Contents

CHAPTER 1 Basics of Molecular Biology

Multiple Choice Questions

1. **Apart from nucleus, which organelle contains DNA?**
   a. Mitochondria b. Golgi Apparatus
   c. Ribosomes d. Microtubules
2. **All of the following are true regarding mitochondria, *except:***
   a. Diseases due to mitochondrial genes are inherited from mother
   b. Mitochondria contain dsDNA
   c. Diseases due to mitochondrial genes are inherited from both parents
   d. The mitochondria in sperm are eliminated during fertilization
3. **Chromosomes with lowest and highest number of genes, respectively:**
   a. x, 1 b. y, 21
   c. x, 22 d. y, 1
4. **A unit of DNA within a chromosome that can be activated to transcribe a specific RNA:**
   a. Gene b. Exon
   c. Intron d. Toroid
5. **The location of a gene on a particular chromosome is designated as:**
   a. Band b. Arm
   c. Locus d. Region
6. **What percentage of genes in human genome is actually involved in encoding protein synthesis?**
   a. 2% b. 4%
   c. 6% d. 10%
7. **7q31.1 is the location for the cystic fibrosis gene. What does the number 1 signifies in this?**
   a. Chromosome number
   b. Arm symbol
   c. Region number
   d. Band number
8. **Correct order of arrangement in mitosis:**
   a. Interphase > Prophase > Metaphase > Anaphase > Telophase
   b. Interphase > Metaphase > Prophase > Anaphase > Telophase
   c. Interphase > Anaphase > Prophase > Metaphase > Telophase
   d. Anaphase > Interphase > Metaphase > Prophase > Telophase
9. **Barr body or the sex chromatin can be seen in female cells in which phase of cell cycle?**
   a. Prophase b. Interphase
   c. Metaphase d. Anaphase
10. **Maximal chromosomal condensation is seen in which phase of cell cycle?**
    a. Interphase b. Prophase
    c. Anaphase d. Metaphase
11. **Oocyte is arrested in which phase of prophase?**
    a. Diplotene b. Leptotene
    c. Pachytene d. Zygotene
12. **Crossing over or recombination (DNA exchange of homologous segments between two of the four strands) occur in which phase of prophase?**
    a. Pachytene b. Leptotene
    c. Diplotene d. Zygotene
13. **Nucleotide is the basic building block of DNA. It consists of all *except:***
    a. Deoxyribose sugar b. Ribose sugar
    c. Phosphate group d. Nucleic acid base
14. **RNA differs from DNA in that it is single stranded, its sugar moiety is ribose, and it substitutes uracil for:**
    a. Thymine b. Cytosine
    c. Adenine d. Guanine
15. **Not a stop codon:**
    a. UGG b. UAG
    c. UAA d. UGA
16. **Process of messenger RNA production of peptide chain is known as:**
    a. Transcription b. Translation
    c. Gene expression d. Transformation

17. True about MicroRNAs all *except:*
a. 18 to 25 nucleotides
b. Regulate target gene expression at both the transcriptional and translational level
c. Over 1,500 mRNAs have been identified
d. Protein-coding small RNAs

18. Concept of cellular context, similar agents having different actions in different tissues is explained by:
a. Adapter proteins
b. Homeoproteins
c. Epiproteins
d. Proteomics

19. Sequence of gene expression
a. Transcription > epigenetic modifications > translation
b. Translation > transcription > epigenetic modifications
c. Transcription > translation > epigenetic modifications
d. Epigenetic modifications > Transcription > translation

20. Numerical abnormalities due to nondisjunction, is seen in which phase of mitosis or meiosis?
a. Anaphase
b. Prophase
c. Telophase
d. Metaphase

21. With autosomal dominant inheritance, what is the risk of inheritance for child with two heterozygous parents and with one heterozygous parent, respectively?
a. 75%, 50%
b. 50%, 50%
c. 100%, 50%
d. 75%, 0%

22. Which of the following is not included in epigenetic change?
a. Glycosylation
b. Methylation
c. Translation
d. Proteolytic cleavage

23. Enzyme involved in production of complementary DNA:
a. Reverse transcriptase
b. Deoxyribonuclease
c. DNA Polymerase
d. Restriction endonuclease

24. Electrophoresis to separate and quantitate proteins?
a. Southern blotting
b. Northern blotting
c. Western blotting
d. Slot blotting

25. Sequence of PCR in correct order:
a. Denaturation > annealing > amplification
b. Denaturation > amplification > annealing
c. Annealing > amplification > denaturation
d. Amplification > denaturation > annealing

Answer with Explanations

1. a. Mitochondria

(Ref: Speroff 8th/ed p4; U Satyanarayana biochemistry 4th/ed p6)

Mitochondria are double membrane bound organelle.

Mitochondria

- Mitochondrial DNA is the small circular chromosome.
- Mitochondria and mitochondrial DNA are passed almost exclusively from mother to offspring.
- The Mitochondrial matrix contains a circular double stranded DNA (**mtDNA**), RNA and ribosomes.

2. b. Mitochondria contain dsDNA

Ref: Speroff 8th/ed p4; Robbins Basic Pathology 10th/ed p14

- Mitochondrial diseases are transmitted from the mother.
- With the exception of DNA within mitochondria, all of our DNA is packaged in a nucleus surrounded by a nuclear membrane.
- Mitochondria are believed to be descendants of primitive bacteria engulfed by our ancestors, and they still contain some important genes.
- Because ova are rich in mitochondria, diseases due to mitochondrial genes (for example, Leber's optic neuropathy) are transmitted by the mother.
- The mitochondria in sperm are eliminated during fertilization.
- Because the ovum contributes to vast majority of cytoplasmic organelles to fertilized zygote, mitochondrial DNA is virtually entirely **maternally inherited**.

3. d. y, 1

Ref: Speroff 8th/ed p4

The chromosomes vary in size, ranging from 50 million to 250 million base pairs.

Chromosome **1** contains the most genes (2,968), and the **Y** chromosome has the smallest number (231).

4. a. Gene

Ref: Speroff 8th/ed p4; U Satyanarayana biochemistry 4th/ed p543

A single **gene** is a unit of DNA within a chromosome that can be activated to transcribe a specific RNA.

The word **gene** refers to the **functional unit of DNA** that can be transcribed.

5. c. Locus

Ref: Speroff 8th/ed p4

The location of a gene on a particular chromosome is designated its **locus**.

6. a. 2%

Ref: Speroff 8th/ed p5; Harper's illustrated biochemistry 31st/ed p872

- Because there are 22 pairs of autosomes, most genes exist in pairs. The pairs are homozygous when similar and heterozygous when dissimilar.
- Only **2%** of the human genome consists of genes that encode protein synthesis.

7. d. Band Number

Ref: Speroff 8th/ed p5

The usual human karyotype is an arrangement of the chromosomes into pairs, usually after proteolytic treatment and Giemsa staining to produce characteristic banding patterns, allowing a blueprint useful for location. The staining characteristics divide each arm into regions, and each region into bands that are numbered from the centromere outward.

A given point on a chromosome is designated by the following order: chromosome number, arm symbol (p for short arm, q for long arm), region number, and band number.

8. a. Interphase > Prophase > Metaphase > Anaphase > Telophase

Ref: Speroff 8th/ed p6

9. b. Interphase

Ref: Speroff 8th/ed p5

During Interphase, all normal cell activity occurs ***except:*** active division. It is during this stage that the inactive X chromosome (the **Barr body** or the sex chromatin) can be seen in female cells.

10. d. Metaphase

Ref: Speroff 8th/ed p5

During **metaphase**, the chromosomes migrate to the center of the cell, forming a line designated the equatorial plate. The chromosomes are now maximally condensed. The spindle, microtubules of protein that radiate from the centrioles and attach to the centromeres, is formed.

11. a. Diplotene

Ref: Yen & Jaffe's 8th/ed p 134

Oocytes are arrested in **diplotene** stage of prophase of **first** meiotic division.

- During embryonic development, oocytes within the ovary are found as clusters, or germ cell cysts. These clusters form by both aggregation as well as clonal division.
- Meiotic progression in oocytes ceases at the diplotene stage of prophase I when germ cells are enclosed by somatic cells into individual follicles called primordial follicles.
- Oocytes in primordial follicles remain arrested until released to complete meiosis I during ovulation and form the "ovarian reserve", which is thought to ultimately determine reproductive lifespan.
- Massive germ cell loss also occurs in humans, with an estimated 1 million oocytes surviving at birth from approximately 6 million in the fetal human ovary.

12. a. Pachytene

Ref: Speroff 8th/ed p6

- **Pachytene** is the stage in which crossing over or recombination can occur (DNA exchange of homologous segments between two of the four strands).
- Chiasmata are the places of contact where crossovers occur (and can be visualized). This movement of blocks of DNA is a method for creating genetic diversity.

13. b. Ribose Sugar

Ref: Speroff 8th/ed p8; U Satyanarayana Biochemistry 4th/ed p71

- **RNA contains D-ribose** while **DNA contains D-deoxyribose.**

Each molecule of DNA has a deoxyribose backbone, identical repeating groups of deoxyribose sugar linked through phosphodiester bonds. Each deoxyribose is attached in order (giving individuality and specificity) to one of four nucleic acids, the nuclear bases:
A purine—adenine or guanine.
A pyrimidine—thymine or cytosine.

14. a. Thymine

Ref: Speroff 8th/ed p9; U Satyanarayana Biochemistry 4th/ed p70

RNA differs from DNA in that it is single stranded, its sugar moiety is ribose, and it substitutes uracil for **thymine.**
The nucleic acids differ with respect to second pyrimidine base **DNA contains thymine (T) whereas RNA contains uracil (U).**

15. a. UGG

Ref: Speroff 8th/ed p13; Harper's Illustrated Biochemistry 31st/ed p958

- Three codons (UAG, UAA, UGA) are called **stop codons,** because they specify a stop to translation of RNA into protein (like a period at the end of a sentence).
- By contrast, an **open reading frame** is a long series of base pairs between two stop codons; therefore, an open reading frame encodes the amino acid sequence of the protein product.

16. b. Translation

Ref: Speroff 8th/ed p15; Harper's Illustrated Biochemistry 31st/ed p956,957

Gene expression is composed of the following steps: transcription of DNA to RNA, RNA processing to produce functional messenger RNA by splicing out introns, **translation** of messenger RNA on a ribosome to a peptide chain, and protein structural processing to the functional form.

17. d. Protein-coding small RNAs

Ref: Speroff 8th/ed p15; Harper's illustrated biochemistry 31st/ed p912

- MicroRNAs are **non-protein-coding** small RNAs of 18 to 25 nucleotides
- Over 1,500 mRNAs have been identified.

- MicroRNAs are transcribed from genes and regulate target gene expression at both the transcriptional and translational levels.
- All eukaryotic cells have two major classes of RNA , the **protein coding RNAs**, or **mRNAs**, and two forms of abundant **nonprotein coding RNAs** delineated on the basis of size: the large ribosomal RNAs (**rRNAs**) and long noncoding RNAs (**lncRNAs**) and small noncoding transfer RNAs (**tRNAs**), the small nuclear RNAs (**snRNAs**) and the micro and silencing RNAs (**miRNAs** and **siRNAs**)

18. a. Adapter proteins

Ref: Speroff 8th/ed p15

Final result of hormonal activity and gene expression is a reflection of cellular context, the nature and activity of transcription factors as influenced by specific intracellular **adapter proteins.** This explains how similar agents (and similar transcription factors, e.g., the estrogen receptor) can have different actions in different tissues.

19. c. Transcription > Translation > Epigenetic modifications

Ref: Speroff 8th/ed p16

The final expression of a gene may not end with the translation process.