

VU Learning HUB

BIO5101 Quiz File

Chapter-wise Solved MCQs

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Lesson 1: Biotechnology: Definition, History and Scope

1. Which era of biotechnology is characterized by Pasteur's germ theory and the industrial production of antibiotics such as penicillin?

- A) Ancient biotechnology
- B) Classical biotechnology
- C) Modern biotechnology
- D) Environmental biotechnology

2. Modern biotechnology began in the 1970s with which key milestone?

- A) The discovery of fermentation for bread and wine
- B) The development of Koch's postulates
- C) The cloning of a gene by Cohen and Boyer using recombinant DNA technology
- D) The completion of the Human Genome Project

3. In the colour-coded classification of biotechnology, which branch covers industrial processes such as the production of enzymes, biofuels, and bioplastics?

- A) Red biotechnology
- B) Green biotechnology
- C) White or grey biotechnology
- D) Blue biotechnology

4. How is genetic engineering defined in the handout?

- A) The ancient process of selective breeding in plants and animals
- B) The direct manipulation of an organism's DNA using laboratory techniques to add, remove, or modify genes
- C) The technological application of marine resources for medical therapies
- D) The natural selection of cellular proteins over generations

Answer Key

1. B — Classical biotechnology (1800–1950) brought microbiology, including Pasteur's germ theory and penicillin production.
2. C — Modern biotechnology began in the 1970s when Cohen and Boyer first cloned a gene using recombinant DNA technology.
3. C — White or grey biotechnology covers industrial application areas, including enzymes, biofuels, and bioplastics.
4. B — Genetic engineering is defined as the direct manipulation of an organism's DNA using laboratory techniques to add, remove, or modify genes.

Lesson 2: Cell and Molecular Biology Foundations

1. Why are eukaryotic host cells, such as yeast or mammalian cell lines, utilized in biotechnology?

- A) They lack a membrane-bound nucleus and grow rapidly
- B) They are required when recombinant proteins need complex folding and modification
- C) They replicate solely through bacterial binary fission
- D) They do not require promoter sequences for transcription

2. According to the central dogma of molecular biology, which enzyme copies a gene into messenger RNA during transcription?

- A) DNA polymerase
- B) Reverse transcriptase
- C) RNA polymerase
- D) DNA ligase

3. Which molecular tool is defined as a small, circular, extra-chromosomal DNA molecule in bacteria that replicates independently?

- A) Promoter
- B) Plasmid
- C) Ribosome
- D) Restriction enzyme

4. What is the specific function of reverse transcriptase as a molecular tool?

- A) Cutting DNA molecules at specific restriction sites
- B) Joining distinct DNA fragments together
- C) Making DNA from an RNA template
- D) Amplifying DNA fragments exponentially

Answer Key

1. B — Eukaryotic host cells are used when recombinant proteins require complex folding and post-translational modification.
2. C — Transcription copies a gene sequence into messenger RNA using the enzyme RNA polymerase.
3. B — A plasmid is defined as a small, circular, extra-chromosomal bacterial DNA molecule that replicates independently.
4. C — Reverse transcriptase is a molecular enzyme that synthesizes DNA using an RNA template.

Lesson 3: Recombinant DNA Technology and Gene Cloning

1. Which type of cloning vector carries large foreign DNA inserts of 100–300 kb and was essential for the Human Genome Project?

- A) Plasmid
- B) Bacteriophage lambda
- C) Cosmid
- D) Bacterial artificial chromosome (BAC)

2. What is the standard sequence of the five major steps in a gene cloning experiment?

- A) Transform host cell → isolate DNA → cut with restriction enzyme → join with ligase → select clones
- B) Isolate target DNA → cut DNA and vector → join with DNA ligase → transform host → select carrying cells
- C) Join with DNA ligase → isolate DNA → transform host → cut with restriction enzyme → screen colonies
- D) Cut vector → select carrying cells → isolate target DNA → transform host → ligate fragments

3. In blue-white colony screening, why do bacterial colonies carrying the recombinant DNA insert remain white?

- A) The functional lacZ gene produces a blue enzymatic product
- B) Antibiotic selection degrades the blue pigment

- C) DNA insertion disrupts the lacZ gene sequence, preventing functional enzyme synthesis
- D) The multiple cloning site seals the lacZ promoter region

4. Which key distinction differentiates selection from screening in recombinant DNA experiments?

- A) Selection confirms host viability, whereas screening isolates plasmid vector DNA
- B) Selection indicates vector uptake, whereas screening confirms foreign DNA insert integration
- C) Selection measures colony color changes, whereas screening uses antibiotic medium
- D) Selection replicates recombinant DNA, whereas screening cuts the vector at restriction sites

Answer Key

1. D — Bacterial artificial chromosomes (BACs) carry 100–300 kb inserts and were essential for the Human Genome Project.
2. B — The standard cloning workflow follows: isolate DNA, cut DNA and vector, join with ligase, transform host, and select cells.
3. C — Foreign DNA insertion disrupts the lacZ gene, preventing functional enzyme synthesis and leaving colonies white.
4. B — Antibiotic selection indicates vector presence, while screening specifically confirms foreign DNA insert integration.

Lesson 4: Polymerase Chain Reaction and DNA Analysis

1. During a standard PCR cycle, what occurs during the annealing step at 50–60 °C?

- A) Double-stranded target DNA melts into single strands
- B) Heat-stable Taq polymerase synthesizes new complementary strands
- C) Short single-stranded primers bind to target DNA sequences
- D) Dideoxynucleotides terminate chain extension

2. Which PCR variant converts messenger RNA into cDNA to perform gene expression studies?

- A) Quantitative real-time PCR (qPCR)
- B) Reverse-transcriptase PCR (RT-PCR)
- C) Multiplex PCR
- D) Colony PCR

3. Why is Taq DNA polymerase specifically utilized in the polymerase chain reaction?

- A) It synthesizes cDNA directly from an RNA strand
- B) It is derived from a thermophilic bacterium and withstands high denaturation temperatures
- C) It eliminates the requirement for oligonucleotide primers during thermal cycling
- D) It makes precise double-strand breaks at specific restriction sites

4. Which DNA analysis technique utilizes chain-terminating dideoxynucleotides to determine a nucleotide sequence?

- A) Agarose gel electrophoresis
- B) Sanger sequencing
- C) Multiplex PCR
- D) Biolistic transformation

Answer Key

1. C — Annealing at 50–60 °C enables short oligonucleotide primers to bind target DNA sequences.

2. B — Reverse-transcriptase PCR (RT-PCR) converts RNA into cDNA for gene expression analysis.
3. B — Taq polymerase originates from *Thermus aquaticus* and resists high denaturation heat.
4. B — Sanger sequencing uses chain-terminating dideoxynucleotides to deduce sequence order.

Lesson 5: Genomics, Proteomics and Bioinformatics

1. Which sequencing strategy breaks a genome into random fragments, sequences them, and reassembles them computationally using overlapping regions?

- A) Sanger chain-termination sequencing
- B) Whole-genome shotgun sequencing
- C) Reverse-transcriptase sequencing
- D) Dideoxy sequencing

2. What primary technology does proteomics utilize to identify and quantify thousands of proteins at once in a cell or organism?

- A) Mass spectrometry
- B) Agarose gel electrophoresis
- C) Polymerase chain reaction
- D) Gel filtration chromatography

3. Which bioinformatics algorithm is used to perform sequence similarity searches against biological databases?

- A) PDB
- B) BLAST
- C) UniProt
- D) GenBank

4. Which database serves as a primary repository specifically for 3D protein structures?

- A) GenBank
- B) PDB
- C) UniProt
- D) BLAST

Answer Key

1. B — Whole-genome shotgun sequencing breaks DNA into random fragments, sequences them, and reassembles them via overlaps.
2. A — Proteomics relies on mass spectrometry to identify and quantify thousands of proteins simultaneously.
3. B — BLAST is the core sequence alignment tool used to search query sequences against biological databases.
4. B — PDB (Protein Data Bank) is the specialized database for storing 3D protein structures.

Lesson 6: Plant Biotechnology

1. Which principle of plant tissue culture describes the ability of a single plant cell to divide and regenerate into a complete plant?

- A) Micropropagation
- B) Somatic hybridization
- C) Totipotency

D) Embryo rescue

2. Which biological vector is standard for transforming dicotyledonous plants by transferring its T-DNA into the plant genome?

- A) *Thermus aquaticus*
- B) *Escherichia coli*
- C) *Agrobacterium tumefaciens*
- D) Bacteriophage lambda

3. Which physical gene transfer method uses DNA-coated particles and is suitable for monocots like cereals that are poorly infected by *Agrobacterium*?

- A) Biolistics (gene gun)
- B) Protoplast fusion
- C) Electroporation
- D) Meristem culture

4. What nutritional enhancement is Golden Rice specifically engineered to produce to combat deficiency blindness?

- A) Glyphosate resistance
- B) Beta-carotene (vitamin A precursor)
- C) Bacterial insecticidal protein
- D) Lignocellulosic biomass

Answer Key

1. C — Totipotency is defined as the ability of a single plant cell to divide and regenerate into a complete plant.
2. C — *Agrobacterium tumefaciens* naturally transfers its T-DNA into plant genomes and serves as the standard vector for dicots.
3. A — Biolistics (the gene gun) shoots DNA-coated particles into cells, making it ideal for monocots like cereals.
4. B — Golden Rice is genetically engineered to synthesize beta-carotene, a precursor of vitamin A, to combat deficiency blindness.

Lesson 7: Medical and Animal Biotechnology

1. Which host cells are required for producing recombinant therapeutic proteins when correct folding and complex glycosylation are needed?

- A) *Escherichia coli*
- B) Unmodified bacterial cells
- C) Mammalian cells (such as CHO cells) or yeast
- D) Bacteriophages

2. Which vaccine platform delivers genetic instructions so that the patient's own cells construct the target antigen?

- A) First generation live-attenuated vaccines
- B) First generation killed pathogen vaccines
- C) Second generation subunit vaccines
- D) Third generation DNA and mRNA vaccines

3. How is a monoclonal antibody defined in the handout?

- A) An antibody produced by a single clone of B cells, specific for one epitope
- B) A mixture of antibodies secreted by multiple plasma cell strains
- C) A recombinant viral vector designed to alter target DNA
- D) An enzyme synthesized via bacterial binary fission

4. What term describes transgenic animals producing therapeutic proteins in their milk?

- A) Biostimulation
- B) Pharming
- C) Bioaugmentation
- D) Micropropagation

Answer Key

1. C — Mammalian cells (such as CHO cells) or yeast are used when recombinant proteins require complex folding and glycosylation.
2. D — Third generation DNA and mRNA vaccines deliver genetic instructions so the patient's own cells make the antigen.
3. A — Monoclonal antibodies are produced by a single clone of B cells and are specific for one epitope.
4. B — Pharming refers to transgenic animals synthesizing therapeutic proteins in their milk.

Lesson 8: Industrial and Environmental Biotechnology

1. Why are industrial enzymes physically immobilized onto solid supports in continuous reactors?

- A) To convert starches directly into bioethanol
- B) To fix enzymes so they can be reused, significantly reducing costs
- C) To introduce specialist microbial strains into wastewater
- D) To eliminate the need for temperature control in fermenters

2. Which bioremediation approach involves adding specialized microbial strains to clean up pollutants?

- A) Biostimulation
- B) Bioaugmentation
- C) Transesterification
- D) Micropropagation

3. How is bioremediation defined in the handout?

- A) The large-scale cultivation of microbes to produce useful metabolites
- B) The physical confinement of enzymes to a support matrix for reusability
- C) The use of living organisms, usually microbes, to degrade environmental pollutants
- D) The chemical conversion of vegetable oils into biological diesel fuel

4. What chemical process is used to produce biodiesel from oils?

- A) Lignocellulosic breakdown
- B) Transesterification
- C) Bioaugmentation
- D) Continuous aeration

Answer Key

1. B — Immobilizing enzymes onto solid supports allows them to be reused in continuous processes, dramatically cutting costs.
2. B — Bioaugmentation is the practice of adding specialist microbial strains to degrade specific environmental pollutants.
3. C — Bioremediation is defined as using living organisms, usually microbes, to degrade environmental pollutants.
4. B — Biodiesel is synthesized by transesterifying oils.

Lesson 9: CRISPR, Genome Editing and Emerging Tools

1. In the CRISPR-Cas9 genome editing system, what component directs the Cas9 nuclease to a specific complementary DNA sequence?

- A) Protospacer adjacent motif (PAM)
- B) Guide RNA
- C) Zinc-finger domain
- D) Donor DNA template

2. Which repair mechanism occurs after Cas9 creates a double-strand break when a donor template is provided to insert a new sequence?

- A) Non-homologous end joining (NHEJ)
- B) Homology-directed repair (HDR)
- C) Transesterification
- D) Biolistic recombination

3. Why is CRISPR-Cas9 faster and significantly cheaper to target to new DNA sites than ZFNs or TALENs?

- A) ZFNs and TALENs require redesigning a guide RNA for every target
- B) CRISPR-Cas9 requires engineering a new protein for every target
- C) CRISPR-Cas9 requires redesigning only a 20-nucleotide guide RNA rather than engineering a new protein
- D) CRISPR-Cas9 completely avoids making double-strand breaks in target DNA

4. Which type of genome editing alters heritable DNA passed to future generations, leading to near-universal calls for a moratorium?

- A) Somatic editing
- B) Germline editing
- C) Biostimulation
- D) Molecular diagnostic editing

Answer Key

1. B — Guide RNA base-pairs with the target DNA and leads the Cas9 nuclease directly to it.
2. B — Homology-directed repair (HDR) inserts a new DNA sequence when a donor template is provided.
3. C — Only the 20-nucleotide guide RNA needs redesigning per target, whereas ZFNs and TALENs require engineering new proteins.
4. B — Germline editing causes heritable changes across generations and is subject to strict ethical moratoriums.

Lesson 10: Biosafety, Bioethics and Regulation

1. Which biosafety containment level is assigned to laboratories working with low-risk, harmless microbes using basic precautions?

- A) BSL-1
- B) BSL-2
- C) BSL-3
- D) BSL-4

2. Which international agreement governs the transboundary movement of living modified organisms (LMOs/GMOs)?

- A) The PEPA Framework
- B) The Cartagena Protocol
- C) The Human Genome Project
- D) The NIBGE Mandate

3. In Pakistan, which body evaluates GM crops under the Pakistan Environmental Protection Act framework?

- A) National Biosafety Committee
- B) Protein Data Bank (PDB)
- C) Universal Bioethics Council
- D) Cartagena Regulatory Bureau

4. Which bioethical requirement defines a person's voluntary agreement to participate in research after understanding its risks and benefits?

- A) Biostimulation
- B) Informed consent
- C) Bioaugmentation
- D) Totipotency

Answer Key

1. A — BSL-1 is designated for harmless microbes requiring only basic microbiological precautions.
2. B — The Cartagena Protocol is the international agreement governing the transboundary movement of GMOs.
3. A — The National Biosafety Committee evaluates GM crops under Pakistan's environmental legislation.
4. B — Informed consent requires a participant's voluntary agreement after being informed of risks and benefits.

Lesson 11: Biotechnology in Pakistan and Future Prospects

1. Which Faisalabad-based institution is highlighted in the handout as a primary hub for biotechnology research in Pakistan?

- A) CEMB
- B) NIBGE
- C) PARC
- D) HEC

2. How is synthetic biology defined in the handout?

- A) The detection of disease using DNA, RNA, or protein biomarkers
- B) Medical treatment tailored specifically to a patient's individual genetic profile
- C) The design and construction of new biological parts, devices, and systems not found in nature

D) The computational alignment of whole-genome sequencing datasets

3. According to the handout, which set of skills strongly multiplies employability for biotechnology graduates handling modern sequencing data?

- A) Plant tissue micropropagation
- B) Biodiesel transesterification
- C) Bioinformatics and data analysis
- D) Protoplast fusion

4. Which medical concept is defined in the handout as treatment tailored to a patient's individual genetic profile?

- A) Personalized medicine
- B) Somatic gene therapy
- C) Molecular diagnostics
- D) Recombinant pharming

Answer Key

1. B — NIBGE (located in Faisalabad) is cited as a primary biotechnology research institute in Pakistan.
2. C — Synthetic biology is defined as the design and construction of new biological parts, devices, and systems not found in nature.
3. C — Bioinformatics and data analysis skills multiply employability by enabling graduates to analyze sequencing datasets.
4. A — Personalized medicine is defined as medical treatment tailored to a patient's individual genetic profile.

End of Quiz

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