogen fixation in soil (no household pro
$D =$ Penicillium chrysogenum $\rightarrow$ penicillin (an antibiotic), not a "household-
$E =$ Acetobacter aceti $\rightarrow$ vinegar (acetic acid) production

Step 1: Which of these microbes are actually used in making everyday household products (bread, curd, vinegar, detergents, etc.)?
— $A \rightarrow$ yes (bread, wine)
— $B \rightarrow$ yes (curd)
— $E \rightarrow$ yes (vinegar)

Step 2: Which are _not_ used in any household-level preparation?
— C (Azotobacter) $\rightarrow$ soil bacterium, not used in food/cleaning
— D (Penicillium chrysogenum) $\rightarrow$ makes penicillin, not a household-food or home-cleaning product

Hence the two _not_ involved in household preparations are C and D. That corresponds to choice (3).

Answer: (3) C and D only.

178 Problem 178

Match List - I with List - II.

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

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

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

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

Hide Solution

Solution:

It seems the actual items in List I and List II were omitted from your question. Could you please repost the full lists so we can carry out the matching and show you the detailed step-by-step solution?

179 Problem 179

The blue and white selectable markers have been developed which differentiate recombinant colonies from non-recombinant colonies on the basis of their ability to produce colour in the presence of a chromogenic substrate. Given below are two statements about this method: Statement I : The blue coloured colonies have DNA insert in the plasmid and they are identified as recombinant colonies. Statement II : The colonies without blue colour have DNA insert in the plasmid and are identified as recombinant colonies. In the light of the above statements, choose the most appropriate answer from the options given below :

(1) Both Statement I and Statement II are correct

(2) Both Statement I and Statement II are incorrect

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

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

Hide Solution

Solution:

Here is a detailed, step-by-step explanation:

Step 1: The basis of blue/white screening
– We use a plasmid carrying the $lacZ^{\alpha}$ fragment (the "α-complementation" part of β-galactosidase) cloned into a multiple-cloning site (MCS) within that fragment.
– The host strain supplies the complementary $lacZ^{\omega}$ fragment. When both fragments are present and functional, they assemble into active β-galactosidase.

Step 2: Role of the chromogenic substrate (X-gal)
– X-gal (5-bromo-4-chloro-3-indolyl-β-D-galactopyranoside) is colorless.
– Active β-galactosidase cleaves X-gal, producing a blue product.

Step 3: What happens when foreign DNA is inserted into the MCS?
– Insertion of a DNA fragment into the MCS disrupts the $lacZ^{\alpha}$ coding sequence.
– Disrupted $lacZ^{\alpha}$ + host $lacZ^{\omega}$ ⇒ no active β-galactosidase ⇒ no cleavage of X-gal ⇒ colonies remain white.

Step 4: Interpretation of colony colors
– Blue colonies
• Have an intact $lacZ^{\alpha}$ ⇒ active β-galactosidase ⇒ cleave X-gal ⇒ blue color
• These are non-recombinants (no insert)
– White colonies
• Have a disrupted $lacZ^{\alpha}$ ⇒ no β-galactosidase activity ⇒ no X-gal cleavage ⇒ white color
• These are recombinants (contain insert)

Step 5: Evaluate the statements
Statement I : "The blue coloured colonies have DNA insert in the plasmid and they are identified as recombinant colonies."
– Actually, blue colonies have no insert. ⇒ Statement I is incorrect.

Statement II : "The colonies without blue colour have DNA insert in the plasmid and are identified as recombinant colonies."
– White colonies (no blue) do carry the insert. ⇒ Statement II is correct.

Answer: Statement I is incorrect but Statement II is correct ⇒ option (4).

180 Problem 180

Which one of the following equations represents the Verhulst-Pearl Logistic Growth of population?

(1) $\frac{dN}{dt} = r\left(\frac{K-N}{K}\right)$

(2) $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$

(3) $\frac{dN}{dt} = rN\left(\frac{N-K}{N}\right)$

(4) $\frac{dN}{dt} = N\left(\frac{r-K}{K}\right)$

Hide Solution

Solution:

Here's a step-by-step derivation and comparison with the four choices:

Step 1: Recall the standard Verhulst–Pearl logistic equation

$$\frac{dN}{dt} = r\,N\left(1 - \frac{N}{K}\right),$$

where
• $N(t)$ is the population at time t,
• r is the intrinsic growth rate,
• K is the carrying capacity.

Step 2: Rewrite the factor $1 - \frac{N}{K}$ in a single fraction:

$$1 - \frac{N}{K} = \frac{K}{K} - \frac{N}{K} = \frac{K - N}{K}.$$

Step 3: Substitute back into the equation:

$$\frac{dN}{dt} = r\,N\,\frac{K - N}{K}.$$

Step 4: Match against the four options:

(1) $\frac{dN}{dt} = r\left(\frac{K - N}{K}\right)$
– Missing the factor N, so at $N = 0$ it would still give nonzero growth (wrong).

(2) $\frac{dN}{dt} = r\,N\left(\frac{K - N}{K}\right)$
– Exactly the form derived above.

(3) $\frac{dN}{dt} = r\,N\left(\frac{N - K}{N}\right) = r\,(N - K)$
– This is equivalent to $r\,N\,(1 - \frac{K}{N})$, which is not the logistic form and has the wrong sign for small N.

(4) $\frac{dN}{dt} = N\left(\frac{r - K}{K}\right)$
– The term $(r - K)/K$ is constant; this is a simple exponential law with a shifted rate, not logistic.

Step 5: Conclusion
The correct logistic-growth equation is option (2):

$$\boxed{\frac{dN}{dt} = r\,N\,\frac{K - N}{K}.}$$