Molecular Basis of Inheritance

Class 12 Biology · 24 NEET MCQs with answers & explanations

Molecular Basis of Inheritance is one of NEET's most concept-heavy chapters. DNA structure, replication, transcription, translation, lac operon, the genetic code properties and the Human Genome Project are all tested. Diagram-based questions on DNA packaging, the replication fork and the lac operon model appear frequently.

Key Molecular Facts

Concept	Key Fact
DNA structure	Double helix; A=T (2 H-bonds), G≡C (3 H-bonds); antiparallel strands
Replication	Semi-conservative (Meselson & Stahl); continuous (leading) + discontinuous (lagging, Okazaki fragments)
Transcription	Template strand read 3'→5'; mRNA made 5'→3'; needs RNA polymerase
Translation	AUG = start + Met; UAA/UAG/UGA = stop; ribosome moves 5'→3' on mRNA
Genetic code	Universal, degenerate (64 codons, 20 amino acids), non-overlapping, comma-less
Lac operon	Inducer = allolactose; repressor (i gene) blocks operator when lactose absent

Questions

Q1. In E. coli, when lactose is absent, the repressor protein blocks transcription by binding to which specific DNA region?

(A) Promoter
(B) Operator
(C) Structural gene
(D) Regulatory gene

Q2. Which cellular organelle is the primary site of translation?

(A) Ribosome
(B) Lysosome
(C) Nucleus
(D) Golgi apparatus

Q3. After one generation of replication of 15N-labelled E. coli DNA in a 14N medium, what DNA density pattern is expected according to the Meselson-Stahl experiment?

(A) All DNA remains at heavy density
(B) All DNA becomes light density
(C) All DNA molecules are hybrid intermediate density
(D) Half remains heavy and half becomes fully light

Q4. Which enzyme catalyses the joining of two DNA fragments by forming phosphodiester bonds?

(A) Restriction endonuclease
(B) Helicase
(C) DNA ligase
(D) Primase

Q5. The genetic code is described as degenerate because

(A) Multiple codons specify the same amino acid
(B) Each codon codes for multiple amino acids
(C) Genetic code varies among organisms
(D) Each amino acid has exactly one codon

Q6. Which factor enables RNA polymerase to recognize and bind the promoter in prokaryotes?

(A) Sigma (σ) factor
(B) Rho factor
(C) DNA ligase
(D) Transcription factor II

Q7. Which observation in Griffith's experiment demonstrated bacterial transformation?

(A) Living S strain kills mice directly
(B) Heat-killed R and living R mixture kills mice
(C) Heat-killed S and living R mixture kills mice
(D) Heat-killed S strain alone kills mice

Q8. Which base pairing rule proposed by Chargaff forms the basis of the Watson–Crick DNA model?

(A) A equals G; T equals C
(B) A equals T; G equals C
(C) A equals C; G equals T
(D) A equals U; G equals C

Q9. In eukaryotic cells, DNA is packaged with which proteins to form nucleosomes?

(A) Histone proteins
(B) Actin proteins
(C) Tubulin proteins
(D) Keratin proteins

Q10. DNA replication in cells follows which fundamental mechanism?

(A) Semiconservative replication
(B) Conservative replication
(C) Dispersive replication
(D) Random replication

Q11. The lac operon regulates metabolism of which sugar in E. coli?

(A) Lactose
(B) Glucose
(C) Maltose
(D) Sucrose

Q12. Which scientist developed the technique of DNA fingerprinting?

(A) Alec Jeffreys
(B) James Watson
(C) Francis Crick
(D) Frederick Sanger

Q13. Which international project aimed to determine the complete nucleotide sequence of human DNA?

(A) Human Genome Project
(B) Protein Structure Initiative
(C) Human Proteome Project
(D) Genome Editing Initiative

Q14. Which field integrates biology, computer science, and statistics to store and analyze biological sequence data?

(A) Bioinformatics
(B) Biophysics
(C) Ethology
(D) Biochemistry

Q15. The smooth (S) strain of Streptococcus pneumoniae is virulent due to which structure?

(A) Polysaccharide capsule
(B) Peptidoglycan cell wall
(C) Surface protein flagella
(D) Lipopolysaccharide outer layer

Q16. Which option correctly identifies what Griffith's experiment proved about the transforming principle?

(A) Protein from S strain transforms R cells
(B) Hereditary material transfers from dead S to live R cells
(C) Heat destroys all bacterial genetic material
(D) R strain spontaneously becomes virulent

Q17. Which result in Griffith's experiment directly indicated hereditary material transfer?

(A) Living S strain injected alone kills mice
(B) Heat-killed S alone does not kill mice
(C) Heat-killed S mixed with living S kills mice
(D) Living S bacteria recovered from mice injected with heat-killed S and living R

Q18. Which scientists provided biochemical proof that DNA is the transforming principle?

(A) Griffith, Avery, and Hershey
(B) Avery, MacLeod, and McCarty
(C) Hershey, Chase, and Meselson
(D) Meselson, Stahl, and Franklin

Q19. In Avery, MacLeod, and McCarty's experiment, transformation was abolished only when which enzyme was added?

(A) Protease
(B) RNase
(C) DNase
(D) Lipase

Q20. Which result from Avery's experiment most conclusively rules out protein as the transforming principle?

(A) Protease treatment did not abolish transformation
(B) DNase destroyed transformation but RNase did not
(C) Heat-killed S filtrate lost transforming ability
(D) RNase treatment destroyed all transformation

Q21. In the Hershey–Chase experiment, which isotopes labelled DNA and protein respectively?

(A) ^{35}S labels DNA; ^{32}P labels protein
(B) ^{32}P labels DNA; ^{35}S labels protein
(C) ^{14}C labels DNA; ^{32}P labels protein
(D) ^{32}P labels DNA; ^{14}C labels protein

Q22. In the Hershey–Chase experiment, ^{32}P was detected mainly in which fraction after centrifugation?

(A) Supernatant with phage protein coats
(B) Supernatant with bacterial cytoplasm
(C) Supernatant with viral RNA
(D) Pellet containing infected bacterial cells

Q23. Which property of genetic material ensures accurate inheritance during cell division?

(A) Capacity to undergo frequent mutation
(B) Ability to replicate faithfully
(C) Capacity to synthesize proteins directly
(D) Tendency to remain chemically reactive

Q24. Which of the following correctly explains why RNA can serve as genetic material in some viruses?

(A) RNA is always more stable than DNA
(B) RNA cannot undergo mutation hence is safer
(C) RNA can store genetic information and self-replicate in host cells
(D) RNA directly synthesizes proteins without replication

Answer key

1-B	**2-A**	**3-C**	**4-C**	**5-A**	**6-A**	**7-C**	**8-B**
9-A	**10-A**	**11-A**	**12-A**	**13-A**	**14-A**	**15-A**	**16-B**
17-D	**18-B**	**19-C**	**20-A**	**21-B**	**22-D**	**23-B**	**24-C**

Answers with explanations

Q1 — Answer: (B) Operator
The active repressor binds the operator and physically blocks RNA polymerase from transcribing the structural genes. The promoter is the RNA polymerase binding site; the regulatory gene produces the repressor but is not the repressor binding target.

Q2 — Answer: (A) Ribosome
Ribosomes are the molecular machines where mRNA codons are decoded and polypeptides are assembled. They are found free in cytoplasm or bound to rough ER, but translation always occurs on ribosomes.

Q3 — Answer: (C) All DNA molecules are hybrid intermediate density
In the Meselson-Stahl experiment, after one generation in 14N medium, each daughter DNA molecule contains the original 15N parental strand and a newly synthesised 14N strand. All molecules are therefore hybrid and appear at a single intermediate density band on caesium chloride density gradient centrifugation. This is the definitive evidence for semiconservative replication.

Q4 — Answer: (C) DNA ligase
DNA ligase joins adjacent DNA fragments by sealing nicks in the phosphodiester backbone. Restriction endonucleases cut DNA at specific sequences, helicase unwinds the double helix and primase synthesises RNA primers during replication.

Q5 — Answer: (A) Multiple codons specify the same amino acid
Degeneracy means several codons can specify the same amino acid. For example, leucine is coded by six codons. This reduces the mutational impact on protein sequence.

Q6 — Answer: (A) Sigma (σ) factor
Sigma factor confers promoter specificity to the core RNA polymerase holoenzyme, enabling initiation at the correct site. Rho factor is involved in termination, not initiation.

Q7 — Answer: (C) Heat-killed S and living R mixture kills mice
Mice died when living R bacteria mixed with heat-killed S bacteria because DNA from dead S cells transformed R cells into virulent S type. Option D fails because heat-killed S alone cannot infect.

Q8 — Answer: (B) A equals T; G equals C
Chargaff found that in DNA, adenine content equals thymine and guanine equals cytosine — this complementarity became the chemical foundation of Watson-Crick base pairing. Option D uses uracil, which is RNA-specific.

Q9 — Answer: (A) Histone proteins
DNA wraps around histone proteins forming nucleosomes, enabling compaction of eukaryotic DNA inside the nucleus.

Q10 — Answer: (A) Semiconservative replication
In semiconservative replication, each daughter DNA contains one parental strand and one new strand; conservative would keep both parental strands together — a common distractor.

Q11 — Answer: (A) Lactose
Lac operon encodes enzymes specifically for lactose uptake and hydrolysis. Glucose is the preferred sugar but is not regulated by the lac operon.

Q12 — Answer: (A) Alec Jeffreys
Alec Jeffreys developed DNA fingerprinting in 1985 using polymorphism in minisatellite DNA sequences. Watson and Crick elucidated DNA structure; Sanger developed DNA sequencing.

Q13 — Answer: (A) Human Genome Project
The Human Genome Project (HGP) had sequencing and mapping of the entire human genome as its primary goal. The Human Proteome Project deals with proteins, not DNA sequences.

Q14 — Answer: (A) Bioinformatics
Bioinformatics combines biology, computer science, and mathematics to manage and interpret large biological datasets such as genome sequences. Biophysics and biochemistry do not involve computational sequence analysis.

Q15 — Answer: (A) Polysaccharide capsule
The polysaccharide capsule gives S strain colonies a smooth appearance and protects bacteria from host immune destruction. R strain lacks this capsule and is non-virulent.

Q16 — Answer: (B) Hereditary material transfers from dead S to live R cells
Recovery of living S bacteria from dead mice proved genetic material passed from heat-killed S to R cells, converting them permanently. Griffith did not identify the molecule — that was Avery et al.

Q17 — Answer: (D) Living S bacteria recovered from mice injected with heat-killed S and living R
Recovery of living virulent S bacteria from dead mice proved R bacteria were genetically transformed — not just transiently altered — by material from dead S cells.

Q18 — Answer: (B) Avery, MacLeod, and McCarty
Avery, MacLeod, and McCarty purified DNA, RNA, and protein separately from S strain and showed only DNA transformed R cells into S type.

Q19 — Answer: (C) DNase
DNase specifically degrades DNA; its addition destroyed transforming activity while protease and RNase treatments had no effect — proving DNA is the transforming principle.

Q20 — Answer: (A) Protease treatment did not abolish transformation
Protease digests proteins completely; if protein were the transforming principle, transformation would stop. Since it continued, protein is ruled out. DNase result confirms DNA is the molecule.

Q21 — Answer: (B) ^{32}P labels DNA; ^{35}S labels protein
DNA contains phosphorus (in phosphate backbone) but no sulfur, so ^{32}P labels DNA. Proteins contain sulfur in amino acids cysteine and methionine, so ^{35}S labels protein.

Q22 — Answer: (D) Pellet containing infected bacterial cells
^{32}P-labelled DNA was injected into bacterial cells during infection; centrifugation sediments bacteria into the pellet, carrying the ^{32}P DNA with them.

Q23 — Answer: (B) Ability to replicate faithfully
Faithful semi-conservative replication ensures each daughter cell receives an identical copy of genetic information — this is the foundational replication criterion for genetic material.

Q24 — Answer: (C) RNA can store genetic information and self-replicate in host cells
Viruses like TMV and retroviruses have RNA genomes; RNA carries heritable sequence information and can be replicated by RNA-dependent RNA polymerase or reverse transcriptase in host cells.

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