

VU Learning HUB

BIO502 Quiz File

Chapter-wise Solved MCQs

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Lesson 1: What is Genetics?

1. Genetics is defined as the biological study of:

- A) Cell membranes, organelles, and respiration
- B) Genes, heredity, and variation
- C) Environmental ecosystems and taxonomy
- D) Protein folding and tertiary structures

2. In what year did Gregor Mendel formulate the fundamental principles of heredity?

- A) 1848
- B) 1866
- C) 1900
- D) 1953

3. Which experimental organism was selected by Gregor Mendel to formulate the laws of heredity?

- A) Fruit fly (*Drosophila*)
- B) Garden pea (*Pisum sativum*)
- C) Snapdragon plant
- D) *E. coli* bacteria

4. Which of the following is NOT listed as an experimental advantage of the garden pea in the source?

- A) Short generation time
- B) Produces many offspring
- C) Requires a large physical space
- D) Capability to self and cross-pollinate

Answer Key

- 1. B — Genetics is specifically defined as the study of genes, heredity, and biological variation.
- 2. B — Gregor Mendel explained the core principles of heredity in 1866.
- 3. B — Mendel conducted his inheritance experiments using the garden pea plant.
- 4. C — Garden pea plants take up little space rather than requiring large areas.

Lesson 2: Sub Types of Genetics

1. Which subdiscipline of genetics developed historically first?

- A) Population genetics
- B) Molecular genetics
- C) Transmission (Classical) genetics
- D) Quantitative genetics

2. The study of the movement of genes and genetic traits from parents to offspring is known as:

- A) Transmission genetics
- B) Population genetics
- C) Quantitative genetics
- D) Molecular genetics

3. Which branch of genetics focuses on traits determined by many genes simultaneously, such as human skin color and height?

- A) Classical genetics
- B) Quantitative genetics
- C) Population genetics
- D) Microbial genetics

4. Population genetics primarily examines heredity in groups for traits determined by:

- A) Thousands of chromosomes at once
- B) One or a few genes
- C) Environmental factors only
- D) Non-coding RNA molecules

Answer Key

1. C — Transmission genetics developed first historically, followed by population, quantitative, and molecular genetics.
2. A — Transmission or classical genetics deals with the movement of genes and traits across generations.
3. B — Quantitative genetics studies group inheritance for traits controlled by multiple genes simultaneously.
4. B — Population genetics investigates traits within populations governed by one or a few genes.

Lesson 3: Common Genetics Terminologies

1. In genetic terminology, a variant for a heritable character (e.g., white or brown color) is called a:

- A) Locus
- B) Trait
- C) Genome
- D) Karyotype

2. A cross between two true-breeding organisms with contrasting traits is designated as a:

- A) Pure cross
- B) Hybrid cross
- C) Test cross
- D) Back cross

3. The physical appearance or observable characteristic of an organism is termed its:

- A) Genotype
- B) Phenotype
- C) Allele
- D) Karyotype

4. In Gregor Mendel's pea experiments, which seed shape trait was dominant over wrinkled seeds?

- A) Oval
- B) Round
- C) Flat
- D) Elongated

Answer Key

1. B — A trait is defined as a specific variant of a heritable character.
2. A — A pure cross occurs between true-breeding parents.
3. B — Phenotype refers to physical appearance, whereas genotype represents genetic makeup.
4. B — Round seed shape exhibited dominance over the wrinkled seed trait in Mendel's crosses.

Lesson 4: Mendel's Law of Dominance

1. Mendel's Law of Dominance states that crossing two parents pure for contrasting traits results in F1 offspring showing:

- A) Both parental traits equally
- B) A blend of both parental traits
- C) Only one version of the trait (the dominant phenotype)
- D) Neither parental trait

2. When Mendel crossed true-breeding purple-flowered plants with true-breeding white-flowered plants, all F1 plants had:

- A) Pink flowers
- B) White flowers
- C) Purple flowers
- D) Striped flowers

3. Where does a gene for a particular inherited character reside on a homologous chromosome?

- A) Centromere
- B) Locus (position)
- C) Telomere
- D) Spindle pole

4. According to the current model of inheritance, an organism inherits how many alleles for each character?

- A) One allele total
- B) Two alleles, one from each parent
- C) Four alleles from the mother
- D) Three alleles randomly

Answer Key

1. C — Only the dominant form of the trait appears in the F1 generation during a monohybrid cross of true-breeding parents.
2. C — Purple flower color was completely dominant over white in the F1 generation.
3. B — Genes reside at specific physical locations called loci on homologous chromosomes.
4. B — Organisms inherit two alleles per gene, receiving one from each parent.

Lesson 5: Monohybrid Cross and Dihybrid Cross

1. A cross-fertilization between true-breeding plants differing in only ONE character is called a:

- A) Dihybrid cross
- B) Monohybrid cross
- C) Polyhybrid cross

D) Test cross

2. Mendel utilized monohybrid crosses specifically to determine the:

- A) Interaction of multiple non-allelic genes
- B) Segregation of alleles at a single gene locus
- C) Linkage distance between two chromosome arms
- D) Rate of cytoplasmic inheritance

3. In dependent segregation, alleles at two different loci are transmitted to gametes:

- A) Independently as separate units
- B) Together as a single unit
- C) Only in female gametes
- D) Via crossing over in meiosis II

4. When Mendel performed a dihybrid cross tracking seed shape and seed color, how did the two traits transmit to offspring?

- A) As an linked package
- B) Independently of each other
- C) Through blending inheritance
- D) Exclusively via maternal DNA

Answer Key

1. B — A monohybrid cross examines inheritance for a single contrasting character.
2. B — Monohybrid crosses demonstrate how alleles separate at a single locus during gamete formation.
3. B — Dependent segregation implies that alleles at two gene loci segregate together as a unit.
4. B — Dihybrid crosses confirmed that distinct traits segregate independently during inheritance.

Lesson 6: Law of Segregation

1. According to the Law of Segregation, when do the two alleles responsible for a trait separate?

- A) During fertilization
- B) During gamete formation (gametogenesis)
- C) During zygote cleavage
- D) During organogenesis

2. When are separated alleles recombined to re-establish diploid pairs?

- A) During fertilization
- B) During meiotic prophase I
- C) During DNA replication in interphase
- D) During cell senescence

3. If a pure-breeding yellow seed plant (YY) is crossed with a pure-breeding green seed plant (yy), the genotype of the F1 hybrid is:

- A) YY
- B) yy
- C) Yy
- D) YYyy

4. The Modern Concept of Segregation states that every gene possesses:

- A) A single allele that mutates in every generation
- B) Two alleles that separate during gametogenesis and reunite during fertilization
- C) Continuous non-particulate fluids
- D) Multiple structural centromeres

Answer Key

1. B — Alleles separate during gametogenesis so that each gamete receives only one allele.
2. A — Fertilization reunites haploid gametes, restoring allele pairs in the offspring.
3. C — Combining Y and y gametes yields heterozygous Yy F1 hybrids.
4. B — The modern principle asserts allele pairs segregate into gametes and reunite at fertilization.

Lesson 7: Mendel's Law of Independent Assortment**1. What phenotypic ratio did Mendel observe in the F2 generation of a dihybrid cross with independent assortment?**

- A) 3:1
- B) 1:2:1
- C) 9:3:3:1
- D) 1:1:1:1

2. In Mendel's dihybrid experiments, which combination of pod color and seed color traits were dominant?

- A) Yellow pod color and green seed color
- B) Green pod color (G) and yellow seed color (Y)
- C) Yellow pod color and yellow seed color
- D) Green pod color and green seed color

3. What is the genotype of F1 plants produced from crossing true-breeding green-pod/yellow-seed (GGYY) and yellow-pod/green-seed (ggyy) plants?

- A) GGyy
- B) ggYY
- C) GgYy
- D) GGYy

4. The Law of Independent Assortment applies when genes governing different traits are located:

- A) Close together on the same chromosome arm
- B) On different chromosomes or far apart
- C) Exclusively on mitochondrial DNA
- D) On the same nucleosome linker

Answer Key

1. C — Self-pollination of F1 dihybrids yields a characteristic 9:3:3:1 phenotypic ratio in F2.
2. B — Green pod color (G) and yellow seed color (Y) are dominant traits.
3. C — F1 plants are double heterozygotes (GgYy) displaying dominant phenotypes.
4. B — Independent assortment occurs for genes on non-homologous chromosomes or far apart.

Lesson 8: Modern Genetic Concepts

1. How is genetic material organized in prokaryotic cells compared to eukaryotic cells?

- A) Prokaryotes have multiple linear chromosomes; eukaryotes have one circular chromosome
- B) Prokaryotes generally have one circular chromosome; eukaryotes have linear chromosomes in their nuclei
- C) Both prokaryotes and eukaryotes lack chromosomes
- D) Prokaryotes possess 46 linear chromosomes

2. How is a "gene" formally defined in modern genetics?

- A) A cytoplasmic lipid layer
- B) A heredity unit on chromosomes
- C) An enzyme involved in glucose digestion
- D) A protein band stained by Q-banding

3. Patterns of inheritance that deviate from standard Mendelian rules include:

- A) Autosomal dominant inheritance
- B) Autosomal recessive inheritance
- C) Linkage, maternal effect, and mitochondrial inheritance
- D) Monohybrid dominance

4. In general genetic terminology, what does the word "mutation" indicate?

- A) A permanent increase in cellular size
- B) "A change" in genetic material
- C) Complete destruction of nuclear envelope
- D) Continuous blending of phenotypes

Answer Key

- 1. B — Prokaryotic genomes typically consist of a single circular chromosome, while eukaryotes possess linear nuclear chromosomes.
- 2. B — A gene is defined as a functional heredity unit located on a chromosome.
- 3. C — Non-Mendelian inheritance includes exceptions like linkage, epigenetics, and mitochondrial inheritance.
- 4. B — Broadly defined, mutation indicates a change in genetic sequence or structure.

Lesson 9: What is Heredity?

1. Heredity is explicitly defined as the:

- A) Synthesis of proteins from amino acids
- B) Transmission of traits from parents to offspring
- C) Division of somatic cells during mitosis
- D) Replication of bacterial cell walls

2. Prior to the 19th century, most biologists believed inheritance was:

- A) Particulate
- B) Blending
- C) Epigenetic
- D) Chromosomal

3. What main problem caused scientists to reject the blending hypothesis?

- A) Cells would stop growing
- B) New genetic variations would quickly be diluted rather than passed onward
- C) Chromosomes would break during meiosis
- D) Phenotypes would become strictly dominant

4. According to the particulate hypothesis demonstrated by Mendel, parents pass on:

- A) Mixing liquids like blue and yellow paint
- B) Distinct heritable units (genes) inherited unchanged
- C) Acquired environmental traits
- D) Cytoplasmic organelles only

Answer Key

1. B — Heredity refers to passing biological traits from parents to their progeny.
2. B — Early biologists incorrectly assumed traits blended together like fluid mixing.
3. B — Blending would dilute variation rapidly, making evolutionary selection impossible.
4. B — The particulate model proves discrete units (genes/alleles) pass intact between generations.

Lesson 10: Mendelian and Non-Mendelian Inheritance**1. Which of the following is a key feature of Gregor Mendel's core inheritance model?**

- A) Traits are controlled by dozens of interacting genes
- B) Each trait is controlled by a single gene with two alleles showing clear dominance/recessiveness
- C) Alleles blend irreversibly in F1 hybrids
- D) Inheritance is exclusively maternal

2. Which pattern of inheritance strictly obeys Mendelian rules?

- A) Mitochondrial inheritance
- B) Autosomal dominant inheritance
- C) Epigenetic imprinting
- D) Incomplete dominance

3. Inheritance patterns that deviate from Mendelian predictions are termed:

- A) Classical genetics
- B) Non-Mendelian inheritance
- C) Monohybrid segregation
- D) Pure breeding

4. Which of the following is explicitly listed as an example of Non-Mendelian inheritance?

- A) Law of Segregation
- B) Law of Dominance
- C) Incomplete dominance and co-dominance
- D) Autosomal recessive cross

Answer Key

1. B — Classical Mendelian traits depend on one gene with two alleles exhibiting complete dominance.
2. B — Autosomal dominant traits follow standard Mendelian transmission patterns.
3. B — Deviations from expected Mendelian ratios are categorized as Non-Mendelian inheritance.

4. C — Incomplete dominance and co-dominance represent classic non-Mendelian modifications.

Lesson 11: Gene Interaction

1. Which of the following best defines "gene interaction"?

- A) A single gene controlling multiple unrelated traits
- B) The combined effect of two or more genes on a single phenotypic trait
- C) The independent assortment of alleles during meiosis
- D) A mutation in a promoter region altering transcription

2. In Labrador retrievers, coat color is determined by the interaction of the B and E genes. A dog with genotype $bbEe$ will have which coat color?

- A) Black
- B) Brown (chocolate)
- C) Yellow
- D) Albino

3. The 9:3:3:1 phenotypic ratio in a dihybrid cross is modified to 9:7 when:

- A) One gene masks the effect of another (epistasis)
- B) Two genes with complementary action interact to produce a single phenotype
- C) A single gene has multiple alleles
- D) Genes are linked on the same chromosome

4. Which term describes a situation where one gene interferes with or masks the phenotypic expression of another non-allelic gene?

- A) Pleiotropy
- B) Epistasis
- C) Codominance
- D) Incomplete dominance

Answer Key

- 1. B — Gene interaction occurs when two or more genes combine to influence a single trait.
- 2. B — The bb genotype produces brown pigment, and E_* allows pigment deposition in the coat.
- 3. B — Complementary gene action (9:7) occurs when two genes must both have dominant alleles to produce the phenotype.
- 4. B — Epistasis is the masking of one gene's expression by another gene at a different locus.

Lesson 12: Epistasis

1. In the 12:3:1 epistatic ratio, the "12" class represents:

- A) The recessive phenotype
- B) The dominant epistatic phenotype masking both other genes
- C) The double recessive phenotype
- D) A lethal phenotype

2. Summer squash fruit color shows dominant epistasis where W (white) masks Y (yellow) and y (green). A plant with genotype $WwYy$ will produce:

- A) Yellow fruit
- B) Green fruit

- C) White fruit
- D) Striped fruit

3. Recessive epistasis (9:3:4 ratio) is exemplified by:

- A) Labrador retriever coat color
- B) Bombay blood group phenotype
- C) Mouse coat color (*C* gene masking *A* gene)
- D) Human eye color

4. The key difference between dominant and recessive epistasis is:

- A) Dominant epistasis requires two recessive alleles to mask; recessive requires one dominant allele
- B) Dominant epistasis is masked by a dominant allele; recessive epistasis is masked by homozygous recessive alleles
- C) Dominant epistasis only occurs in plants; recessive only in animals
- D) There is no difference; the terms are interchangeable

Answer Key

1. B — In 12:3:1, the dominant epistatic allele masks the other gene, producing 12/16 in that class.
2. C — The dominant W* allele masks all other color genes, producing white fruit.
3. C — In mice, homozygous recessive cc (albino) masks the A* gene for coat pattern.
4. B — Dominant epistasis uses a dominant masking allele; recessive epistasis uses homozygous recessive.

Lesson 13: Pleiotropy

1. Pleiotropy is best defined as:

- A) Multiple genes affecting one trait
- B) A single gene affecting multiple, seemingly unrelated phenotypic traits
- C) Two alleles both expressed in the heterozygote
- D) Genes located on the same chromosome

2. Which human disorder is a classic example of pleiotropy?

- A) Cystic fibrosis (affects lungs, pancreas, sweat glands)
- B) Huntington's disease (affects only the brain)
- C) Color blindness (affects only vision)
- D) Hemophilia (affects only blood clotting)

3. In pea plants, the gene controlling flower color also affects seed coat color and leaf axil pigmentation. This is an example of:

- A) Epistasis
- B) Pleiotropy
- C) Polygenic inheritance
- D) Linkage

4. The primary challenge in studying pleiotropic genes is:

- A) They are always lethal
- B) Disentangling direct gene effects from downstream cascading consequences
- C) They cannot be mapped
- D) They only occur in prokaryotes

Answer Key

1. B — Pleiotropy is one gene influencing multiple distinct traits.
2. A — The CFTR mutation in cystic fibrosis affects multiple organ systems.
3. B — One pea gene affects flower, seed, and leaf traits (pleiotropy).
4. B — Pleiotropic effects cascade, making direct vs. indirect effects hard to separate.

Lesson 14: Polygenic Inheritance

1. Polygenic inheritance is characterized by:

- A) A single gene with many alleles
- B) Multiple genes contributing additively to a single quantitative trait
- C) One gene masking another
- D) Traits controlled exclusively by the environment

2. Human skin color is a polygenic trait. If three genes (A, B, C) control skin pigmentation with additive effects, how many phenotypic classes are expected in the F2?

- A) 3
- B) 5
- C) 7
- D) 9

3. Which of the following is NOT a polygenic trait?

- A) Human height
- B) Wheat kernel color
- C) ABO blood group
- D) Human eye color (partially)

4. The distribution of polygenic traits in a population typically follows:

- A) A bimodal distribution
- B) A normal (bell-shaped) distribution
- C) A uniform distribution
- D) A discontinuous distribution

Answer Key

1. B — Polygenic traits involve multiple genes with small additive effects.
2. C — Three genes with additive alleles produce 7 phenotypic classes (0-6 active alleles).
3. C — ABO blood group is controlled by a single gene with multiple alleles, not polygenic.
4. B — Quantitative polygenic traits show continuous normal distribution.

Lesson 15: Multiple Alleles

1. The ABO blood group system is controlled by how many alleles?

- A) Two (I^A and I^B)
- B) Three (I^A , I^B , and i)
- C) Four (I^A , I^B , i , and I^O)
- D) One with multiple mutations

2. A person with genotype $I^A i$ has which blood type?

- A) Type A
- B) Type B
- C) Type AB
- D) Type O

3. In the ABO system, the I^A and I^B alleles are:

- A) Completely dominant over each other
- B) Codominant with each other, both dominant over i^*
- C) Recessive to i^*
- D) Incompletely dominant

4. How many distinct genotypes are possible in the ABO blood group system?

- A) 3
- B) 4
- C) 6
- D) 9

Answer Key

1. B — ABO is controlled by three alleles: I^A , I^B , and i^* .
2. A — I^A is dominant over i^* , producing Type A blood.
3. B — I^A and I^B are codominant; both dominate the recessive i^* .
4. C — Six genotypes: $I^A I^A$, $I^A i$, $I^B I^B$, $I^B i$, $I^A I^B$, ii^* .

Lesson 16: Codominance and Incomplete Dominance

1. In codominance, the heterozygote phenotype:

- A) Is intermediate between the two homozygotes
- B) Shows both parental phenotypes simultaneously
- C) Resembles the dominant homozygote
- D) Resembles the recessive homozygote

2. Pink snapdragon flowers from a red $\times$ white cross demonstrate:

- A) Codominance
- B) Incomplete dominance
- C) Complete dominance
- D) Epistasis

3. A person with AB blood type is an example of:

- A) Incomplete dominance
- B) Codominance (both A and B antigens expressed)
- C) Complete dominance
- D) Pleiotropy

4. The key distinction between codominance and incomplete dominance is:

- A) Codominance shows both traits fully; incomplete dominance shows an intermediate blend
- B) They are the same phenomenon
- C) Codominance only occurs in plants
- D) Incomplete dominance only occurs in animals

Answer Key

1. B — Codominant heterozygotes express both alleles distinctly.
2. B — Pink is an intermediate blend (incomplete dominance).
3. B — AB blood expresses both A and B antigens (codominance).
4. A — Codominance = both visible; incomplete = intermediate.

Lesson 17: Lethal Alleles

1. A lethal allele is defined as:

- A) An allele that always kills the organism
- B) An allele that causes death when present in a certain genotype (often homozygous recessive)
- C) A dominant allele that is always expressed
- D) An allele on the Y chromosome

2. In mice, the A_y (yellow) allele is dominant for coat color but recessive lethal. A cross between two yellow mice ($A_y A \times A_y A$) produces:

- A) 3 yellow : 1 agouti
- B) 2 yellow : 1 agouti
- C) 1 yellow : 2 agouti
- D) All yellow

3. Tay-Sachs disease is caused by a:

- A) Dominant lethal allele
- B) Recessive lethal allele (homozygous recessive is fatal in early childhood)
- C) Codominant lethal allele
- D) Y-linked lethal allele

4. The 2:1 phenotypic ratio (instead of 3:1) in a monohybrid cross suggests:

- A) Incomplete dominance
- B) A recessive lethal allele killing one homozygous class
- C) Codominance
- D) Linkage

Answer Key

1. B — Lethal alleles cause death in specific genotypes (e.g., homozygous).
2. B — $A_y A_y$ is lethal, so the ratio is 2 yellow ($A_y A$) : 1 agouti (AA^*).
3. B — Tay-Sachs is autosomal recessive lethal.
4. B — A 2:1 ratio indicates one homozygous class is lethal.

Lesson 18: Gene-Environment Interaction

1. Phenotypes result from:

- A) Genotype alone
- B) Environment alone
- C) Complex interactions between genotype and environment
- D) Random chance

2. In Himalayan rabbits and Siamese cats, fur color at the body extremities is dark because the enzyme tyrosinase is:

- A) Active at 15 °C
- B) Active at 25 °C
- C) Inactivated above 33 °C, restricting dark pigment to cooler extremities
- D) 42 °C

3. Environmental soil pH directly alters the flower color of which plant?

- A) Garden pea (*Pisum sativum*)
- B) Hydrangea
- C) Snapdragon
- D) Blue-eyed Mary

4. Arctic foxes change coat color between summer and winter due to environmental influence on:

- A) Chromosomal translocations
- B) Gene expression and pigment synthesis
- C) Meiotic non-disjunction
- D) Kinetochore attachment

Answer Key

1. A — Phenotypes result from complex interactions between an organism's genotype and its environment.
2. C — Tyrosinase inactivates above 33 °C, restricting dark pigment to cooler extremities.
3. B — Soil pH strongly influences the phenotypic flower color of Hydrangea plants.
4. B — Seasonal temperature changes alter gene expression for fur pigmentation in arctic foxes.

Lesson 19: Euchromatin and Heterochromatin

1. Chromatin that is less condensed, stains lightly, and is transcriptionally active is termed:

- A) Heterochromatin
- B) Euchromatin
- C) Constitutive heterochromatin
- D) Kinetochore DNA

2. In contrast to euchromatin, heterochromatin is characterized by being:

- A) Unwound and open for continuous transcription
- B) Highly condensed and transcriptionally inactive/silent
- C) Lacking histone octamers
- D) Exclusive to prokaryotic nucleoids

3. Which type of heterochromatin remains permanently condensed and does NOT revert to euchromatin?

- A) Facultative heterochromatin
- B) Constitutive heterochromatin
- C) Linker heterochromatin
- D) Reversible euchromatin

4. Facultative heterochromatin is best described as:

- A) Permanent centromeric DNA repeats

- B) Euchromatin that takes on heterochromatic compactness during specific developmental phases
- C) Unwound 10-nm fiber
- D) Non-coding RNA molecules

Answer Key

1. B — Euchromatin represents unwound, active genomic regions that stain lightly.
2. B — Heterochromatin is tightly packed, dark-staining, and transcriptionally silent.
3. B — Constitutive heterochromatin permanently stays in the condensed, inactive state.
4. B — Facultative heterochromatin is euchromatin converted to condensed heterochromatin during development.

Lesson 20: Staining and Banding Chromosomes

1. During Feulgen staining, cells undergo mild hydrolysis in 1N HCl at 60 °C for 10 minutes to expose what chemical group in deoxyribose?

- A) Free phosphate group
- B) Free aldehyde group
- C) Amino group
- D) Methyl group

2. Which chromosome banding technique produces fluorescent bands under UV light using quinacrine mustard?

- A) G Banding
- B) C Banding
- C) Q Banding
- D) R Banding

3. C Banding specifically stains regions of chromosomes that correspond to:

- A) Transcriptionally active euchromatin
- B) Constitutive heterochromatin (centromeric regions)
- C) Telomeric single-stranded overhangs
- D) RNA polymerase binding sites

4. R Banding (Reverse Banding) visualizes zones located between Q bands as which color?

- A) Red
- B) Blue
- C) Green
- D) Yellow

Answer Key

1. B — Acid hydrolysis in Feulgen staining releases free aldehyde groups from deoxyribose.
2. C — Q Banding utilizes quinacrine mustard staining to yield fluorescent bands under UV light.
3. B — C Banding selectively stains constitutive heterochromatin located mainly at centromeres.
4. C — R Banding produces reverse bands located between Q bands that appear green.

Lesson 21: Nucleosomes

- 1. A basic nucleosome core particle consists of approximately 147 base pairs of DNA wrapped around a protein core of how many histones?**
 - A) 4 histones
 - B) 6 histones
 - C) 8 histones (octamer)
 - D) 10 histones
- 2. The segment of DNA spanning between adjacent nucleosomes is called linker DNA and typically ranges from:**
 - A) 5–10 base pairs
 - B) 20–60 base pairs
 - C) 147–200 base pairs
 - D) 1000–2000 base pairs
- 3. Histone proteins are small and positively charged because they contain high percentages of which basic amino acids?**
 - A) Alanine and Glycine
 - B) Lysine and Arginine
 - C) Tryptophan and Tyrosine
 - D) Leucine and Valine
- 4. Which histone functions outside the octamer core to help stabilize higher-order chromatin packaging?**
 - A) H2A
 - B) H2B
 - C) H3
 - D) H1

Answer Key

1. C — The nucleosome core consists of 147 bp of DNA wrapped around an octamer of eight histone proteins.
2. B — Linker DNA connecting nucleosome cores ranges between 20 to 60 base pairs in length.
3. B — Histones carry an overall positive charge due to high amounts of basic Lysine and Arginine.
4. D — Histone H1 binds to linker DNA outside the eight-histone core octamer.

Lesson 22: Chromatin and Chromosomes

- 1. Chromatin is defined as the complex of eukaryotic DNA combined with histones and approximately equal mass of:**
 - A) Ribosomal RNA
 - B) Non-histone proteins
 - C) Lipopolysaccharides
 - D) Centromeric RNA primers
- 2. According to the comparison in the handout, "Chromosomes" represent tightly packaged DNA found exclusively during:**
 - A) Interphase
 - B) Cell division (M phase)
 - C) The G_0 resting state

D) S phase DNA replication

3. In contrast to condensed chromosomes, unwound "Chromatin" is present throughout which cell cycle phase?

- A) Anaphase
- B) Metaphase
- C) Interphase
- D) Telophase

4. When DNA is in its unwound chromatin state during interphase, it is actively being used for:

- A) Spindle fiber attachment
- B) Macromolecule synthesis (transcription/gene expression)
- C) Chromosome karyotyping
- D) Barr body condensation

Answer Key

1. B — Chromatin contains DNA, histones, and an equal mass of diverse non-histone proteins.
2. B — Tightly packaged chromosomes are visible only during active cell division.
3. C — Unwound chromatin is present throughout interphase.
4. B — Unwound interphase chromatin allows DNA access for macromolecule synthesis.

Lesson 23: Higher Order Chromatin Folding

1. The first basic level of chromatin packaging forms an 11-nm structure commonly known as the:

- A) 30-nm fiber
- B) "Beads-on-a-string" form of chromatin
- C) Metaphase chromosome scaffold
- D) Kinetochore plate

2. In the next level of folding, nucleosomes pack together to form a fiber with a diameter of:

- A) 2 nm
- B) 10 nm
- C) 30 nm
- D) 100 nm

3. Higher-order 30-nm chromatin fibers organize into extended loops attached to a central structural support called the:

- A) Centromere CDE-III domain
- B) Chromosome scaffold / nuclear matrix
- C) Histone fold domain
- D) Telomerase complex

4. Which histone protein plays a crucial role in promoting the packing of 10-nm fibers into the 30-nm chromatin fiber?

- A) H1
- B) H2A
- C) H2B
- D) H4

Answer Key

1. B — Unfolded nucleosomes form the 10-nm / 11-nm "beads-on-a-string" chromatin structure.
2. C — Nucleosome assembly coils into a thicker 30-nm chromatin fiber.
3. B — 30-nm fibers fold into large DNA loops anchored to a protein chromosome scaffold.
4. A — Histone H1 mediates the coiling of 10-nm nucleosomes into the 30-nm fiber.

Lesson 24: Kinetochore

1. The kinetochore is the specific structure within the centromere region where spindle fibers attach, composed of:

- A) Pure lipids
- B) Both DNA and protein
- C) Single-stranded RNA only
- D) Histone H1 exclusively

2. The centromeric DNA sequence in yeast (CEN DNA) is approximately how many base pairs long?

- A) 20 base pairs
- B) 120 base pairs
- C) 147 base pairs
- D) 1000 base pairs

3. CEN DNA is organized into how many distinct sub-domains?

- A) Two sub-domains (CDE-I and CDE-II)
- B) Three sub-domains (CDE-I, CDE-II, and CDE-III)
- C) Four sub-domains (CDE-I through CDE-IV)
- D) Five sub-domains

4. While mutations in CDE-I and CDE-II have no effect on chromosome segregation, a point mutation in which sub-domain completely eliminates centromere function?

- A) CDE-I
- B) CDE-II
- C) CDE-III
- D) CDE-IV

Answer Key

1. B — The kinetochore is a specialized complex made of both DNA and protein.
2. B — CEN DNA spans roughly 120 base pairs within the centromere.
3. B — CEN DNA consists of three sub-domains named CDE-I, CDE-II, and CDE-III.
4. C — A single point mutation in CDE-III abolishes centromeric function during segregation.

Lesson 25: Karyotyping

1. A karyotype is formally defined as the general morphology of the somatic chromosomes arranged in descending order of:

- A) Staining intensity
- B) Chromosome size

- C) Centromere thickness
- D) Base pair mutation rate

2. A diagrammatic representation of a species' karyotype showing all morphological chromosome features is called an:

- A) Idiotype
- B) Phenotype
- C) Genotype
- D) Nucleosome map

3. In preparing a human karyotype from blood culture, which chemical solution is added to make cells swell so chromosomes spread out?

- A) Concentrated 1N HCl
- B) Hypotonic solution
- C) Quinacrine mustard
- D) Fixative ether

4. A standard human somatic cell karyotype displays how many total chromosomes organized into 23 pairs?

- A) 23
- B) 44
- C) 46
- D) 92

Answer Key

1. B — Karyotypes arrange somatic chromosomes in descending order of size.
2. A — An idiotype is a diagrammatic representation showing a species' full chromosome layout.
3. B — Hypotonic treatment swells cells and bursts red blood cells, allowing metaphase chromosomes to spread out.
4. C — Human body cells contain 46 total chromosomes in 23 pairs (22 pairs of autosomes, 1 pair of sex chromosomes).

Lesson 26: Chromosome Number and Structure

1. How many chromosomes do prokaryotic organisms typically possess?

- A) One circular chromosome
- B) 23 pairs
- C) 46 individual chromosomes
- D) Multiple linear chromosomes

2. Which of the following is a key structural difference between prokaryotic and eukaryotic chromosomes?

- A) Prokaryotic chromosomes are linear; eukaryotic are circular
- B) Prokaryotic chromosomes are circular and lack histones; eukaryotic are linear and associate with histones
- C) Both are linear and associate with histones
- D) Prokaryotic chromosomes are diploid; eukaryotic are haploid

3. The term "ploidy" refers to:

- A) The number of genes on a chromosome
- B) The number of complete sets of chromosomes in a cell
- C) The length of telomeres
- D) The degree of chromatin condensation

4. A haploid human gamete contains:

- A) 46 chromosomes
- B) 23 chromosomes
- C) 92 chromosomes
- D) 22 chromosomes

Answer Key

1. A — Most prokaryotes have a single circular chromosome.
2. B — Prokaryotic chromosomes are typically circular DNA without histones; eukaryotic chromosomes are linear and wrapped around histones.
3. B — Ploidy denotes the number of chromosome sets.
4. B — Human gametes are haploid with 23 chromosomes.

Lesson 27: DNA Supercoiling

1. DNA supercoiling refers to:

- A) The double helix structure itself
- B) The coiling of the DNA double helix upon itself (over- or under-winding)
- C) The separation of DNA strands during replication
- D) The binding of histones to DNA

2. Which enzyme is required for unwinding the supercoiled loops of the E. coli chromosome during replication?

- A) DNA polymerase
- B) DNA gyrase (a topoisomerase)
- C) Helicase
- D) Primase

3. Positive supercoiling (overwinding) of DNA:

- A) Facilitates strand separation
- B) Makes strand separation more difficult
- C) Has no effect on replication
- D) Only occurs in eukaryotes

4. Topoisomerases function to:

- A) Synthesize RNA primers
- B) Relieve torsional strain by cutting and rejoining DNA strands
- C) Add telomere repeats
- D) Methylate cytosine bases

Answer Key

1. B — Supercoiling is the twisting of the helix axis itself.
2. B — DNA gyrase relieves supercoiling ahead of the replication fork in E. coli*.

3. B — Overwinding tightens the helix, hindering strand separation.
4. B — Topoisomerases cut/rejoin DNA to relieve supercoiling tension.

Lesson 28: The Double Helix

1. The DNA double helix was described by Watson and Crick as:

- A) A left-handed helix with parallel strands
- B) A right-handed helix with antiparallel strands
- C) A triple helix
- D) A single-stranded loop

2. In the Watson-Crick model, base pairing follows the rule:

- A) A pairs with C, G pairs with T
- B) A pairs with T, G pairs with C
- C) A pairs with G, T pairs with C
- D) All bases pair randomly

3. The sugar-phosphate backbones of the two DNA strands are:

- A) Parallel (both 5' to 3')
- B) Antiparallel (one 5' to 3', the other 3' to 5')
- C) Linked by hydrogen bonds
- D) Identical in sequence

4. How many hydrogen bonds form between G and C base pairs?

- A) One
- B) Two
- C) Three
- D) Four

Answer Key

1. B — B-DNA is a right-handed antiparallel double helix.
2. B — Chargaff pairing: A-T (2 H-bonds), G-C (3 H-bonds).
3. B — Strands run antiparallel.
4. C — G-C pairs share three hydrogen bonds.

Lesson 29: Nucleotides — Structure and Bases

1. Which three components form the basic monomeric structure of a nucleotide?

- A) A 5-carbon pentose sugar, a nitrogenous base, and a phosphate group
- B) A 6-carbon hexose sugar, a fatty acid, and a phosphate group
- C) An amino acid, a nitrogenous base, and a carboxyl group
- D) A glycerol backbone, a nitrogenous base, and a lipid tail

2. How does a nucleoside differ from a complete nucleotide?

- A) A nucleoside contains a phosphate group but lacks a nitrogenous base
- B) A nucleoside consists only of a pentose sugar and a nitrogenous base, lacking a phosphate group
- C) A nucleoside is a long polymer containing more than 10 nucleotides
- D) A nucleoside is made exclusively of double-ring purines

3. In a polynucleotide chain, adjacent nucleotide monomers are joined together by which type of covalent bond?

- A) Peptide bonds
- B) Phosphodiester bonds
- C) Glycosidic bonds
- D) Hydrogen bonds

4. In the 5' to 3' orientation of a polynucleotide strand, phosphodiester bonds link the 5'-phosphate of one nucleotide to which group of the adjacent sugar?

- A) 1'-position
- B) 2'-hydroxyl
- C) 3'-hydroxyl
- D) 4'-carbon

Answer Key

1. A — A complete nucleotide consists of a 5-carbon pentose sugar, a nitrogenous base, and a phosphate group.
2. B — A nucleoside is a monomer composed solely of a sugar bonded to a nitrogenous base without a phosphate group.
3. B — Nucleotide monomers in a polynucleotide chain are covalently joined together by phosphodiester bonds.
4. C — Phosphodiester linkages connect the 3'-hydroxyl group of one sugar to the 5'-phosphate group of the next nucleotide in a 5' to 3' direction.

Lesson 29: Chargaff's Rules

1. Chargaff's first rule states that in DNA:

- A) $[A] = [T]$ and $[G] = [C]$
- B) $[A] = [G]$ and $[T] = [C]$
- C) $[A] + [G] = [T] + [C]$
- D) All four bases are equal

2. According to Chargaff's G-C rule, the percentage of (G+C) in DNA is:

- A) Identical across all living species
- B) Constant within a species, but often differs between species
- C) Variable within a single individual organism
- D) Always 50%

3. If a DNA sample contains 30% adenine, what percentage is guanine?

- A) 30%
- B) 20%
- C) 40%
- D) 70%

4. Chargaff's rules provided critical evidence for:

- A) The central dogma
- B) The Watson-Crick double helix model with specific base pairing
- C) The existence of introns
- D) DNA methylation patterns

Answer Key

1. A — $[A]=[T]$ and $[G]=[C]$ in duplex DNA.
2. B — $(G+C)\%$ is characteristic of a species.
3. B — If $A=30\%$, $T=30\%$, then $G+C=40\%$, so $G=20\%$.
4. B — Base equivalence suggested the complementary double helix.

Lesson 30: Conformations of DNA

1. Which DNA conformation is characterized as a left-handed helix?

- A) A-DNA
- B) B-DNA
- C) Z-DNA
- D) C-DNA

2. Which form of DNA is the widest among the three primary helical conformations?

- A) A-DNA
- B) B-DNA
- C) Z-DNA
- D) C-DNA

3. In the standard B-DNA conformation, the major groove is described as:

- A) Narrow and deep
- B) Wide and accessible for protein binding
- C) Absent
- D) Identical to the minor groove

4. Z-DNA formation is favored by:

- A) High humidity and low salt
- B) Alternating purine-pyrimidine sequences under high salt or negative supercoiling
- C) AT-rich sequences
- D) RNA-DNA hybrids only

Answer Key

1. C — Z-DNA is left-handed.
2. A — A-DNA is the widest (short and broad).
3. B — B-DNA has a wide major groove where proteins bind.
4. B — Alternating GC sequences favor Z-DNA under torsional stress.

Lesson 31: Base Composition

1. The $(A+T)/(G+C)$ ratio in DNA:

- A) Is constant across all species
- B) Varies between species and can be used for taxonomic classification
- C) Is always greater than 1
- D) Cannot be measured

2. According to Chargaff's G-C rule, the percentage of $(G+C)$ in DNA is:

- A) Identical across all living species

- B) Constant within a species, but often differs between species
- C) Variable within a single individual organism
- D) Inversely proportional to genome size

3. A bacterial species with 70% (G+C) content would be expected to have:

- A) A higher melting temperature (T_m) than a species with 40% (G+C)
- B) A lower melting temperature than a species with 40% (G+C)
- C) The same T_m regardless of G+C content
- D) No double-stranded DNA

4. The greater thermal stability of G-C rich DNA is due to:

- A) Stronger phosphodiester bonds
- B) Three hydrogen bonds per G-C pair vs. two per A-T pair, plus stronger base stacking
- C) Covalent crosslinks
- D) Methylation

Answer Key

1. B — Base composition ratios differ taxonomically.
2. B — (G+C)% is species-specific.
3. A — Higher G+C means higher T_m (more H-bonds).
4. B — Triple H-bonds and stacking stabilize G-C rich DNA.

Lesson 32: Cell Cycle

1. The cell cycle consists of:

- A) Mitosis only
- B) Interphase (G1, S, G2) and M phase (mitosis/cytokinesis)
- C) Meiosis I and II only
- D) G0 phase only

2. During which phase does DNA replication occur?

- A) G1
- B) S phase
- C) G2
- D) M phase

3. The G1 checkpoint (restriction point) primarily assesses:

- A) DNA damage and cell size/nutrient status before committing to S phase
- B) Chromosome alignment
- C) Spindle formation
- D) Cytokinesis completion

4. Cells that exit the cell cycle and enter a quiescent state are in:

- A) G1
- B) S
- C) G0
- D) M

Answer Key

1. B — Interphase (growth/DNA synthesis) plus M phase (division).
2. B — DNA is replicated in S phase.
3. A — G1 checkpoint monitors growth signals and DNA integrity.
4. C — G0 is the non-dividing quiescent state.

Lesson 33: Mitosis and Meiosis

1. A diploid cell ($(2n)$) undergoing mitosis produces:

- A) Two haploid ((n)) cells
- B) Two diploid ($(2n)$) genetically identical cells
- C) Four haploid cells
- D) One tetraploid cell

2. Meiosis reduces the chromosome number because:

- A) DNA is not replicated
- B) There is one round of DNA replication followed by two rounds of division
- C) Crossing over occurs
- D) Chromosomes do not condense

3. The key difference between mitosis and meiosis I is:

- A) Mitosis has crossing over; meiosis does not
- B) In meiosis I, homologous chromosomes separate; in mitosis, sister chromatids separate
- C) Mitosis produces 4 cells
- D) Meiosis occurs in somatic cells

4. A triploid ($(3n)$) organism undergoing meiosis would likely produce:

- A) Normal haploid gametes
- B) Aneuploid gametes due to uneven chromosome segregation
- C) Diploid gametes
- D) No gametes at all

Answer Key

1. B — Mitosis yields two identical diploid daughters.
2. B — One S phase + two divisions = haploid products.
3. B — Homologs separate in anaphase I; sisters separate in mitotic anaphase.
4. B — Odd ploidy disrupts pairing, causing aneuploidy.

Lesson 34: Genetic Linkage

1. Genes are considered linked when:

- A) They are on different chromosomes
- B) They are located close together on the same chromosome and tend to be inherited together
- C) They assort independently
- D) They are both dominant

2. The farther apart two linked genes are, the:

- A) Lower the recombination frequency
- B) Higher the recombination frequency (up to 50%)

- C) Less likely they are to be inherited
- D) More likely they show epistasis

3. A testcross of a dihybrid ($AaBb \times aabb$) yields 45% AB, 45% ab, 5% Ab, 5% aB. The recombination frequency is:

- A) 5%
- B) 10%
- C) 45%
- D) 90%

4. Linkage maps are constructed based on:

- A) Physical distance in base pairs only
- B) Recombination frequencies between genes
- C) Gene expression levels
- D) Chromosome size

Answer Key

1. B — Linked genes co-segregate due to chromosomal proximity.
2. B — Greater distance allows more crossing over (max 50%).
3. B — Recombinants ($Ab + aB$) = 10%.
4. B — Map units (cM) derive from recombination frequencies.

Lesson 35: Multiple Alleles — Blood Groups

1. The ABO blood group alleles I^A , I^B , and i are an example of:

- A) Polygenic inheritance
- B) Multiple alleles at a single locus
- C) Epistasis
- D) Pleiotropy

2. A mother with type O blood (ii) and a father with type AB blood ($I^A I^B$) can have children with which blood types?

- A) A and B only
- B) AB and O only
- C) A, B, AB, and O
- D) O only

3. The Bombay phenotype (hh) masks ABO expression. This is an example of:

- A) Codominance
- B) Recessive epistasis
- C) Incomplete dominance
- D) Linkage

4. How many phenotypes are possible in the ABO system?

- A) 3
- B) 4 (A, B, AB, O)
- C) 6
- D) 9

Answer Key

1. B — Three alleles at one locus = multiple alleles.
2. A — $i^i \times I^A I^B \rightarrow 50\% I^A i$ (A), $50\% I^B i$ (B).
3. B — Homozygous recessive hh^* masks ABO (recessive epistasis).
4. B — ABO alleles control antigen production on the outer membrane of red blood cells.

Lesson 36: Blood Groups and Transfusions

1. A person with type O blood can donate to:

- A) Only type O recipients
- B) All ABO types (universal donor for red cells)
- C) Only AB recipients
- D) No one

2. A person with AB blood can receive from:

- A) Only AB donors
- B) All ABO types (universal recipient)
- C) Only O donors
- D) Only A donors

3. The Rh factor refers to:

- A) A blood protein determining ABO type
- B) The D antigen; Rh+ individuals have it, Rh- do not
- C) A white blood cell marker
- D) Platelet compatibility

4. Hemolytic disease of the newborn (erythroblastosis fetalis) occurs when:

- A) Mother is Rh+ and fetus is Rh-
- B) Mother is Rh- and fetus is Rh+ (maternal antibodies attack fetal Rh+ cells)
- C) Both are Rh+
- D) Both are Rh-

Answer Key

1. B — Type O red cells lack A/B antigens (universal donor).
2. B — AB recipients lack anti-A/anti-B antibodies.
3. B — Rh status depends on the D antigen.
4. B — Rh- mother sensitized to Rh+ fetal cells.

Lesson 37: Coat Color in Rabbits

1. Rabbit coat color is controlled by the C gene with alleles C (full color), c^{ch} (chinchilla), c^h (Himalayan), and c (albino). The dominance hierarchy is:

- A) $C^* > c^h > c^{ch} > c^*$
- B) $C^* > c^{ch} > c^h > c^*$
- C) All codominant
- D) $C^* = c^{ch} > c^h > c^*$

2. A Himalayan rabbit has genotype:

- A) $*CC^*$
- B) $*c^h c^h*$ or $*c^h c^*$
- C) $*cc^*$
- D) $*C c^{ch}*$

3. The Himalayan phenotype (dark extremities, white body) is due to:

- A) A temperature-sensitive allele producing pigment only in cooler areas
- B) Complete albinism
- C) Epistasis
- D) Polygenic inheritance

4. An albino rabbit (cc) crossed with a full-color rabbit (CC) produces:

- A) All albino
- B) All full-color ($*Cc^*$)
- C) 50% albino, 50% full-color
- D) Himalayan

Answer Key

1. B — Dominance: C (full) $> c^{ch} > c^h > c^*$ (albino).
2. B — Himalayan requires c^h with c^h or the recessive c^* .
3. A — Temperature-sensitive tyrosinase limits pigment to cool extremities.
4. B — $CC \times cc \rightarrow$ all Cc (full color, since C^* dominates).

Lesson 38: Gene Counting

1. If a trait is controlled by n genes with two alleles each (additive), the number of phenotypic classes in the F2 is:

- A) $\sqrt{3^n}$
- B) $\sqrt{2n + 1}$
- C) $\sqrt{n^2}$
- D) $\sqrt{2^n}$

2. For $n = 2$ genes, the number of genotypic classes in the F2 is:

- A) 5
- B) 9 ($\sqrt{3^2}$)
- C) 4
- D) 16

3. The formula $\sqrt{n(n+1)/2}$ calculates:

- A) The number of gamete types
- B) The number of phenotypic classes for codominant alleles
- C) The recombination frequency
- D) The mutation rate

4. With 3 genes each having 2 alleles, how many different gamete genotypes can an F1 produce?

- A) 6
- B) 8 ($\sqrt{2^3}$)
- C) 9

D) 27

Answer Key

1. B — Additive polygenes yield $(2n+1)$ phenotypic classes.
2. B — $(3^2 = 9)$ genotypic classes for 2 genes.
3. B — Used for counting phenotypic classes with codominance.
4. B — $(2^3 = 8)$ gamete types.

Lesson 39: Dihybrid Crosses

1. In a dihybrid cross ($AaBb \times AaBb$), the expected phenotypic ratio is:

- A) 3:1
- B) 9:3:3:1
- C) 1:1:1:1
- D) 9:7

2. The genotype $rryy$ in a Mendelian dihybrid cross represents:

- A) The dominant parental type
- B) The double homozygous recessive
- C) A recombinant
- D) A lethal combination

3. If R = round (dominant) and r = wrinkled, Y = yellow (dominant) and y = green, the phenotype of $RrYy$ is:

- A) Wrinkled green
- B) Round yellow
- C) Round green
- D) Wrinkled yellow

4. A testcross ($AaBb \times aabb$) is used to:

- A) Determine the genotype of the dominant-phenotype parent
- B) Produce only dominant phenotypes
- C) Map genes
- D) Induce mutations

Answer Key

1. B — Classic 9:3:3:1 dihybrid ratio.
2. B — $rryy$ is homozygous recessive for both genes.
3. B — Dominant alleles R and Y give round yellow.
4. A — Testcross reveals the unknown genotype.

Lesson 40: Trihybrid Crosses

1. In a trihybrid cross ($AaBbCc \times AaBbCc$), the expected phenotypic ratio includes how many classes?

- A) 4
- B) 8
- C) 16

D) 27

2. The probability of obtaining the aabbcc genotype from AaBbCc × AaBbCc is:

- A) 1/4
- B) 1/16
- C) 1/64
- D) 1/8

3. If R (round) is dominant to r (wrinkled) and P (purple) is dominant to p (white), the phenotype R_ P_ indicates:

- A) Round purple (genotype has at least one dominant allele of each)
- B) Wrinkled white
- C) Round white
- D) Cannot be determined

4. The forked-line method is used to:

- A) Count chromosomes
- B) Calculate probabilities in multi-gene crosses by branching
- C) Sequence DNA
- D) Stain chromosomes

Answer Key

- 1. B — $(2^3 = 8)$ phenotypic classes.
- 2. C — $((1/4)^3 = 1/64)$.
- 3. A — R_ P_* = round and purple.
- 4. B — Forked-line diagrams track independent probabilities.

Lesson 41: Epistasis Types

1. Which epistatic ratio results from dominant epistasis?

- A) 9:3:4
- B) 12:3:1
- C) 9:7
- D) 15:1

2. The 9:7 ratio (complementary gene action) occurs when:

- A) One dominant allele masks another gene
- B) Two genes must both contribute dominant alleles to produce the phenotype
- C) A lethal allele is present
- D) Genes are linked

3. Duplicate dominant epistasis (15:1) means:

- A) Either of two genes can produce the phenotype when dominant
- B) Both genes must be recessive
- C) One gene is lethal
- D) Genes are on different chromosomes

4. In Labrador retrievers, the E gene shows recessive epistasis over the B gene because:

- A) *EE* masks *B*

- B) *ee* (homozygous recessive) prevents pigment deposition, masking *B/b*
- C) *B* is dominant
- D) They are linked

Answer Key

1. B — Dominant epistasis gives 12:3:1.
2. B — Complementary action requires both dominants (9:7).
3. A — Either dominant allele suffices (15:1).
4. B — ee blocks pigment, masking the B* locus.

Lesson 42: Epigenetics Overview

1. Epigenetics refers to:

- A) Changes in DNA sequence
- B) Heritable changes in gene expression without altering the DNA sequence
- C) Mutations in introns
- D) Chromosomal abnormalities

2. Which of the following is an epigenetic mechanism?

- A) DNA methylation
- B) Point mutation
- C) Frameshift
- D) Nondisjunction

3. Epigenetic marks are:

- A) Always permanent
- B) Potentially reversible and influenced by environment
- C) Only found in prokaryotes
- D) Identical in all cell types

4. The epigenome refers to:

- A) The complete DNA sequence
- B) The complete set of epigenetic modifications on the genome
- C) The proteome
- D) The transcriptome

Answer Key

1. B — Epigenetics = heritable expression changes without DNA sequence change.
2. A — DNA methylation is a key epigenetic mark.
3. B — Epigenetic marks are dynamic and reversible.
4. B — The epigenome is the full complement of epigenetic marks.

Lesson 43: DNA Methylation

1. In mammals, DNA methylation most commonly occurs on:

- A) Adenine in GATC sequences
- B) Cytosine in CpG dinucleotides
- C) Guanine in telomeres

D) Thymine in promoters

2. Methylation of promoter CpG islands generally:

- A) Activates transcription
- B) Represses/silences transcription
- C) Has no effect
- D) Causes mutations

3. The enzymes that add methyl groups to DNA are called:

- A) DNA polymerases
- B) DNA methyltransferases (DNMTs)
- C) Histone acetyltransferases
- D) Topoisomerases

4. Genomic imprinting is an example of:

- A) Random X-inactivation
- B) Parent-of-origin specific DNA methylation leading to monoallelic expression
- C) A chromosomal deletion
- D) A point mutation

Answer Key

- 1. B — Mammalian methylation targets CpG cytosines.
- 2. B — Promoter methylation silences genes.
- 3. B — DNMTs catalyze DNA methylation.
- 4. B — Imprinting uses methylation for parent-specific expression.

Lesson 44: Histone Modifications

1. Histone acetylation generally:

- A) Condenses chromatin and silences genes
- B) Loosens chromatin and activates transcription
- C) Methylates DNA
- D) Degrades histones

2. Histone deacetylases (HDACs) function to:

- A) Add acetyl groups
- B) Remove acetyl groups, promoting chromatin condensation
- C) Phosphorylate histones
- D) Ubiquitinate histones

3. The "histone code" hypothesis proposes that:

- A) Histones encode proteins
- B) Combinations of histone modifications regulate gene expression
- C) Histones are unnecessary
- D) Only DNA methylation matters

4. Methylation of histone H3 at lysine 9 (H3K9me) is typically associated with:

- A) Active transcription
- B) Heterochromatin and gene silencing

- C) DNA replication
- D) Mitosis only

Answer Key

1. B — Acetylation opens chromatin for transcription.
2. B — HDACs remove acetyl groups, silencing genes.
3. B — The histone code links modification patterns to expression states.
4. B — H3K9 methylation marks silent heterochromatin.

Lesson 45: Chromosomal Aberrations — Deletions

1. A deletion is defined as:

- A) Loss of a chromosomal segment
- B) Gain of a chromosomal segment
- C) Inversion of a segment
- D) Exchange between chromosomes

2. Cri-du-chat syndrome is caused by:

- A) A deletion on chromosome 5p
- B) A duplication on chromosome 21
- C) A translocation
- D) An inversion

3. The severity of a deletion syndrome depends on:

- A) The size and gene content of the deleted segment
- B) The patient's age only
- C) The chromosome number only
- D) Environmental factors only

4. A terminal deletion involves:

- A) Loss from the middle of a chromosome arm
- B) Loss of the chromosome end (telomere region)
- C) Gain of centromere
- D) Fusion of two chromosomes

Answer Key

1. A — Deletion = loss of chromosomal material.
2. A — Cri-du-chat = 5p deletion.
3. A — Phenotype reflects deleted genes.
4. B — Terminal deletions remove the chromosome end.

Lesson 46: Duplications and Inversions

1. A duplication results in:

- A) Loss of genetic material
- B) Extra copies of a chromosomal segment
- C) Reversed gene order without loss
- D) Chromosome fusion

2. Charcot-Marie-Tooth disease type 1A is commonly caused by:

- A) A deletion
- B) A 1.5 Mb duplication on chromosome 17p (PMP22 gene)
- C) An inversion
- D) Aneuploidy

3. A paracentric inversion:

- A) Includes the centromere
- B) Does NOT include the centromere
- C) Involves two chromosomes
- D) Always causes disease

4. Inversions can lead to:

- A) No consequences if balanced
- B) Unbalanced gametes due to crossing over within the inversion loop
- C) Always lethal
- D) Polyploidy

Answer Key

- 1. B — Duplication = extra chromosomal segment.
- 2. B — CMT1A is caused by PMP22 duplication.
- 3. B — Paracentric inversions exclude the centromere.
- 4. B — Crossovers in inversion loops create unbalanced products.

Lesson 47: Translocations

1. A reciprocal translocation involves:

- A) Exchange of segments between two non-homologous chromosomes
- B) Movement within the same chromosome
- C) Loss of a segment
- D) Doubling of a chromosome

2. The Philadelphia chromosome (BCR-ABL) results from:

- A) t(9;22) translocation causing chronic myeloid leukemia
- B) A deletion
- C) An inversion
- D) Trisomy 21

3. A Robertsonian translocation involves:

- A) Two acrocentric chromosomes fusing at centromeres
- B) Two metacentric chromosomes
- C) X and Y chromosomes
- D) Sister chromatids

4. Carriers of balanced translocations are typically:

- A) Always symptomatic
- B) Phenotypically normal but at risk for unbalanced offspring
- C) Infertile
- D) Mosaic

Answer Key

1. A — Reciprocal translocation swaps segments between non-homologs.
2. A — t(9;22) creates the BCR-ABL oncogene in CML.
3. A — Robertsonian = fusion of two acrocentrics.
4. B — Balanced carriers are healthy but risk unbalanced gametes.

Lesson 48: Non-disjunction and Aneuploidy

1. Non-disjunction is:

- A) Failure of homologous chromosomes or sister chromatids to separate properly
- B) Normal chromosome segregation
- C) A type of point mutation
- D) DNA replication error

2. Down syndrome (trisomy 21) most commonly results from:

- A) Paternal non-disjunction in meiosis II
- B) Maternal non-disjunction in meiosis I
- C) Mitotic non-disjunction
- D) A translocation

3. Turner syndrome (45,X) is an example of:

- A) Trisomy
- B) Monosomy
- C) Triploidy
- D) Disomy

4. The risk of non-disjunction increases with:

- A) Decreasing maternal age
- B) Advanced maternal age
- C) Paternal diet
- D) Altitude

Answer Key

1. A — Non-disjunction = segregation failure.
2. B — Most trisomy 21 arises from maternal MI errors.
3. B — Turner is monosomy X.
4. B — Advanced maternal age raises aneuploidy risk.

Lesson 49: Failure of Chromosome Separation

1. The phenomenon where two homologous chromosomes or sister chromatids fail to separate during cell division is called:

- A) Epistasis
- B) Non-disjunction
- C) Translocation
- D) Cytokinesis

2. If non-disjunction occurs during the first meiotic division (Meiosis I), what is the outcome for the resulting gametes?

- A) All sperms or ova derived from the primary cell will be abnormal
- B) Exactly 50% of the resulting gametes will be normal
- C) All gametes will maintain a normal haploid chromosome count
- D) Only male gametes are affected

3. Which of the following is explicitly listed in the source handout as a cause of non-disjunction?

- A) Delayed fertilization after ovulation
- B) Histone acetylation
- C) High ambient humidity
- D) Excessive dietary protein intake

4. What types of daughter cells are formed as a result of mitotic non-disjunction during cell cleavage?

- A) Polyploid cells only
- B) Trisomic and monosomic daughter cells
- C) Completely haploid daughter cells
- D) Hexaploid daughter cells

Answer Key

1. B — Non-disjunction is defined as the failure of homologous chromosomes or sister chromatids to separate during division.
2. A — First division meiotic non-disjunction causes all resulting sperms or ova to be abnormal.
3. A — Causes of non-disjunction specified in the text include aging of primary oocytes, radiation, and delayed fertilization after ovulation.
4. B — Mitotic non-disjunction causes one cell to gain an extra chromatid and the other to lack one, producing trisomic and monosomic daughter cells.

Lesson 50: Autosomal Trisomy

1. Trisomy is a type of aneuploidy (or polysomy) defined as having how many copies of a particular chromosome instead of the normal two?

- A) One copy
- B) Three copies
- C) Four copies
- D) Six copies

2. Which type of trisomy is specifically characterized by an extra chromosome that possesses duplicated arms?

- A) Primary trisomy
- B) Partial trisomy
- C) Secondary trisomy
- D) Tertiary trisomy

3. Which autosomal trisomy condition is caused by an extra copy of chromosome 21?

- A) Edwards syndrome
- B) Down syndrome

- C) Patau syndrome
- D) Turner syndrome

4. Which category of trisomy occurs when the extra chromosome is composed of copies of arms derived from two different chromosomes?

- A) Primary trisomy
- B) Secondary trisomy
- C) Tertiary trisomy
- D) Partial trisomy

Answer Key

1. B — Trisomy is a form of aneuploidy where three copies of a specific chromosome exist instead of two.
2. C — Secondary trisomy occurs when the extra chromosome has duplicated arms.
3. B — Trisomy 21 is the autosomal trisomy responsible for Down syndrome.
4. C — Tertiary trisomy features an extra chromosome made up of copies of arms from two other chromosomes.

End of Quiz

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