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BIO301 Quiz File

Chapter-wise Solved MCQs

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Lesson 1: What is Genetics?

1. Genetics is defined as the study of which of the following?

A) Cells, tissues, and organs
B) Genes, heredity, and variation
C) Proteins, enzymes, and lipids
D) Bacteria, viruses, and fungi

2. Genetics is considered a sub-field of which broader discipline?

A) Chemistry
B) Physics
C) Biology
D) Geology

3. Who explained the fundamental principles of heredity in 1866?

A) Strausberger
B) Gregor Mendel
C) Waldeyer
D) T. H. Morgan

4. Which plant did Gregor Mendel use as an experimental plant to formulate the laws of heredity?

A) Sweet pea
B) Garden pea
C) Sunflower
D) Snapdragon

Answer Key

1. B — Genetics is specifically defined as the study of genes, heredity, and variation
2. C — Genetics is categorized as a field of Biology
3. B — Gregor Mendel explained the core principles of heredity in the year 1866
4. B — Mendel utilized the garden pea as his experimental plant for formulating inheritance laws

Lesson 2: Sub Types of Genetics

1. Which sub-discipline of genetics deals with the movement of genes and genetic traits from parents to offspring, Mendel's Laws, and genetic recombinations?

A) Population Genetics
B) Transmission (Classical) Genetics
C) Quantitative Genetics
D) Molecular Genetics

2. Which branch of genetics studies traits in a group of population when those traits are determined by one or a few genes?

A) Molecular Genetics
B) Quantitative Genetics
C) Population Genetics
D) Transmission Genetics

3. Quantitative genetics specifically studies group heredity for traits that are determined by:

A) A single gene only
B) Molecular structure of DNA
C) Many genes simultaneously
D) Extracellular enzymes

4. What is the primary focus of Molecular Genetics?

A) Mendel's Laws of inheritance
B) Traits determined by one or a few genes in a population
C) The molecular structure and function of genes
D) Physical traits like skin color and height

Answer Key

1. B — Transmission (Classical) Genetics deals with the movement of genes from parents to offspring, Mendel's Laws, and recombinations.

2. C — Population genetics studies traits in a group of population when determined by one or a few genes.

3. C — Quantitative genetics studies group heredity for traits determined by many genes simultaneously (e.g., skin color, height).

4. C — Molecular genetics deals specifically with the molecular structure and function of genes.

Lesson 3: Common Genetics Terminologies

1. How is a "character" defined in genetics?

A) A variant for a specific feature
B) A heritable feature such as skin color or height
C) The physical appearance of a disease
D) An offspring resulting from a hybrid cross

2. What is a "trait"?

A) A heritable feature
B) The total genetic makeup of an organism
C) A variant for a character (e.g., brown, black, white)
D) The cross between two different species

3. A cross between a true-breed plant or animal with another true-breed plant or animal is called a:

A) Monohybrid test cross
B) Pure cross
C) Dihybrid reciprocal cross
D) Back cross

4. The first filial generation resulting from a parental cross is denoted as:

A) P generation
B) F1 generation
C) F2 generation
D) F3 generation

Answer Key

1. B — A character is defined as a heritable feature such as skin color or height

2. C — A trait represents a specific variant for a character, such as brown or white color

3. B — A pure cross refers to crossing a true-breed organism with another true-breed organism

4. B — The first filial generation derived from the parent (P) generation is termed the F1 generation

Lesson 4: Mendel's Law of Dominance

1. According to Mendel's law of dominance, what happens in a cross of parents pure for contrasting traits?

A) Both traits blend equally in the next generation
B) Only one form of the trait appears in the next generation
C) Neither form of the trait appears
D) A completely novel phenotype is created

2. In a monohybrid cross of true-breeding plants, what happens to one version of the trait in the F1 generation?

A) It duplicates
B) It disappears
C) It mutates
D) It becomes co-dominant

3. When true-breeding purple-flowered pea plants are crossed with white-flowered pea plants, all F1 plants have purple flowers because:

A) Purple is recessive to white
B) Purple is dominant to white
C) White flower genes are completely destroyed
D) Environment altered flower pigments

4. Mendel's law of dominance specifically describes the behavior of contrasting traits during which type of cross?

A) Monohybrid cross
B) Trihybrid cross
C) Test cross
D) Pedigree cross

Answer Key

1. B — Mendel's law of dominance states that in a cross of pure parents with contrasting traits, only one trait form appears in the next generation

2. B — In a monohybrid cross, one version of the contrasting trait disappears in the F1 generation

3. B — Purple color is dominant to white color, causing all F1 offspring to exhibit purple flowers

4. A — The law of dominance illustrates trait expression in a monohybrid cross

Lesson 5: Monohybrid cross and Dihybrid cross

1. Cross-fertilization of true-breeding plants that differ in just one character is defined as a:

A) Dihybrid cross
B) Monohybrid cross
C) Trihybrid cross
D) Testcross

2. What did Gregor Mendel determine using a monohybrid cross?

A) The segregation of alleles at a single gene locus
B) The physical length of chromosomes in micrometers
C) The G-C base ratio across species
D) The rate of histone acetylation

3. What is the primary purpose of conducting a dihybrid cross?

A) To count the number of centrioles in dividing cells
B) To determine whether alleles at two different gene loci segregate dependently or independently
C) To measure the water content of active nuclei
D) To observe polytene chromosome puffs

4. How are two characters transmitted from parents to offspring when their genes are located on different chromosomes?

A) As a linked package
B) Independently
C) As a single fused allele
D) Exclusively through maternal mitochondria

Answer Key

1. B — A monohybrid cross involves cross-fertilization of true-breeding plants differing in a single character.

2. A — Mendel used monohybrid crosses to demonstrate the segregation of alleles at a single gene locus.

3. B — Dihybrid crosses evaluate whether alleles at two distinct gene loci segregate dependently or independently.

4. B — Characters controlled by genes on separate chromosomes transmit independently to offspring.

Lesson 6: Law of Segregation

1. According to the Law of Segregation, what happens to the two alleles responsible for a trait during gamete formation?

A) They mutate into new alleles
B) They separate from each other
C) They fuse permanently
D) They remain bound to histones

2. What process recombines or reunites the separated alleles to form a new genotype in offspring?

A) Transcription
B) Fertilization
C) Translation
D) Cytokinesis

3. According to the Modern Concept of Segregation, when do the two alleles of a gene separate?

A) During fertilization
B) During gametogenesis
C) During DNA replication in S phase
D) During organogenesis

4. In a cross, what determines the resulting phenotype of an offspring after gametes reunite?

A) The environmental temperature alone
B) The resulting genotype formed during fertilization
C) The size of the ribosome
D) Random chance without genetic influence

Answer Key

1. B — The Law of Segregation specifies that the two alleles for a trait separate from each other during gamete formation.

2. B — Separated alleles are recombined during the process of fertilization to form new genotypes.

3. B — Under the modern concept, alleles separate specifically during gametogenesis.

4. B — Gametes combine during fertilization to yield a new genotype, which determines the resulting phenotype.

Lesson 7: Mendel's Law of Independent Assortment

1. What does Mendel's Law of Independent Assortment state regarding alleles for different traits?

A) They are always inherited as a single linked package
B) They are distributed to sex cells independently of one another
C) They destroy one another during meiotic prophase
D) They blend together to produce a single uniform phenotype

2. In Mendel's dihybrid cross example with pod color and seed color, which traits were dominant?

A) Yellow pod color and green seed color
B) Green pod color and yellow seed color
C) Yellow pod color and yellow seed color
D) Green pod color and green seed color

3. What phenotypic ratio did Mendel observe in the F2 generation after self-pollinating F1 dihybrid plants?

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

4. The 9:3:3:1 phenotypic ratio in the F2 generation of a dihybrid cross supports which hypothesis?

A) Dependent segregation unit hypothesis
B) Independent assortment of alleles
C) Acquired environmental variation
D) Maternal mitochondrial inheritance

Answer Key

1. B — The Law of Independent Assortment states that alleles for different traits distribute to sex cells independently.

2. B — In the source example, green pod color (GG) and yellow seed color (YY) are dominant traits.

3. C — Mendel observed a classic 9:3:3:1 phenotypic ratio among the F2 offspring of a dihybrid cross.

4. B — The 9:3:3:1 ratio supports the hypothesis that alleles for different traits sort into gametes independently.

Lesson 8: Modern Genetics Concepts

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

A) Prokaryotes have multiple linear chromosomes, while eukaryotes have one circular chromosome
B) Prokaryotes generally have one circular chromosome, while eukaryotes have linear chromosomes in their nuclei
C) Both prokaryotes and eukaryotes possess linear chromosomes only
D) Prokaryotes lack chromosomes entirely and rely solely on RNA

2. In modern genetics, a gene is defined as which of the following?

A) A complete cell membrane structure
B) A heredity unit located on chromosomes
C) A protein enzyme in the cytoplasm
D) A carbohydrate energy polymer

3. Which of the following is listed as an example of a Non-Mendelian inheritance pattern?

A) Monohybrid 3:1 dominance
B) Mitochondrial inheritance
C) Pure-breed monohybrid segregation
D) Dihybrid 9:3:3:1 independent assortment

4. In genetics, how is a mutation broadly defined, and what impacts can it have?

A) It strictly indicates a lethal disease in all cases
B) It indicates "a change" and can be harmful, beneficial, or have no effect
C) It refers only to changes caused by cold temperature
D) It is an acquired physical training adaptation

Answer Key

1. B — Prokaryotes typically have a single circular chromosome, whereas eukaryotes have linear chromosomes in their nucleus.

2. B — A gene is defined in modern genetics as a unit of heredity located on chromosomes.

3. B — Non-Mendelian inheritance includes patterns such as mitochondrial inheritance, linkage, maternal effects, and epigenetics.

4. B — In genetics, mutation indicates a change that may be harmful, beneficial, or neutral.

Lesson 9: Importance of Genetics

1. Which of the following is listed as one of the three core characteristics of human genetic data?

A) Temporary
B) Personal
C) Changeable
D) Anonymous

2. Genetic information is described as Personal, Predictive, and:

A) Permanent

B) Reversible
C) Environmental
D) Diagnostic

3. Genetics assists medical science in which of the following areas?

A) Newborn and population screening
B) Pharmacogenetics and individualized medicine
C) Predictive planning and diagnostic treatments
D) All of the above

4. How does genetics contribute to our understanding of biological history?

A) It proves traits do not change
B) It helps us understand the process of evolution
C) It eliminates environmental influences
D) It prevents random mutations

Answer Key

1. B — Genetic data is characterized as Personal, Permanent, and Predictive
2. A — Genetic data possesses three key characteristics: Personal, Permanent, and Predictive
3. D — Genetics aids diagnostics, treatments, screening, and individualized pharmacogenetics
4. B — Genetics helps scientists understand the process and mechanisms of evolution

Lesson 10: What is Heredity?

1. What is the fundamental definition of heredity?

A) The change in species over evolutionary time
B) The transmission of traits from parents to offspring
C) The environmental modification of physical organs
D) The breakdown of proteins during digestion

2. Gregor Mendel demonstrated that inheritance occurs through which model rather than blending?

A) Blending inheritance
B) Particulate inheritance
C) Acquired inheritance
D) Environmental inheritance

3. According to the particulate theory of inheritance, how are characters (alleles) passed from parents to offspring?

A) They are blended and permanently diluted
B) They are inherited unchanged
C) They are destroyed during fertilization
D) They are altered by physical exercise

4. What did the observed pattern of inheritance of unchanged characters provide in early genetics?

A) The first definition of a gene
B) The discovery of electron microscopy
C) The proof that DNA lacks nitrogenous bases

D) The complete classification of all animal species

Answer Key

1. B — Heredity is defined as the transmission of traits from parents to offspring.

2. B — Mendel showed that inheritance follows a particulate model rather than a blending model.

3. B — In particulate inheritance, hereditary units (alleles) are transmitted unchanged across generations.

4. A — The inheritance pattern of unchanged particulate characters provided the first biological definition of a gene.

Lesson 11: Concept of variation

1. How is biological variation defined among living organisms?

A) Differences seen among individuals of the same species
B) Structural differences between completely different kingdoms
C) The exact duplication of parental physical traits
D) Chemical changes in non-living minerals

2. What two primary factors influence variations seen in individuals of the same species?

A) Atmospheric pressure and soil pH only
B) Genotype and environment
C) Ribosome count and tRNA length
D) Gravitational pull and magnetic fields

3. In the handout's example of snail shells, which variations are observed among individuals?

A) Length of antennae and eye size
B) Shell color, presence/absence of bands, and number of bands
C) Number of legs and internal lung capacity
D) Thickness of the foot muscle alone

4. Which of the following is listed in the handout as an example of variation in humans (Homo sapiens)?

A) Presence of circular prokaryotic plasmids
B) Variations in hair curliness, eye color, and skin color
C) Presence of polytene giant chromosomes
D) Ability to perform photosynthesis in warm sunlight

Answer Key

1. A — Variation refers to the observed differences among individuals belonging to the same species.

2. B — Variation among individuals arises due to their genetic makeup (genotype), environment, or a combination of both.

3. B — Snail shell variations include shell color, presence or absence of bands, and band count.

4. B — Human variations highlighted in the text include skin color, hair color, eye color, hair curliness, and sex.

Lesson 12: Genetic and Acquired Variation

1. Inherited variations result directly from the activity of:

A) Environmental factors
B) Genes

C) Nutritional habits
D) Physical training

2. Which of the following is an example of an inherited variation?

A) Language spoken
B) Athletic skills
C) Blood groups
D) Obesity

3. Acquired variations result from an individual's activities, nutrition, or:

A) Gene activity
B) Environmental conditions during a lifetime
C) Meiotic recombination
D) Chromosomal nondisjunction

4. Can acquired characteristics be inherited by offspring?

A) Yes, always
B) Yes, if beneficial
C) No, they cannot be inherited
D) Only under cold conditions

Answer Key

1. B — Inherited variations are genetically controlled and result from gene activity
2. C — Blood groups, fingerprints, and sex are genetically controlled inherited variations
3. B — Acquired variations arise from an individual's activities, diet, or lifetime environmental conditions
4. C — Acquired characteristics cannot be inherited by subsequent generations

Lesson 13: Types of variation: Two types of Variation

1. Which type of variation is entirely genetically controlled and cannot be altered by external environmental conditions?

A) Continuous variation
B) Discontinuous variation
C) Acquired variation
D) Environmental variation

2. Which of the following human traits is an example of discontinuous variation?

A) Height
B) Weight
C) Blood group
D) Skin color gradient

3. How is continuous variation characterized regarding gene control and environmental influence?

A) Controlled by a single gene and unaffected by the environment
B) Controlled by a lot of genes and strongly influenced by the environment
C) Caused exclusively by physical exercise
D) Unaffected by both genes and environment

4. When plotted on a graph, measurements of continuous variation (such as human height) typically yield what type of curve?

A) Disjointed bar chart with separated bars
B) Smooth bell-shaped curve
C) Flat horizontal line
D) Exponential upward curve

Answer Key

1. B — Discontinuous variation is entirely genetically controlled and unaffected by external conditions.

2. C — Human blood groups represent discontinuous variation with distinct qualitative categories.

3. B — Continuous variation is polygenic (controlled by many genes) and strongly influenced by environmental factors.

4. B — Continuous variation measurements, such as height, produce a smooth bell-shaped curve when graphed.

Lesson 14: Source of Variation

1. Which of the following is categorized as a genetic cause of variation?

A) Nutrients
B) Meiosis
C) Temperature
D) Physical training

2. Sexual reproduction contributes to genetic variation primarily through:

A) Environmental adaptation
B) Recombination of genetic material
C) Acquired physical training
D) Temperature shifts

3. Which of the following is an environmental cause of variation?

A) Meiosis
B) Mutations
C) Temperature
D) Sexual reproduction

4. Which type of variation acts as the raw material for natural selection?

A) Acquired variation
B) Environmental variation
C) Inherited variation
D) Nutritional variation

Answer Key

1. B — Meiosis, sexual reproduction, and mutations are genetic causes of variation

2. B — Sexual reproduction enables the recombination of genetic material in new ways

3. C — Temperature, nutrients, drugs, and training are environmental causes of variation

4. C — Inherited variation serves as the fundamental raw material for natural selection

Lesson 15: Heredity and variation in Mendel's work

1. In Mendel's work, what was demonstrated when pure-breeding tall plants were self-pollinated?

A) They produced a mix of tall and dwarf plants in equal numbers
B) They produced only tall offspring
C) They produced only purple flowers
D) They failed to produce any offspring

2. What key evidence of heredity was shown by Mendel's pure-breeding purple-flowered plants?

A) They consistently produced white-flowered plants
B) They produced only purple-flowered offspring
C) They produced plants with variable yellow seeds
D) They changed color depending on soil temperature

3. According to the conclusions in Lesson 15, how is biological variation inherited in nature?

A) Solely by random chance
B) According to genetic laws
C) Exclusively through environmental trauma
D) By direct physical training of parents

4. How does Mendel's work address the occurrence of variation in natural populations?

A) Variation is extremely rare and artificial
B) Variation is widespread in nature and follows genetic rules
C) Variation only occurs in bacterial plasmids
D) Variation is impossible in true-breeding lines

Answer Key

1. B — In Mendel's experiments, pure-breeding tall plants consistently produced only tall offspring.

2. B — Pure-breeding purple-flowered plants demonstrated heredity by producing only purple-flowered offspring.

3. B — Variation is inherited according to established genetic laws rather than solely by chance.

4. B — Mendel's work showed that variation is widespread in nature and operates under defined genetic principles.

Lesson 16: Mendelian and Non-Mendelian inheritance

1. In Gregor Mendel's classic model of inheritance, how many alleles control a single trait?

A) Multiple alleles exceeding ten
B) Exactly two alleles with a clear dominant-recessive relationship
C) One allele per chromosome pair only
D) Zero alleles, as traits are non-genetic

2. Mendelian inheritance specifically applies to genes that obey which principles?

A) The laws of dominance, segregation, and independent assortment
B) The rules of acquired inheritance and physical training
C) The principles of cytoplasmic organelle duplication
D) The laws of thermodynamics and fluid dynamics

3. How is Non-Mendelian inheritance defined?

A) Patterns of inheritance that strictly follow the 3:1 monohybrid ratio
B) Patterns of inheritance that deviate from Mendelian patterns
C) Traits that are expressed only in bacterial cells
D) Traits that cannot be passed to offspring under any condition

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

A) Autosomal dominant monohybrid inheritance
B) Mitochondrial inheritance and genomic imprinting
C) Pure-breeding purple flower inheritance
D) Complete dominance in garden peas

Answer Key

1. B — Mendel's classic model assumes each trait is controlled by a single gene with two alleles showing a dominant-recessive relationship.

2. A — Mendelian inheritance involves genes obeying Mendel's laws of dominance, segregation, and independent assortment.

3. B — Non-Mendelian inheritance refers to inheritance patterns that deviate from standard Mendelian rules.

4. B — Examples of Non-Mendelian inheritance include mitochondrial inheritance, genomic imprinting, incomplete dominance, co-dominance, and epigenetics.

Lesson 17: Conclusions of Mendelian Inheritance

1. Mendel's conclusions regarding inheritance were summarized into how many laws?

A) Two
B) Three
C) Four
D) Five

2. In Mendel's experiments, smooth seeds (S) showed what relationship to wrinkled seeds (s)?

A) Incompletely dominant
B) Completely dominant
C) Co-dominant
D) Epistatic

3. The Law of Segregation states that two members of a gene pair separate during:

A) Fertilization
B) Formation of gametes
C) Mitotic anaphase
D) DNA packaging

4. The Law of Independent Assortment asserts that alleles for different traits:

A) Always remain together on the same strand
B) Assort independently of one another
C) Mutate simultaneously
D) Blend in equal ratios

Answer Key

1. B — Mendel's conclusions were formulated into three laws: Dominance, Segregation, and Independent Assortment

2. B — Smooth seeds (S) are completely dominant over wrinkled seeds (s)

3. B — Gene pairs segregate from each other during gamete formation

4. B — Alleles for different traits assort independently during meiosis

Lesson 18: Exceptions to Mendelian inheritance

1. Which exception to Mendelian inheritance occurs when one gene masks or hides the expression of another gene?

A) Pleiotropy
B) Epistasis
C) Incomplete dominance
D) Monohybrid segregation

2. What is defined as a phenomenon where a single gene produces multiple distinct phenotypic effects?

A) Polygenic inheritance
B) Pleiotropy
C) Co-dominance
D) Complete dominance

3. When a single phenotypic trait is influenced and determined by the combined action of multiple genes, it is called:

A) Monohybrid cross
B) Polygenic inheritance
C) Incomplete dominance
D) Sex linkage

4. Which of the following is included in the handout's list of exceptions to Mendelian inheritance?

A) Environmental effects on gene expression and linkage
B) Law of Segregation
C) Pure-breeding monohybrid crosses
D) Law of Dominance

Answer Key

1. B — Epistasis is an exception to Mendelian inheritance where one gene masks the expression of another gene.

2. B — Pleiotropy occurs when a single gene exerts multiple distinct phenotypic effects.

3. B — Polygenic inheritance refers to a single phenotypic trait being controlled by multiple genes.

4. A — Linkage, sex linkage, and environmental effects on gene expression are listed as exceptions to Mendelian inheritance.

Lesson 19: Incomplete dominance

1. In incomplete dominance, what type of phenotype is produced in heterozygous individuals?

A) The phenotype of the dominant parent only

B) The phenotype of the recessive parent only
C) An intermediate phenotype that is a blend of both alleles
D) A completely unexpressed, lethal phenotype

2. In Japanese 4 o'clock flowers, crossing a red-flowered plant (RR) with a white-flowered plant (WW) produces offspring with which phenotype?

A) All red flowers
B) All white flowers
C) All pink flowers
D) A 3:1 ratio of red to white flowers

3. What is the genotype of the pink-flowered Japanese 4 o'clock plant?

A) RR
B) WW
C) RW
D) rr

4. Why does a "new" blended phenotype appear in incomplete dominance?

A) Because one allele completely destroys the other allele
B) Because neither allele is completely dominant over the other
C) Because environmental temperature alters DNA bases
D) Because chromosomes fail to segregate during meiosis

Answer Key

1. C — Incomplete dominance results in an intermediate phenotype that blends the traits of both alleles.

2. C — Crossing red (RR) and white (WW) Japanese 4 o'clock plants yields heterozygous offspring (RW) with pink flowers.

3. C — The pink-flowered Japanese 4 o'clock plant has the heterozygous genotype RW.

4. B — A blended phenotype appears because neither allele is dominant over the other.

Lesson 20: Co-dominance

1. How is co-dominance defined in genetics?

A) One allele completely masks the expression of the other allele
B) Both alleles are simultaneously expressed in the heterozygous individual
C) The dominant allele blends with the recessive allele to form an intermediate phenotype
D) Both alleles are completely suppressed in heterozygotes

2. In roan cattle inheritance, what coat phenotype is produced by the heterozygous genotype (Rr)?

A) Pure red hairs
B) Pure white hairs
C) Roan coat (a mix of red and white hairs)
D) Golden yellow fur

3. In the Appaloosa horse example, what is the phenotype of the heterozygous individual?

A) A pure white coat
B) A pure dark coat
C) A white horse with gray spots

D) A black horse with white mane

4. Which human trait is cited in Lesson 20 as an example of co-dominance?

A) Eye color
B) Blood group inheritance (ABO)
C) Skin pigmentation
D) Hair texture

Answer Key

1. B — Co-dominance occurs when both alleles appear and are expressed in heterozygous individuals.

2. C — In roan cattle, the heterozygous genotype (Rr) produces a roan coat, which is a mix of red and white hairs.

3. C — In Appaloosa horses, the heterozygous phenotype is a white horse with gray spots.

4. B — Human blood group inheritance is cited as an example of co-dominance.

Lesson 21: Polygenic traits

1. How are polygenic traits defined in genetics?

A) Traits controlled by a single gene locus with two alleles
B) Traits controlled by the combined interaction of many gene loci
C) Traits inherited exclusively through sex chromosomes
D) Traits produced by point mutations in intronic sequences

2. Which human feature is explicitly listed in Lesson 21 as an example of a polygenic trait?

A) ABO blood group
B) Human height
C) Color blindness
D) Albinism

3. In contrast to single-gene Mendelian traits, polygenic traits typically exhibit:

A) Only two discrete non-overlapping phenotypes
B) Continuous variation across a range of phenotypic values
C) Complete embryonic lethality
D) Strict sex-linked inheritance

4. Qualitative and quantitative traits that show continuous variation are usually described as being:

A) Polygenic in nature
B) Mono-allelic
C) Acquired variations
D) Epigenetically silenced

Answer Key

1. B — Polygenic traits are determined by the combined interaction of multiple gene loci.

2. B — Human height is cited in Lesson 21 as a primary example of a polygenic trait.

3. B — Combined interactions across multiple loci yield continuous variation in phenotypes.

4. A — Qualitative and quantitative traits exhibiting continuous variation are polygenic in nature.

Lesson 22: Epistasis

1. What is the definition of epistasis as presented in Lesson 22?

A) A single gene controlling multiple distinct physical traits
B) Alleles at one gene locus hiding or preventing the expression of alleles at a second gene locus
C) The failure of homologous chromosomes to separate during meiosis
D) A point substitution resulting in a silent amino acid change

2. In Labrador retrievers, what coat color is specified by the dominant allele B when pigment deposition is active?

A) Brown (Chocolate)
B) Black
C) Yellow
D) White

3. What coat color phenotype results when a Labrador retriever is homozygous recessive (ee) at the pigment deposition locus?

A) Black fur
B) Brown fur
C) Yellow fur, regardless of the alleles present at the first locus
D) Spotted fur

4. What is the genotype of a brown (chocolate) Labrador retriever according to the lesson examples?

A) BBEE or BbEe
B) bbEE or bbEe
C) BBee or Bbee
D) bbee

Answer Key

1. B — Epistasis occurs when alleles at one gene locus prevent or mask the expression of alleles at another locus.

2. B — The dominant allele B specifies black coat pigment in Labrador retrievers.

3. C — Homozygous recessive `ee` blocks pigment deposition in fur, producing yellow fur regardless of the B locus.

4. B — Genotypes `bbEE` and `bbEe` combine brown pigment (`bb`) with functional deposition (`E_`) to yield brown fur.

Lesson 23: Pleiotropy

1. How is pleiotropy defined in genetics?

A) The combined interaction of many genes controlling a single trait
B) The ability of a single gene locus/allele to affect an organism in many ways by producing more than one trait
C) The exchange of genetic material between non-sister chromatids
D) The duplication of an entire chromosome set during mitosis

2. Which group of human genetic conditions is cited in Lesson 23 as examples of pleiotropy?

A) Sickle cell anemia, Cystic fibrosis, and Huntington disease

B) Down syndrome, Turner syndrome, and Klinefelter syndrome
C) Hemophilia A and Red-green color blindness
D) Scurvy, Rickets, and Beriberi

3. In the Huntington disease example of pleiotropy, what two distinct phenotypic effects stem from the single gene mutation?

A) Short stature and webbed neck
B) Progressive dementia (at age 40–50) and death ~5 years after disease onset
C) Extra fingers and fused toes
D) Blindness and deafness

4. How does pleiotropy differ fundamentally from polygenic inheritance?

A) Pleiotropy involves multiple genes affecting one trait, whereas polygenic inheritance involves one gene affecting multiple traits
B) Pleiotropy involves one gene affecting multiple traits, whereas polygenic inheritance involves multiple genes affecting one trait
C) Pleiotropy applies only to prokaryotes, whereas polygenic traits apply only to eukaryotes
D) Neither pleiotropy nor polygenic inheritance involves nuclear genes

Answer Key

1. B — Pleiotropy occurs when a single gene locus produces multiple phenotypic effects.

2. A — Sickle cell anemia, Cystic fibrosis, and Huntington disease are human examples of pleiotropic gene action.

3. B — A single mutant gene in Huntington disease causes both progressive dementia and early death.

4. B — Pleiotropy involves one gene influencing multiple traits, whereas polygenic inheritance involves many genes influencing a single trait.

Lesson 24: Environmental effects

1. According to Lesson 24, an organism's phenotype depends on an interaction between which two factors?

A) Genotype and environment
B) Diet and exercise only
C) Temperature and humidity only
D) Age and gender only

2. In Himalayan rabbits and Siamese cats, what effect occurs when the temperature exceeds 33 °C?

A) Fur becomes darker due to increased melanin production
B) The tyrosinase enzyme inactivates, resulting in reduced melanin and lighter fur
C) The allele mutates permanently into a dominant allele
D) Melanin converts into blue anthocyanin

3. What specific environmental factor alters the color of Hydrangea flowers?

A) Atmospheric pressure
B) Soil pH
C) Light intensity
D) Wind speed

4. Which of the following animals is explicitly listed as an example where coat color is affected by temperature?

A) Polar bear
B) Arctic fox
C) Desert lizard
D) Tropical parrot

Answer Key

1. A — The phenotype of an organism depends on its genotype as well as the environment under which genes act.

2. B — At temperatures above 33 °C, the tyrosinase enzyme inactivates, resulting in reduced melanin production.

3. B — Soil pH impacts phenotype by altering the color of Hydrangea flowers.

4. B — Arctic foxes are listed alongside Himalayan rabbits and Siamese cats as examples of temperature-sensitive coat color.

Lesson 25: What Are Chromosomes?

1. Chromosomes are described as rod-shaped, filamentous bodies located in the:

A) Cytoplasm
B) Nucleus
C) Cell wall
D) Vacuole

2. Who first described chromosomes in 1875?

A) Waldeyer
B) Strausberger
C) Gregor Mendel
D) T. H. Morgan

3. The term "chromosome" (meaning colored body) was first used in 1888 by:

A) Strausberger
B) Waldeyer
C) Watson
D) Crick

4. During which cell division stage can chromosome numbers be counted most easily?

A) Interphase
B) Prophase
C) Mitotic metaphase
D) Telophase

Answer Key

1. B — Chromosomes are rod-shaped bodies present within the cell nucleus

2. B — Strausberger first described chromosomes in 1875

3. B — Waldeyer coined the term "chromosome" in 1888

4. C — Chromosome numbers can be counted easily during mitotic metaphase

Lesson 26: Chromosome Structure

1. Chromosomes are composed of which two primary constituents?

A) Carbohydrates and lipids
B) DNA and associated proteins
C) RNA and cell wall polysaccharides
D) Centrosomes and centrioles

2. What is the constricted region of a chromosome where sister chromatids are attached?

A) Nucleolus
B) Centromere
C) Telomere
D) Kinetochore corona

3. Where are chromosomes or DNA located within a cell?

A) In the cell membrane
B) In the nucleus or nucleoid region
C) Floating freely in the cell wall
D) Inside cytoplasmic vesicles

4. Which type of protein is specifically mentioned as part of a chromosome's structure alongside DNA?

A) Tubulin
B) Histones
C) Securin
D) Separase

Answer Key

1. B — Chromosomes are made of DNA and associated proteins.
2. B — The centromere is defined as the constricted region where chromatids are attached.
3. B — DNA or chromosomes are present within the cell's nucleus or nucleoid region.
4. B — A chromosome constitutes a DNA molecule, Histone proteins, and supercoiled DNA.

Lesson 27: Variation in number of chromosomes

1. What is the total chromosome count in human somatic cells?

A) 23 chromosomes
B) 46 chromosomes
C) 48 chromosomes
D) 78 chromosomes

2. Which organism is noted as having only two chromosomes?

A) Mosquito
B) Fruit fly
C) Round worm
D) Fungi

3. Which pair of organisms both possess a total chromosome count of 78?

A) Chimpanzee and Horse

B) Dog and Chicken
C) Goldfish and Fruit fly
D) Mosquito and Round worm

4. Most organisms possess chromosome numbers falling within which general range?

A) 2 to 6
B) 12 to 50
C) 100 to 200
D) 300 or more

Answer Key

1. B — Humans have 46 total chromosomes (23 pairs: 22 pairs of autosomes and one pair of sex chromosomes).

2. C — Round worms have a total chromosome count of only two.

3. B — Both the Dog and the Chicken have 78 chromosomes.

4. B — Most organisms have chromosome numbers ranging between 12 and 50.

Lesson 28: Centromere-function

1. What are the two essential features of all eukaryotic chromosomes, each absolutely necessary for chromosome stability?

A) Centrosomes and centrioles
B) Centromere and telomeres
C) Chromatin and nucleoplasm
D) Kinetochore and spindle fibers

2. For which process are centromeres required?

A) DNA replication during interphase
B) Segregation of chromosomes during meiosis and mitosis
C) Protein synthesis at the ribosome
D) Formation of the nuclear envelope

3. When chromosomes are stained, how does the centromere appear, and what does it join?

A) A light-stained region where chromatids repel each other
B) A dark-stained region where the two sister chromatids of a chromosome are joined during mitotic metaphase
C) A dark-stained region at the terminal ends of the chromosome
D) A light-stained region that dissolves before anaphase

4. What must happen to the centromere shared by the sister chromatids during mitosis, and what is observed in anaphase?

A) It must fuse with the telomeres so chromatids stay together
B) It must divide so chromatids can migrate to opposite poles; centromeres are the first parts of chromosomes seen moving towards opposite poles during anaphase
C) It remains unchanged while the telomeres lead the movement
D) It dissolves so the chromatids can separate randomly

Answer Key

1. B — Centromere and telomeres are the two essential features of all eukaryotic chromosomes, each absolutely necessary for chromosome stability.

2. B — Centromeres are required for segregation of chromosomes during meiosis and mitosis; telomeres provide terminal stability and ensure survival.

3. B — When chromosomes are stained, the centromere shows as a dark-stained region where the two sister chromatids of a chromosome are joined during mitotic metaphase.

4. B — During mitosis the centromere shared by the sister chromatids must divide so chromatids can migrate to opposite poles; centromeres are the first parts seen moving toward opposite poles during anaphase, with the remaining regions lagging behind as if pulled by the centromere.

Lesson 28: Chromosomes in Prokaryotes and Eukaryotes

1. Prokaryotic cells typically possess:

A) Many linear chromosomes made of DNA and histones
B) A single circular chromosome plus plasmids
C) Multiple membrane-bound nuclear chromosomes
D) No DNA molecules

2. Prokaryotic chromosomes are composed of:

A) DNA and histones
B) Made only of DNA
C) RNA and carbohydrates
D) Lipids and histones

3. Eukaryotic chromosomes are situated in the:

A) Cytoplasm
B) Nucleus
C) Cell membrane
D) Nucleoid region

4. Unlike prokaryotes, eukaryotic chromosomes are composed of DNA bound to:

A) Plasmids
B) Histones
C) Ribosomes
D) Peptidoglycan

Answer Key

1. B — Prokaryotes contain a single circular chromosome along with plasmids

2. B — Prokaryotic chromosomes consist only of DNA without histone proteins

3. B — Eukaryotic chromosomes are enclosed within a true membrane-bound nucleus

4. B — Eukaryotic DNA is packaged together with histone proteins

Lesson 29: Salient features of Chromosomes

1. Which of the following statements accurately describes the shape of chromosomes as detailed in Lesson 29?

A) Chromosomes are always spherical in shape
B) Chromosomes can be either circular or linear in shape

C) Chromosomes are always rod-shaped and never circular
D) Chromosomes lack any defined shape

2. According to Lesson 29, what is the estimated gene count in humans?

A) 5,800
B) 13,700
C) 25,000 - 27,000
D) 45,000

3. Which organism listed in Lesson 29 possesses the highest total number of genes among the given examples?

A) Human
B) Drosophila
C) E. coli
D) Rice

4. How does the gene density per Mb of DNA in prokaryotes compare to that in eukaryotes?

A) Prokaryotes have lower gene density per Mb of DNA than eukaryotes
B) Prokaryotes exhibit higher gene density per Mb of DNA than eukaryotes
C) Both have identical gene density per Mb of DNA
D) Gene density cannot be compared between the two groups

Answer Key

1. B — Lesson 29 establishes that chromosome shapes can be either circular or linear.
2. C — The source handout specifies that humans have an estimated 25,000 to 27,000 genes.
3. D — Rice is listed with 45,000 genes, which exceeds the counts for humans, Drosophila, and E. coli.
4. B — Prokaryotic genomes exhibit higher gene density per Mb of DNA than eukaryotic genomes.

Lesson 30: Size of Chromosomes

1. The length of chromosomes generally varies between:

A) 0.01 µm to 0.1 µm
B) 0.5 µm to 32 µm
C) 50 µm to 100 µm
D) 1 mm to 5 mm

2. Which plant species possesses the longest known normal chromosomes (32 µm)?

A) Maize
B) Trillium
C) Onion
D) Pea

3. Giant chromosomes found in Diptera can reach lengths up to:

A) 32 µm
B) 100 µm
C) 300 µm
D) 1000 µm

4. In general, how do plant chromosome sizes compare to animal chromosome sizes?

A) Plants have shorter chromosomes than animals
B) Plants have longer chromosomes than animals
C) Plant and animal chromosomes are identical in size
D) Plants lack chromosomes entirely

Answer Key

1. B — Chromosome length ranges from 0.5 µm to 32 µm
2. B — The longest normal chromosomes are found in Trillium (32 µm)
3. C — Giant polytene chromosomes in Diptera can measure up to 300 µm in length
4. B — Generally, plant species possess longer chromosomes than animal species

Lesson 31: Types of Chromosomes

1. Which two primary types of eukaryotic chromosomes are described in Lesson 31?

A) Homologous chromosomes and heterologous chromosomes
B) Autosomes and sex chromosomes
C) Linear chromosomes and circular plasmids
D) Metacentric chromosomes and telocentric chromosomes

2. How are autosomes defined in genetics?

A) Chromosomes that differ between males and females
B) Paired chromosomes with the same length, shape, centromere location, and genes (any chromosomes other than sex chromosomes)
C) Unpaired chromosomes found only in gametes
D) Chromosomes composed entirely of heterochromatin

3. Sex chromosomes are defined as members of a pair of chromosomes that:

A) Are identical in length and shape in both sexes
B) Differ between males and females
C) Carry no genes at all
D) Exist only in prokaryotes

4. Which of the following statements is true regarding autosomes?

A) They are non-paired single chromosomes
B) They include all chromosomes other than the sex chromosomes
C) They determine the sex of the offspring
D) They are found only in plants

Answer Key

1. B — Eukaryotic chromosomes are classified into two main types: autosomes and sex chromosomes.
2. B — Autosomes are paired chromosomes with matching length, shape, centromere location, and genes (all chromosomes except sex chromosomes).
3. B — Sex chromosomes are defined as members of a chromosome pair that differ between males and females.
4. B — Any chromosome that is not a sex chromosome is categorized as an autosome.

Lesson 32: What Are Telomeres?

1. What are the two physical ends of a chromosome called?

A) Centromeres
B) Kinetochores
C) Telomeres
D) Chromatids

2. Telomeres are required for chromosomal:

A) Cleavage and degradation
B) Replication and stability
C) Nondisjunction
D) Spindle attachment

3. The handout compares telomeres to which everyday object?

A) Zipper teeth
B) Ends of shoestrings
C) Buttons
D) Paper clips

4. How do normal chromosome ends compare to broken chromosome ends regarding stickiness?

A) Normal ends are sticky, broken ends are not
B) Broken ends are sticky, whereas normal ends are not sticky
C) Both normal and broken ends are highly sticky
D) Neither normal nor broken ends display stickiness

Answer Key

1. C — The terminal structural ends of chromosomes are called telomeres

2. B — Telomeres are essential for preserving chromosome stability and enabling replication

3. B — Telomeres function analogously to the protective plastic tips at the ends of shoestrings

4. B — Broken chromosome ends readily fuse because they are sticky, whereas normal intact telomeres are non-sticky

Lesson 33: Euchromatin and Heterochromatin

1. What term is used for the darker-staining chromosomal regions generally found near the centromere?

A) Euchromatin
B) Heterochromatin
C) Constitutive chromatin
D) Facultative chromatin

2. What are the light-staining chromosomal regions called?

A) Heterochromatin
B) Euchromatin
C) Constitutive heterochromatin
D) Facultative heterochromatin

3. Heterochromatin is categorized into which two distinct groups?

A) Primary and secondary heterochromatin

B) Active and inactive heterochromatin
C) Constitutive heterochromatin and facultative heterochromatin
D) Dense and loose heterochromatin

4. Which type of heterochromatin remains permanently in the heterochromatic state and does not revert?

A) Facultative heterochromatin
B) Constitutive heterochromatin
C) Euchromatin
D) Centromeric chromatin

Answer Key

1. B — Dark-staining chromosomal regions near centromeres or telomeres represent heterochromatin.

2. B — Light-staining chromosomal regions are designated as euchromatin.

3. C — Heterochromatin is classified into constitutive heterochromatin and facultative heterochromatin.

4. B — Constitutive heterochromatin remains permanently in the heterochromatic stage without reverting to euchromatin.

Lesson 34: Staining and banding chromosomes

1. In Feulgen staining, what treatment produces a free aldehyde group in deoxyribose molecules?

A) Mild hydrolysis in 1N HCl at 60 C for 10 minutes
B) Staining with quinacrine mustard under UV light
C) Digestion with restriction endonucleases
D) Heating in 5N NaOH at 100 C for 1 hour

2. What chemical reagent is used in Q-banding to reveal fluorescent bands under UV light?

A) Giemsa stain
B) Quinacrine mustard
C) Feulgen reagent
D) Ethidium bromide

3. What chromosomal regions do the bands produced by C-banding correspond to?

A) Euchromatin regions
B) Constitutive heterochromatin
C) Single nucleotide polymorphisms
D) Histone H1 protein tails

4. How are R-bands (reverse bands) characterized relative to Q-bands?

A) They stain distal ends exclusively
B) They are located in zones between Q-bands that do not fluoresce with quinacrine mustard
C) They only stain centromeric AT-rich regions
D) They destroy the sugar-phosphate backbone

Answer Key

1. A — Feulgen staining subjects cells to mild hydrolysis in 1N HCl at 60 C for 10 minutes, freeing aldehyde groups in deoxyribose.

2. B — Q-banding utilizes quinacrine mustard to produce fluorescent bands when observed under UV light.

3. B — C-banding specifically stains constitutive heterochromatin, primarily located around centromeres.

4. B — R-bands represent reverse banding situated in non-fluorescing zones between Q-bands.

Lesson 35: Nucleosomes

1. What length of DNA wraps around the octamer core of a single nucleosome?

A) 20 bp
B) 60 bp
C) 147 bp
D) 300 bp

2. What is the length range of linker DNA located between adjacent nucleosomes?

A) 5–10 bp
B) 20–60 bp
C) 147–200 bp
D) 500–1000 bp

3. Which five abundant histone types exist in eukaryotic chromatin?

A) H1, H2A, H2B, H3, and H4
B) CDE-I, CDE-II, CDE-III, CEN, and CBF
C) A, B, C, D, and E
D) DNA, RNA, ATP, GTP, and CTP

4. When are nucleosomes assembled during the cell cycle?

A) Exclusively during mitotic metaphase
B) Immediately after DNA replication
C) During cytokinesis in plant cells
D) Prior to fertilization in mature gametes

Answer Key

1. C — A nucleosome consists of a core of eight histone proteins with 147 bp of DNA wrapped around them.

2. B — Linker DNA situated between nucleosomes spans 20 to 60 base pairs in length.

3. A — The five abundant histone classes in chromatin are H1, H2A, H2B, H3, and H4.

4. B — Nucleosome assembly takes place immediately following DNA replication.

Lesson 36: Chromatin and Chromosomes

1. The complexes formed between eukaryotic DNA and proteins are termed:

A) Plasmids
B) Chromatin
C) Kinetochores
D) Centrioles

2. What are the major proteins associated with eukaryotic chromatin?

A) Polymerases
B) Histones
C) Ligases
D) Endonucleases

3. Histone proteins contain a high proportion of which basic amino acids?

A) Alanine and Glycine
B) Arginine and Lysine
C) Tryptophan and Tyrosine
D) Glutamate and Aspartate

4. How many abundant histone types exist in eukaryotic chromatin (H1, H2A, H2B, H3, H4)?

A) Three
B) Five
C) Ten
D) Twelve

Answer Key

1. B — Chromatin is the eukaryotic complex composed of DNA and associated proteins
2. B — Histones are the primary protein components bound to eukaryotic DNA
3. B — Histones are basic proteins rich in lysine and arginine residues
4. B — Eukaryotic chromatin contains five main histone classes: H1, H2A, H2B, H3, and H4

Lesson 38: Higher order chromatin folding

1. What is the structural diameter of the basic "beads-on-a-string" nucleosome form of chromatin?

A) 2 nm
B) 11 nm
C) 30 nm
D) 300 nm

2. When nucleosomes pack closely together, they form a coiling chromatin fiber with what diameter?

A) 11 nm
B) 20 nm
C) 30 nm
D) 700 nm

3. In extended chromosome structure, loops of the 30-nm chromatin fiber attach to a central chromosome scaffold, producing a fiber of what diameter?

A) 11 nm
B) 30 nm
C) 300 nm
D) 1400 nm

4. What is the total diameter of an entire mitotic metaphase chromosome in its fully condensed state?

A) 300 nm
B) 300 nm (scaffold-associated fiber)
C) 700 nm
D) 1400 nm

Answer Key

1. B — The "beads-on-a-string" nucleosome arrangement measures 11 nm in diameter.

2. C — Packed nucleosomes assemble into a 30-nm chromatin fiber.

3. C — Loops of 30-nm chromatin fiber associate with a chromosome scaffold to form a 300-nm fiber.

4. D — A fully condensed metaphase chromosome spans a total diameter of 1400 nm across its two chromatids.

Lesson 39: Kinetochore

1. What is the actual site within the centromere region where spindle fibers attach during cell division?

A) The telomere
B) The kinetochore
C) The nucleolus organizer
D) The secondary constriction

2. How long is the CEN DNA sequence found within kinetochore regions?

A) 50 base pairs
B) 120 base pairs
C) 300 base pairs
D) 1000 base pairs

3. The CEN DNA sequence consists of which three sub-domains?

A) CDE-I, CDE-II, and CDE-III
B) H1, H2A, and H2B
C) CEN-A, CEN-B, and CEN-C
D) TATA, CAAT, and GC boxes

4. A point mutation in which CEN DNA sub-domain completely eliminates the centromere's ability to function?

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

Answer Key

1. B — The actual attachment location for spindle fibers within the centromere is called the kinetochore.

2. B — CEN DNA located within kinetochore regions is 120 base pairs long.

3. A — CEN DNA comprises three sub-domains designated CDE-I, CDE-II, and CDE-III.

4. C — A point mutation specifically in CDE-III completely abolishes centromere function.

Lesson 40: Karyotyping

1. Karyotype is defined as the general morphology of which type of chromosomes?

A) Gametic chromosomes
B) Somatic chromosomes
C) Bacterial chromosomes
D) Viral chromosomes

2. What is a diagrammatic representation of a species' karyotype showing all its morphological features called?

A) An idiotype (idiogram)
B) A phenotype
C) A genotype
D) A haplotype

3. Which stain is explicitly mentioned in Lesson 40 for producing banding patterns to identify chromosomes?

A) Feulgen stain
B) Quinacrine mustard
C) Giemsa stain
D) Ethidium bromide

4. In what order are chromosomes arranged when constructing a standard karyotype display?

A) Ascending order of size
B) Descending order of size with centromeres aligned
C) Alphabetical order of gene names
D) Random order

Answer Key

1. B — Karyotype refers to the general morphological arrangement of somatic chromosomes.
2. A — An idiotype is a diagrammatic representation of a species' karyotype detailing morphological features.
3. C — Giemsa staining is specified in Lesson 40 for generating characteristic chromosomal banding patterns.
4. B — Karyotypes arrange chromosomes in descending order of size with their centromeres aligned.

Lesson 41: Prokaryotic Chromosomes

1. According to Lesson 41, which group has the smallest genome length?

A) Eukaryotic yeast
B) RNA viruses
C) Bacteria
D) Drosophila

2. Larger bacteriophage genomes may contain up to how many genes?

A) 10 genes
B) 150 genes
C) 3,000 genes
D) 45,000 genes

3. Approximately how many genes are organized into the single circular chromosome of E. coli?

A) 100 genes
B) 1,500 genes
C) 3,000 to 4,000 genes
D) 25,000 genes

4. How many primary chromosomes do prokaryotic organisms usually possess?

A) Only one circular chromosome (plus plasmids)

B) Two linear chromosomes
C) 46 chromosomes
D) No chromosomes at all

Answer Key

1. B — Genome length is smallest among RNA viruses.
2. B — Larger bacteriophage genomes can contain up to 150 genes.
3. C — E. coli contains roughly 3,000 to 4,000 genes organized on its single circular chromosome.
4. A — Prokaryotes typically possess a single circular chromosome plus plasmids.

Lesson 42: Sex chromosomes and sex determination

1. In human gender determination, which sex is heterogametic?

A) Female (XX)
B) Male (XY)
C) Female (ZW)
D) Male (XO)

2. In birds, amphibians, reptiles, and butterflies, which combination represents the female heterogametic sex?

A) XX female
B) XY female
C) ZW female
D) XO female

3. In the XO sex determination system found in grasshoppers, what is the male sex chromosome constitution?

A) XX
B) XO (a single X chromosome, no Y)
C) XY
D) ZW

4. What is the probability of an offspring being male or female in human gender inheritance?

A) 25% male, 75% female
B) 50% male, 50% female
C) 75% male, 25% female
D) 100% determined by temperature

Answer Key

1. B — Human males are heterogametic (XY), producing two types of sex cells (X or Y).
2. C — In birds, reptiles, and butterflies, females are heterogametic with ZW sex chromosomes.
3. B — Male grasshoppers possess a single X chromosome without a Y, represented as XO.
4. B — Human fertilization results in a 50% chance of a girl (XX) and a 50% chance of a boy (XY).

Lesson 43: Salient features of DNA

1. According to the base pairing rules in Lesson 43, Adenine specifically forms complementary pairs with:

A) Guanine
B) Cytosine
C) Thymine
D) Uracil

2. What does Chargaff's G-C rule state regarding the (G+C) percentage in DNA?

A) It is always 50% across all species
B) It remains constant within a given species but varies between different species
C) It equals the (A+T) percentage in all organisms
D) It is always higher than (A+T)

3. What does Chargaff's "Cluster rule" specify regarding pyrimidines?

A) Pyrimidines never occur near purines
B) Pyrimidines cluster together on one strand, dictating purine clustering on the complementary strand
C) Pyrimidines pair only with other pyrimidines
D) Pyrimidines are absent from coding strands

4. What chemical components form the structural outer backbones of the DNA double helix?

A) Amino acids and peptide bonds
B) Nitrogenous bases and hydrogen bonds
C) Alternating sugar and phosphate groups
D) Fatty acids and glycerol

Answer Key

1. C — Purines pair with pyrimidines, specifically Adenine (A) with Thymine (T).

2. B — The (G+C)% remains constant within a given species but varies between different species.

3. B — The cluster rule notes pyrimidines cluster together on one strand, dictating purine clustering on the opposite strand.

4. C — Alternating sugar and phosphate groups form the double-stranded helical backbone.

Lesson 44: Nucleotide

1. A complete nucleotide monomer is composed of how many structural components?

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

2. What are the three components of a nucleotide?

A) Pentose sugar, nitrogenous base, and phosphate group
B) Hexose sugar, amino acid, and lipid
C) Glycerol, fatty acid, and nitrogenous base
D) Histone, DNA, and centromere

3. A nucleic acid polymer containing fewer than 10 monomer units is termed an:

A) Polynucleotide
B) Oligonucleotide
C) Nucleoside
D) Octamer

4. A nucleoside consists of:

A) Sugar + base + phosphate
B) Monomer of sugar + base
C) Base + phosphate group only
D) Histone protein + DNA

Answer Key

1. C — Every nucleotide is constructed from three distinct sub-units
2. A — Nucleotides comprise a 5-carbon pentose sugar, a nitrogenous base, and a phosphate group
3. B — Short nucleic acid polymers under 10 units long are classified as oligonucleotides
4. B — A nucleoside is a two-part molecule formed solely by a sugar and a nitrogenous base

Lesson 45: Conformations of DNA

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

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

2. Which DNA conformation is the widest helix and features a 6Å central hole along its axis?

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

3. Standard B-DNA is characterized as a:

A) Left-handed narrowest helix
B) Right-handed helix with intermediate width
C) Single-stranded left-handed helix
D) Helix lacking a minor groove

4. Which DNA conformation completely lacks a major groove?

A) A-DNA
B) B-DNA
C) Z-DNA
D) All helical forms possess a major groove

Answer Key

1. C — Z-DNA is unique among common DNA conformations for having a left-handed helical structure
2. A — A-DNA represents the widest right-handed DNA conformation with an internal central hole
3. B — B-DNA exhibits a right-handed double-helical structure of intermediate width
4. C — Z-DNA is the narrowest form and lacks a major groove

Lesson 46: Chargaff Rule of Base Ratios

1. Chargaff's rules state that in double-stranded DNA, purines pair with:

A) Other purines

B) Pyrimidines
C) Amino acids
D) Phosphate backbones

2. According to Chargaff's parity rules, the percentage of Adenine (A) approximately equals:

A) Percentage of Guanine (G)
B) Percentage of Cytosine (C)
C) Percentage of Thymine (T)
D) Percentage of Uracil (U)

3. Chargaff's G-C rule states that the (G+C)% is:

A) Variable within individual tissue cells of a single organism
B) Constant within a species, but often differs between species
C) Exactly 50% in all living organisms
D) Zero in prokaryotic DNA

4. The cluster rule states that pyrimidines often occur in clusters, meaning the complementary strand contains clusters of:

A) Pyrimidines
B) Purines
C) Histones
D) Ribose sugars

Answer Key

1. B — Chargaff established that purines specifically pair with pyrimidines

2. C — Parity rules dictate that % A equals % T and % G equals % C

3. B — The overall (G+C) percentage remains constant within a single species but varies across different species

4. B — Pyrimidine clusters on one DNA strand dictate complementary purine clusters on the opposing strand

Lesson 47: Giant or Polytene chromosome

1. Giant chromosomes were first discovered in 1881 in dipteran salivary glands by which scientist?

A) Flemming
B) Balbiani
C) Mendel
D) Morgan

2. What is the total length of giant chromosomes in Drosophila melanogaster?

A) 32 µ
B) 300 µ
C) 2,000 µ
D) 1400 nm

3. Approximately how many dark-staining bands can be recognized in the giant chromosomes of Drosophila?

A) 500
B) 1,000

C) 5,000
D) 45,000

4. How many individual strand copies are estimated to form the polytene giant chromosomes of Chironomus?

A) 64
B) 512
C) 4,096
D) 10,000

Answer Key

1. B — Balbiani first discovered giant chromosomes in 1881 within dipteran salivary glands.

2. C — The total combined length of giant chromosomes in D. melanogaster is approximately 2,000 µ.

3. C — Drosophila giant chromosomes display about 5,000 distinct dark-staining bands under the microscope.

4. C — Repeated DNA replication without cell division yields about 4,096 strands in Chironomus polytene chromosomes.

Lesson 48: Lampbrush Chromosome

1. Lampbrush chromosomes were first observed in 1882 by:

A) Balbiani
B) Flemming
C) Mendel
D) Morgan

2. In vertebrates, lampbrush chromosomes are predominantly found in which cell type?

A) Somatic liver cells
B) Oocytic nuclei
C) Red blood cells
D) Muscle fibers

3. What does a single lateral loop in a lampbrush chromosome structurally represent?

A) One centromere
B) One chromatid (a single DNA molecule)
C) One ribosome
D) One nucleolus

4. How are the two ends of each lateral loop in a lampbrush chromosome structurally distinguished?

A) One thin end and one thick end (asymmetry)
B) Both ends are identical
C) Both ends have centromeres
D) One end is always broken

Answer Key

1. B — Flemming first observed lampbrush chromosomes in the year 1882.

2. B — Lampbrush chromosomes occur prominently in the oocytic nuclei of vertebrates.

3. B — Each extended loop corresponds to one chromatid, representing a single DNA molecule.

4. A — Each lampbrush loop displays asymmetry, having one thin end and one thick end.

Lesson 49: Cell division and reproduction

1. According to Lesson 49, what essential event must occur before a cell's nucleus divides?

A) Cytoplasm is completely pinched off
B) Genetic material replicates
C) Cell wall dissolves entirely
D) Spindle fibers break down and dissolve

2. Cell division and reproduction are described as two fundamental processes occurring in:

A) Eukaryotes only
B) Prokaryotes only
C) Both prokaryotes and eukaryotes
D) Viruses only

3. Why is cell division required in living organisms according to Lesson 49?

A) For cell growth, development, and reproduction
B) To eliminate all histone proteins
C) To convert DNA into single-stranded RNA
D) To prevent DNA replication during interphase

4. What happens to a cell's genetic material prior to nuclear division?

A) It is degraded by endonucleases
B) It replicates so genetic material can be distributed
C) It converts permanently into heterochromatin
D) It translocates to non-homologous chromosomes

Answer Key

1. B — Before the nucleus divides, the cell's genetic material replicates.
2. C — Cell division and reproduction represent fundamental processes in both prokaryotes and eukaryotes.
3. A — Cell division is a fundamental process required for organismal growth, development, and reproduction.
4. B — Genetic material replicates prior to nuclear division to enable proper distribution to daughter cells.

Lesson 50: Cell Cycle

1. The eukaryotic cell cycle is divided into two primary phases:

A) Prophase and Anaphase
B) Interphase and Mitotic phase
C) G1 phase and G2 phase
D) Meiosis I and Meiosis II

2. The G0 phase of the cell cycle is also referred to as the:

A) Synthesis phase
B) Post-mitotic phase
C) Pre-mitotic growth phase
D) Cytokinesis phase

3. Eukaryotic cells generally enter the non-dividing G0 state from which cell cycle stage?

A) G1 phase
B) S phase
C) G2 phase
D) Metaphase

4. Interphase proceeds in three sequential stages in what order?

A) S → G1 → G2
B) G1 → S → G2
C) G2 → S → G1
D) G1 → G2 → S

Answer Key

1. B — The cell cycle consists of Interphase and the Mitotic (M) phase
2. B — G0 is a quiescent post-mitotic state
3. A — Cells exit the G1 phase to enter the G0 post-mitotic state
4. B — Interphase progresses through G1, S (synthesis), and G2 stages

Lesson 51: Mitosis

1. What is the result of mitotic cell division from a single parent cell?

A) Four genetically distinct haploid gametes
B) Two genetically identical daughter cells
C) Eight non-identical daughter nuclei
D) A single tetraploid zygote

2. Which cell types can undergo mitosis according to Lesson 51?

A) Diploid cells only
B) Haploid cells only
C) Both haploid and diploid cells
D) Bacterial plasmids only

3. What essential components must each newly formed daughter cell receive following mitotic division?

A) Its own cytoplasm and DNA
B) Plasmids and a cell wall
C) Four centriole pairs and a cleavage furrow
D) A haploid set of 23 chromosomes only

4. Before sister chromatids break apart during mitosis, what process must occur to produce identical copies of the DNA?

A) Recombination during synapsis
B) DNA replication prior to mitosis
C) Histone acetylation in G0
D) Cytokinesis via cell plate

Answer Key

1. B — Mitosis divides a single cell into two new daughter cells that are genetically identical to the original cell.
2. C — Mitotic cell division occurs in both haploid and diploid cells.

3. A — Each daughter cell produced by mitosis must receive its own cytoplasm and DNA.

4. B — Chromosomes replicate before mitosis to produce identical copies of DNA before sister chromatids separate.

Lesson 52: Un-replicated and replicated chromosome

1. Duplicated chromosomes that remain attached at their centromere are known as:

A) Homologous pairs
B) Sister chromatids
C) Tetrads
D) Polynucleotides

2. When does chromosome duplication (replication) take place during the cell cycle?

A) During metaphase alignment
B) Before cell division takes place
C) During cytokinesis
D) After telophase is complete

3. As long as duplicated chromosomes remain attached at their centromere, they are designated as:

A) Two independent chromosomes
B) Sister chromatids
C) Non-homologous translocations
D) Acquired variations

4. What causes chromosomes to transition from an un-replicated state to a replicated state?

A) Splitting of centromeres in anaphase
B) Replication of the entire DNA of each chromosome
C) Dissolution of the nuclear membrane
D) Attachment of asters to centrioles

Answer Key

1. B — Duplicated chromosomes attached at their centromere are referred to as sister chromatids as long as they remain attached.

2. B — Chromosomes (DNA) replicate before cell division takes place.

3. B — Attached duplicated chromosome copies are defined as sister chromatids.

4. B — Duplicated chromosomes arise through DNA replication, duplicating the entire DNA of each chromosome.

Lesson 53: Interphase

1. What proportion of total cell cycle time is spent in Interphase?

A) ~10%
B) ~50%
C) ~90%
D) 100%

2. What key molecular process occurs specifically during the S phase of Interphase?

A) Absorption of nutrients and initial growth

B) Synthesis of new DNA for daughter cells
C) Splitting of centromeres
D) Pinching of the cleavage furrow

3. What takes place during the G1 phase of Interphase?

A) The new cell absorbs nutrients and grows larger
B) Homologous chromosomes form tetrads
C) Nuclear membranes break down
D) Chromosomes line up at the equator

4. Why does a cell in the G2 phase eventually need to enter cell division?

A) Because it loses all its DNA
B) Because it continues to grow and gets too large, needing to divide
C) Because centrioles fail to replicate
D) Because histone proteins are degraded

Answer Key

1. C — Interphase accounts for approximately 90% of total cell cycle duration.
2. B — Genomic DNA synthesis for daughter cells occurs exclusively during the S phase of Interphase.
3. A — In G1 phase, the newly formed cell absorbs nutrients and expands in size.
4. B — During G2, continued growth causes the cell to get too large, triggering the need for cell division.

Lesson 54: Prophase of mitosis

1. Prophase is defined as which stage of mitotic cell division?

A) The final stage
B) The middle alignment stage
C) The initial stage
D) The resting stage

2. What happens to the nuclear membrane during prophase of mitosis?

A) It doubles in size
B) It disappears
C) It becomes rigid
D) It divides into four

3. Where do centrioles position themselves during prophase?

A) At the metaphase plate
B) On opposite poles of the cell
C) Inside the nucleus
D) At the cell membrane

4. At the start of mitosis, DNA wraps around which proteins to condense into visible chromosomes?

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

Answer Key

1. C — Prophase is the initial stage of mitotic cell division.
2. B — Disappearance of the nuclear membrane is one of four major events characterizing prophase.
3. B — Centrioles separate and move to opposite poles of the cell during prophase.
4. C — Chromatin condenses at mitosis onset as DNA wraps tightly around histone proteins.

Lesson 55: Metaphase

1. What key positioning event occurs to chromosomes during metaphase?

A) They split into single chromatids
B) They line up along the middle alignment (metaphase) plate
C) They dissolve into chromatin
D) They migrate to the poles

2. What structures attach the centromere of each sister chromatid to the centrioles at the poles?

A) Cleavage furrows
B) Spindle fibers
C) Nuclear pores
D) Ribosomes

3. How many major events characterize metaphase according to Lesson 55?

A) One event
B) Two events
C) Three events
D) Four events

4. Where are centrioles positioned during metaphase?

A) At the cell center alongside chromosomes
B) At the cell poles anchoring the spindle apparatus
C) Inside the nucleus
D) At the cleavage furrow

Answer Key

1. B — Metaphase is defined by chromosomes lining up along the middle alignment plate of the cell.
2. B — Spindle fibers connect centromeres to centrioles stationed at opposite cell poles.
3. B — Lesson 55 outlines two key metaphase events: alignment in the middle and spindle attachment.
4. B — Centrioles reside at the cell poles to anchor the spindle apparatus.

Lesson 56: Anaphase of mitosis

1. What event happens to centromeres during anaphase of mitosis?

A) They duplicate
B) They split, separating sister chromatids
C) They dissolve
D) They fuse

2. Once sister chromatids separate during anaphase, they are designated as:

A) Homologous tetrads
B) Individual daughter chromosomes
C) Bivalents
D) Chromatins

3. Destruction of which inhibitory protein permits separase protease to split centromeres during anaphase?

A) Cyclin
B) Securin
C) Tubulin
D) Actin

4. Which spindle fibers push against each other to stretch the dividing cell into an oval shape?

A) Kinetochore fibers
B) Non-kinetochore (polar) spindle fibers
C) Astral fibers only
D) Intermediate filaments

Answer Key

1. B — Anaphase begins with centromere splitting, which separates sister chromatids.
2. B — Upon separation, former sister chromatids become individual daughter chromosomes.
3. B — Securin inhibits separase; its destruction allows separase to cleave centromeres.
4. B — Non-kinetochore spindle fibers elongate and push against one another to stretch the cell.

Lesson 57: Telophase

1. What occurs to spindle fibers during telophase?

A) They condense into chromatin
B) They break down and disappear
C) They duplicate
D) They form the cell plate

2. Telophase effectively reverses the cellular changes brought about by which phase(s)?

A) S phase and G2 phase
B) Prophase (and prometaphase)
C) Metaphase only
D) Cytokinesis

3. What nuclear structures re-emerge inside each newly forming daughter nucleus during telophase?

A) Centrioles
B) Nucleoli (with nuclear membrane reformation)
C) Spindle fibers
D) Chromosomes condense further

4. How do chromosomes change structurally during telophase?

A) They hyper-condense into 1,400 nm fibers
B) They uncoil and return to a relaxed chromatin state
C) They split into chromatids

D) They attach to the cell membrane

Answer Key

1. B — Spindle fibers dissolve and disappear during telophase.
2. B — Telophase reverses the nuclear breakdown and condensation events of prophase.
3. B — Reformation of nuclear membranes is accompanied by the reappearance of nucleoli.
4. B — Condensed chromosomes uncoil and return to a relaxed chromatin state.

Lesson 58: Cytokinesis

1. What is the fundamental definition of cytokinesis?

A) Division of the cell nucleus
B) Division of the cytoplasm into two daughter cells
C) Duplication of chromosomes
D) Formation of the spindle apparatus

2. In animal cells, cytokinesis occurs through the formation of what structure that pinches the cell?

A) Cell plate
B) Contractile cleavage furrow
C) Phragmoplast
D) Nuclear envelope

3. In plant cells, cytokinesis is accomplished via the formation of what midway structure?

A) Cleavage furrow
B) Cell plate (developing into a cell wall)
C) Contractile ring
D) Spindle equator

4. Into how many parts does cytokinesis divide a single parent cell?

A) Two equal parts
B) Four haploid parts
C) Three unequal parts
D) Eight parts

Answer Key

1. B — Cytokinesis is specifically the division of the cytoplasm into two daughter cells.
2. B — Animal cells divide by forming a contractile cleavage furrow that pinches the cell in two.
3. B — Plant cells construct a cell plate midway between nuclei, which develops into a cell wall.
4. A — Cytokinesis splits the parent cell cytoplasm into two equal daughter cells.

Lesson 59: Mitotic apparatus/ spindles

1. What three structural components comprise the mitotic apparatus/spindles?

A) Centromeres, telomeres, and kinetochores
B) Centrosomes, spindle microtubules, and asters
C) Histones, nucleosomes, and chromatin
D) Exons, introns, and promoters

2. What are asters in the mitotic spindle apparatus?

A) Radial arrays of short microtubules extending from each centrosome
B) Protein structures within the CDE-III domain of CEN DNA
C) Contractile rings that form cleavage furrows in animal cells
D) Double-stranded RNA molecules that silence genes

3. Where does the assembly of spindle microtubules begin within the cell?

A) Inside the nucleolus
B) At the centrosome
C) On the cell plate
D) Within the telomere cap

4. During mitosis, spindle microtubules attach to which specific chromosomal structure to move chromosomes to the metaphase plate?

A) Kinetochores
B) Histone tails
C) Nuclear envelope pores
D) Poly-A tails

Answer Key

1. B — The mitotic apparatus includes centrosomes, spindle microtubules, and asters.

2. A — Asters are radial arrays of short microtubules extending outward from each centrosome.

3. B — Spindle microtubule assembly initiates within the centrosome.

4. A — Spindle microtubules attach specifically to kinetochores to align chromosomes along the metaphase plate.

Lesson 60: Diploid cells and haploid cells

1. What symbol is used to represent haploid sex cells (gametes)?

A) 2n
B) n
C) 3n
D) 4n

2. Diploid cells (2n) are also known as:

A) Gametes
B) Somatic cells (body cells)
C) Polar bodies
D) Plasmids

3. Fertilization is defined as the fusion of spermatozoa and ova to produce a diploid cell called a:

A) Gamete
B) Zygote
C) Tetrad
D) Barr body

4. What is the primary function of meiosis regarding chromosome number?

A) It doubles the diploid chromosome number to tetraploid

B) It reduces the diploid chromosome number into a haploid number
C) It preserves identical diploid chromosome sets in body cells
D) It converts linear chromosomes into circular plasmids

Answer Key

1. B — Haploid sex cells (gametes) are represented by the symbol `n`.
2. B — Diploid cells carrying two chromosomes at each location (2n) are somatic/body cells.
3. B — Fertilization is the fusion of haploid spermatozoa and ova to form a diploid zygote (2n=46).
4. B — Meiosis is the cellular process that reduces diploid chromosome numbers to haploid sets.

Lesson 61: Homologous chromosomes

1. Homologous chromosomes are defined as chromosome pairs that share similar:

A) Sequence length only
B) Shape and overall genetic content
C) Centromere number only
D) Telomere caps only

2. Where are gene alleles that control the same inherited traits situated on homologous chromosomes?

A) At the same locus
B) At random loci
C) Only on the p arm
D) Outside the centromere

3. In a diploid organism, where do the two homologous chromosomes originate?

A) Both from the female parent
B) Both from the male parent
C) One from each parent
D) From sister chromatids

4. How many autosome pairs are present in human somatic cells?

A) 22 pairs
B) 23 pairs
C) 46 pairs
D) 1 pair

Answer Key

1. B — Homologous chromosomes are paired chromosomes that share similar shape and overall genetic content.
2. A — Corresponding gene alleles reside at the exact same locus on homologous chromosomes.
3. C — Diploid individuals inherit one homologous chromosome from the maternal parent and one from the paternal parent.
4. A — Human somatic cells contain 22 pairs of autosomes and 1 pair of sex chromosomes.

Lesson 62: Meiosis

1. Meiosis reduces the chromosome number of a diploid cell to form:

A) Tetraploid somatic cells
B) Haploid gametes
C) Diploid zygotes directly
D) Triploid endosperm

2. Why is Meiosis I designated as a reductional division?

A) It reduces cytoplasm volume by half
B) Homologous pairs separate, reducing chromosome number from diploid to haploid
C) It eliminates all sex chromosomes
D) It doubles the DNA content

3. Human gametes (sperm and egg) formed through meiotic division contain how many total chromosomes?

A) 46
B) 23
C) 92
D) 12

4. Fusion of haploid spermatozoa and ova during fertilization yields a diploid cell called a:

A) Gamete
B) Zygote
C) Spore
D) Tetrad

Answer Key

1. B — Meiosis reduces diploid chromosome sets to yield haploid gametes.
2. B — Homologous pairs separate during Meiosis I, reducing chromosome numbers from diploid to haploid.
3. B — Meiotically produced human gametes carry a haploid set of 23 chromosomes.
4. B — Sperm and egg fusion restores diploidy, forming a single-celled zygote.

Lesson 63: Stages of meiosis

1. What major event occurs during Meiosis I?

A) Sister chromatids separate
B) Homologous chromosomes separate
C) DNA replication
D) Cytokinesis only

2. Why is Meiosis I categorized as a reductional division?

A) It reduces the cytoplasm volume by 90%
B) It reduces the diploid chromosome number to haploid
C) It reduces protein synthesis
D) It reduces the nuclear membrane

3. What structures separate from each other during Meiosis II?

A) Homologous chromosome pairs
B) Sister chromatids
C) Tetrads
D) Bivalents

4. Why is Meiosis II referred to as an equational division?

A) It produces four haploid cells with no reduction in chromosome number (sister chromatids separate)
B) It doubles the chromosome number
C) It equates cytoplasm between cells
D) It replicates DNA again

Answer Key

1. B — Homologous chromosomes separate from one another during Meiosis I.

2. B — Meiosis I is termed reductional division because it reduces the diploid chromosome number to haploid.

3. B — Sister chromatids separate during Meiosis II.

4. A — Meiosis II is an equational division because sister chromatids separate without reducing chromosome number.

Lesson 64: Prophase I of meiosis

1. What percentage of the total time required for meiosis is occupied by Prophase I?

A) ~10%
B) ~50%
C) Over 90%
D) ~25%

2. How many sub-stages comprise Prophase I of meiosis?

A) Two sub-stages
B) Three sub-stages
C) Five sub-stages (Leptotene, Zygotene, Pachytene, Diplotene, Diakinesis)
D) Seven sub-stages

3. During which sub-stage of Prophase I do homologous chromosomes pair up (synapsis) to form tetrads?

A) Leptotene
B) Zygotene
C) Diplotene
D) Diakinesis

4. The X-shaped sites where non-sister chromatids exchange genetic material during Prophase I are called:

A) Centromeres
B) Chiasmata
C) Kinetochores
D) Telomeres

Answer Key

1. C — Prophase I is the longest meiotic phase, occupying over 90% of total meiotic duration.

2. C — Prophase I is divided into five distinct sub-stages: Leptotene, Zygotene, Pachytene, Diplotene, and Diakinesis.

3. B — Homologous pairing (synapsis) begins during the Zygotene sub-stage of Prophase I.

4. B — Chiasmata represent the physical crossover sites where non-sister chromatids exchange segments.

Lesson 65: Metaphase I of meiosis

1. What structures line up along the metaphase plate during Metaphase I of meiosis?

A) Single unattached chromatids
B) Tetrads (paired homologous chromosomes)
C) Individual chromosomes like in mitosis
D) Nuclear membranes

2. How do spindle microtubules attach to kinetochores in Metaphase I?

A) Microtubules from one pole attach to both kinetochores of a tetrad
B) Microtubules from opposite poles attach to kinetochores of opposing homologs
C) Microtubules do not attach in Metaphase I
D) Microtubules attach only to one homolog

3. In Metaphase I, how are the two chromosomes of each tetrad oriented?

A) Both facing the same pole
B) One chromosome facing one pole, the other facing the opposite pole
C) Randomly without orientation
D) Facing the cell center

4. How does Metaphase I of meiosis differ fundamentally from Metaphase of mitosis?

A) Homologous pairs line up as tetrads in Metaphase I, unlike individual chromosomes in mitotic metaphase
B) There is no difference
C) Mitosis has tetrads
D) Meiosis I lacks spindle fibers

Answer Key

1. B — Tetrads (paired homologous chromosomes) align at the metaphase plate during Metaphase I.

2. B — Microtubules extending from opposite poles attach to the kinetochores of opposing homologs.

3. B — One chromosome of each tetrad faces one pole, while the other chromosome faces the opposite pole.

4. A — Homologous pairs line up as tetrads in Metaphase I, unlike mitotic metaphase where individual chromosomes align.

Lesson 66: Anaphase I of meiosis

1. What structures separate and move toward opposite poles during Anaphase I of meiosis?

A) Sister chromatids
B) Homologous chromosome pairs
C) Nuclear envelopes
D) Spindle poles

2. What happens to sister chromatids during Anaphase I of meiosis?

A) They split at their centromeres
B) They remain joined at their centromeres and move together to the poles
C) They dissolve completely
D) They duplicate again

3. What guides the movement of separated chromosomes toward opposite poles during Anaphase I?

A) Spindle apparatus
B) Cytoplasmic streaming
C) Nuclear pores
D) Cell plate formation

4. How does Anaphase I of meiosis differ fundamentally from Anaphase of mitosis?

A) Sister chromatids separate in Anaphase I
B) Homologous chromosomes separate in Anaphase I, while sister chromatids stay joined
C) No chromosomes move in Anaphase I
D) Centromeres divide in Anaphase I

Answer Key

1. B — Homologous chromosome pairs separate from each other during Anaphase I.
2. B — Sister chromatids remain joined at their centromeres and move together to poles during Anaphase I.
3. A — Chromosome movement toward poles in Anaphase I is directed by the spindle apparatus.
4. B — Meiosis I keeps sister chromatids joined at centromeres, unlike mitosis where sister chromatids separate.

Lesson 67: Telophase I of meiosis

1. What is the structural state of chromosomes when they arrive at each pole during Telophase I?

A) Single chromatids, haploid
B) Haploid set, each chromosome still composed of two sister chromatids
C) Diploid set of single chromatids
D) Dissolved chromatin

2. How many daughter cells are formed at the completion of Telophase I and cytokinesis?

A) Two haploid daughter cells
B) Four haploid cells
C) Two diploid cells
D) One cell

3. Does DNA replication occur between the end of Meiosis I and the beginning of Meiosis II?

A) Yes, a full S phase occurs
B) No, chromosomes do not replicate between Meiosis I and Meiosis II
C) Yes, but only partially
D) Only in plant cells

4. How does cytokinesis proceed during Telophase I in animal cells compared to plant cells?

A) Both use cell plates
B) Animal cells divide via a contractile cleavage furrow, whereas plant cells construct a cell plate
C) Both use cleavage furrows
D) Cytokinesis does not occur

Answer Key

1. B — Each pole receives a haploid set of chromosomes, each still composed of two sister chromatids.

2. A — Telophase I and simultaneous cytokinesis divide a diploid cell into two haploid daughter cells.

3. B — No chromosome replication takes place between Meiosis I and Meiosis II.

4. B — Animal cells divide via a contractile cleavage furrow, whereas plant cells construct a cell plate.

Lesson 68: Prophase II of meiosis

1. What positioning event occurs to centrioles during Prophase II of meiosis?

A) They dissolve permanently
B) They separate and take up positions at opposite poles
C) They remain at the center
D) They duplicate

2. Is there a round of DNA replication immediately preceding Prophase II?

A) Yes, a brief S phase occurs
B) No, chromosomes are already replicated and do not replicate again
C) Yes, in animal cells only
D) Only the Y chromosome replicates

3. What happens to the nuclear membrane during Prophase II?

A) It thickens into a cell wall
B) It disappears
C) It doubles
D) It remains intact

4. Which structures form during Prophase II and radiate toward the center of the cell?

A) Cleavage furrows
B) Spindle fibers
C) Cell plates
D) Nuclear pores

Answer Key

1. B — Centrioles separate and take up positions at opposite poles during Prophase II.

2. B — Chromosomes do not replicate prior to Prophase II because they are already replicated.

3. B — The nuclear membrane disappears during Prophase II.

4. B — Spindle fibers form and radiate toward the center of the cell during Prophase II.

Lesson 69: Metaphase II of meiosis

1. What structures line up along the metaphase plate during Metaphase II of meiosis?

A) Tetrads of homologous pairs
B) Sister chromatids arranged across the middle of the cell
C) Unreplicated single chromatids
D) Nuclear envelopes

2. Microtubules extending from opposite poles attach to which specific structure on sister chromatids during Metaphase II?

A) Telomeres
B) Kinetochores

C) Nucleoli
D) Histone octamers

3. Why are the two sister chromatids of each chromosome no longer genetically identical during Metaphase II?

A) Because of DNA replication errors
B) Due to crossing over that occurred during Meiosis I
C) Because of independent assortment
D) Due to chromosome loss

4. Where are chromosomes positioned within the cell during Metaphase II?

A) At the cell poles
B) Lined up along the central metaphase plate in the middle of the cell
C) Inside the nucleolus
D) Attached to the cell membrane

Answer Key

1. B — Sister chromatids line up across the middle metaphase plate during Metaphase II.

2. B — Microtubules from opposing spindle poles attach to kinetochores on individual sister chromatids.

3. B — Crossing over during Prophase I recombines non-sister chromatids, making sister chromatids non-identical by Metaphase II.

4. B — Chromosomes align along the central metaphase plate in the middle of the cell during Metaphase II.

Lesson 70: Anaphase II of meiosis

1. What critical structural event permits sister chromatids to separate during Anaphase II?

A) Splitting of centromeres
B) Dissolution of the nuclear membrane
C) DNA replication
D) Formation of tetrads

2. What designation do separated sister chromatids take once they move apart in Anaphase II?

A) Homologous pairs
B) Individual daughter chromosomes
C) Bivalents
D) Tetrads

3. Where do separated chromatids migrate during Anaphase II?

A) To the metaphase plate
B) To opposite poles of the cell
C) To the cell center
D) Out of the cell

4. How does Anaphase II differ fundamentally from Anaphase I?

A) Sister chromatids separate in Anaphase II, whereas homologous chromosomes separate in Anaphase I
B) They are identical
C) Anaphase I separates sister chromatids
D) Anaphase II involves tetrads

Answer Key

1. A — Splitting of centromeres enables sister chromatids to separate during Anaphase II.
2. B — Once separated in Anaphase II, former sister chromatids become individual daughter chromosomes.
3. B — Separated chromatids are pulled toward opposite poles of the cell.
4. A — Anaphase II involves centromere splitting and sister chromatid separation, whereas Anaphase I separates homologous chromosomes.

Lesson 71: Telophase II of meiosis

1. How many total daughter cells are produced at the conclusion of Telophase II and cytokinesis?

A) Two
B) Four haploid daughter cells
C) Eight
D) One

2. How is the genetic composition of the four daughter cells described following Telophase II?

A) All genetically identical
B) Genetically distinct due to crossing over and independent assortment
C) Diploid
D) Triploid

3. What nuclear event takes place during Telophase II as chromosomes arrive at the poles?

A) Nuclear membranes reassemble around haploid sets as chromosomes de-condense
B) Nuclear membranes dissolve
C) Chromosomes condense further
D) Nucleoli duplicate

4. What chromosome set number is present in each resulting daughter cell after Telophase II?

A) Diploid (2n)
B) Haploid (n) set of unreplicated chromosomes
C) Tetraploid
D) Aneuploid

Answer Key

1. B — Meiosis II concludes with Telophase II and cytokinesis, producing four haploid daughter cells.
2. B — Crossing over and independent assortment ensure each of the four daughter cells is genetically unique.
3. A — Nuclear membranes reassemble around the haploid sets as chromosomes de-condense during Telophase II.
4. B — Each resulting daughter cell contains a single haploid (n) set of unreplicated chromosomes.

Lesson 72: Mitosis and meiosis

1. How does mitosis affect the number of chromosome sets in daughter cells relative to the parent cell?

A) It halves the chromosome sets
B) It conserves the number of chromosome sets, producing genetically identical cells

C) It doubles the chromosome sets
D) It eliminates sex chromosomes

2. What change in chromosome sets occurs as a result of meiotic cell division?

A) Chromosome sets double
B) Chromosome sets are reduced from diploid (2n) to haploid (n)
C) Chromosome sets remain unchanged
D) Chromosome sets become triploid

3. How do the daughter cells produced by meiosis compare genetically to one another and to the parent?

A) They are genetically identical to the parent
B) They are genetically distinct due to recombination and independent assortment
C) They contain no genetic material
D) They are twice the size of the parent cell

4. Which division process generates cells dedicated to growth, tissue repair, and asexual reproduction?

A) Meiosis
B) Mitosis
C) Binary fission only
D) Budding only

Answer Key

1. B — Mitosis maintains chromosome number and set counts, creating genetically identical daughter cells.
2. B — Meiosis reduces chromosome sets from diploid (2n) to haploid (n).
3. B — Genetic recombination and independent assortment make meiotic daughter cells genetically distinct.
4. B — Mitosis provides identical somatic cells needed for growth, repair, and tissue regeneration.

Lesson 73: Summary - Mitosis and meiosis

1. How many cell divisions occur in mitosis compared to meiosis?

A) Mitosis has one division, whereas meiosis has two sequential divisions
B) Both have one division
C) Mitosis has two, meiosis has one
D) Both have four divisions

2. During which phase does synapsis of homologous chromosomes and crossing over occur?

A) Mitotic prophase
B) Prophase I of meiosis
C) Metaphase of mitosis
D) Anaphase II

3. What is the primary role of meiosis in the animal body?

A) To repair damaged tissue cells
B) To produce haploid gametes while introducing genetic variability
C) To grow organs
D) To replace skin cells

4. How do the daughter cells of mitosis compare to those of meiosis in number and genetic composition?

A) Mitosis yields two genetically identical diploid (2n) cells, whereas meiosis yields four genetically distinct haploid (n) cells
B) Both yield identical cells
C) Mitosis yields four haploid cells
D) Meiosis yields two diploid cells

Answer Key

1. A — Mitosis involves a single nuclear division, whereas meiosis consists of two sequential divisions.

2. B — Synapsis and crossing over take place exclusively during Prophase I of meiosis.

3. B — Meiosis generates haploid gametes while introducing genetic variability among offspring.

4. A — Mitosis yields two genetically identical diploid (2n) cells, whereas meiosis yields four genetically distinct haploid cells.

Lesson 74: Chromosomal theory of inheritance

1. According to the Chromosomal Theory of Inheritance, where are genes physically located?

A) In the cytoplasm
B) On chromosomes at specific loci
C) In the mitochondria only
D) In the cell membrane

2. The movement and behavior of chromosomes during cell division aligns with which laws?

A) Lamarck's laws
B) Mendel's laws of segregation and independent assortment
C) Hardy-Weinberg principles
D) Central dogma

3. Around what year did scientists begin to recognize parallels between Mendelian hereditary factors and chromosome behavior?

A) 1865
B) Around 1900
C) 1953
D) 1970

4. Which meiotic processes physically account for Mendel's laws of segregation and independent assortment?

A) DNA replication and cytokinesis
B) Segregation and independent sorting of chromosomes during meiosis
C) Crossing over only
D) Random fertilization only

Answer Key

1. B — The Chromosomal Theory of Inheritance establishes that genes occupy specific physical positions (loci) on chromosomes.

2. B — Chromosome movements during meiotic divisions directly follow Mendel's laws of segregation and independent assortment.

3. B — Parallels between Mendelian factors and cytogenetic chromosome behavior were first recognized around 1900.

4. B — Segregation and independent sorting of chromosomes during meiosis provide the physical basis for Mendel's laws.

Lesson 75: Experiment of T. H. Morgan

1. In T. H. Morgan's experiment with Drosophila melanogaster, which eye color was the wild type and which was mutant?

A) Red wild-type, white mutant
B) White wild-type, red mutant
C) Both wild-type
D) Brown wild-type

2. In Morgan's cross between red-eyed females and white-eyed males, what phenotype was observed in the F1 generation?

A) All white-eyed
B) All red-eyed
C) Half red, half white
D) All brown-eyed

3. In the F2 generation of Morgan's experiment, in which sex did the white-eyed mutant phenotype appear?

A) Females only
B) Males only (exclusively in male offspring)
C) Both sexes equally
D) Neither sex

4. What fundamental genetic conclusion did T. H. Morgan derive from his eye color experiment?

A) Eye color is autosomal
B) Eye color inheritance correlates with X chromosome transmission (sex linkage)
C) Eye color is random
D) Eye color follows blending inheritance

Answer Key

1. A — Red eye color represented the wild-type phenotype, while white eye color was the mutant.

2. B — All F1 offspring resulting from wild-type females crossed with mutant males displayed red eyes.

3. B — In the F2 generation, the white-eyed mutant trait appeared exclusively in male fruit flies.

4. B — Morgan demonstrated that eye color inheritance correlates with X chromosome transmission.

Lesson 76: Effect of linkage on inheritance

1. Which two traits did T. H. Morgan test in Drosophila to study the effect of gene linkage on inheritance?

A) Body color (gray vs. black) and wing size (normal vs. vestigial)
B) Eye color and bristle number
C) Body color and eye color

D) Wing size and leg length

2. What testcross phenotypic ratio was expected if the genes for body color and wing size assorted independently?

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

3. In Morgan's testcross experiment, what were the two predominant phenotypic classes observed among progeny?

A) Recombinant classes
B) Parental phenotypes: wild-type (965) and double mutant
C) All white-eyed
D) All vestigial

4. What biological mechanism did Morgan propose to explain the presence of a smaller number of recombinant offspring?

A) Independent assortment
B) Crossing over breaking the physical linkage between genes
C) Mutation
D) Random drift

Answer Key

1. A — Morgan examined body color (gray vs. black) and wing size (normal vs. vestigial).
2. C — Independent assortment predicts a 1:1:1:1 phenotypic ratio among testcross offspring.
3. B — The vast majority of progeny exhibited parental phenotypes: wild-type (965) and double mutant.
4. B — Recombinant phenotypes arise when crossing over breaks the physical linkage between genes.

Lesson 77: Linkage map

1. What is a linkage map?

A) A microscopic photograph of condensed metaphase chromosomes
B) An ordered map of genetic loci along a chromosome based on recombination frequencies
C) A pedigree chart
D) A karyotype

2. What parameters are used to determine gene positions on a linkage map rather than physical base-pairs?

A) Chromosome size
B) Recombination frequencies (relative positions in terms of recombination)
C) Gene expression levels
D) Protein sizes

3. What is the relationship between the frequency of recombination between two genetic markers and their physical distance?

A) A higher recombination frequency indicates a greater physical distance between two markers
B) Higher recombination means shorter distance
C) No relationship

D) Recombination only occurs in mitosis

4. Which molecular markers are explicitly mentioned in Lesson 77 as tools used in constructing linkage maps?

A) Microsatellites and Restriction Fragment Length Polymorphisms (RFLPs)
B) SNPs only
C) Karyotypes
D) Pedigrees

Answer Key

1. B — A linkage map orders genetic loci along a chromosome based on recombination frequencies.
2. B — Linkage map positions reflect the relative position of genes in terms of recombination frequency.
3. A — A higher recombination frequency indicates a greater physical distance between two markers.
4. A — Microsatellites and Restriction Fragment Length Polymorphisms (RFLPs) serve as key markers.

Lesson 78: Linkage map of drosophila chromosome

1. Which scientist first utilized recombination frequencies from fruit fly crosses to construct a chromosome map?

A) Morgan
B) Alfred Sturtevant
C) Mendel
D) Watson

2. How is one map unit (1 cM / centiMorgan) defined on a genetic linkage map?

A) Equivalent to a 1% recombination frequency
B) Equivalent to 1 base pair
C) Equivalent to one chromosome
D) Equivalent to 100 genes

3. Sturtevant mapped three Drosophila genes with recombination frequencies: y-w = 1%, w-m = 9.5%, y-m = 17%. What is the correct relative order of these genes?

A) y - m - w
B) y - w - m (w between y and m, since 1% + 9.5% is approximately the y-m distance)
C) m - y - w
D) w - y - m

4. Why does a greater distance between two genes increase their recombination frequency?

A) Because greater distance provides more opportunity and crossover points between the genes
B) Because genes attract each other
C) Because of mutation
D) Because of independent assortment

Answer Key

1. B — Alfred Sturtevant used recombination frequencies from fruit fly crosses to construct the first chromosome map.
2. A — One map unit (1 centiMorgan) is defined as equal to a 1% recombination frequency.

3. B — Because the smaller distances add up to the largest distance, the relative gene order places the middle gene between the other two.

4. A — A greater distance between genes provides more opportunity and crossover points along the chromosome.

Lesson 79: Sex determination and chromosomes role

1. Which specific gene located on the human Y chromosome triggers the development of male gonads (testes)?

A) SRY gene
B) BRCA1 gene
C) CFTR gene
D) HTT gene

2. What happens to generic embryonic gonads in an embryo that lacks a functional SRY gene?

A) They form testes
B) They develop into ovaries by default
C) They disappear completely
D) They become kidneys

3. Besides sex determination via SRY, what other essential role do genes on the Y chromosome serve?

A) Production of functional sperms
B) Determination of eye color
C) Regulation of blood clotting
D) Control of height

4. In the human X-Y sex determination system, what are the sex chromosome compositions of females and males?

A) Females XY, males XX
B) Females XX, males XY
C) Females XO, males XY
D) Females ZW, males ZZ

Answer Key

1. A — The SRY gene on the Y chromosome serves as the master switch initiating male testes development.

2. B — Without SRY gene activity, embryonic gonadal tissue defaults to developing into ovaries.

3. A — Y chromosome genes carry vital information required for spermatogenesis and functional sperm production.

4. B — Human females possess two X chromosomes (XX), while males possess one X and one Y chromosome (XY).

Lesson 80: Sex determination systems

1. In the X-O sex determination system observed in insects, what are the sex chromosome compositions of females and males?

A) Females XY and males XX
B) Females are XX and males are XO
C) Females are ZW and males are ZZ

D) Both females and males are XX

2. In birds, some fishes, and certain insects, which sex chromosome combination represents the female?

A) XX
B) XO
C) ZW
D) ZZ

3. In the haploid-diploid sex determination system found in bees and ants, how do male offspring develop?

A) From fertilized diploid eggs
B) From unfertilized ova, becoming haploid
C) From diploid zygotes with ZW chromosomes
D) Through mitotic fragmentation of sperm cells

4. In honeybees (*Apis mellifera*), what is the chromosome count of a diploid female worker or queen bee compared to a haploid male drone?

A) Females have 46 chromosomes and males have 23 chromosomes
B) Females have 32 chromosomes and males have 16 chromosomes
C) Both females and males have 46 chromosomes
D) Females have 23 chromosomes and males have 22 chromosomes

Answer Key

1. B — Under the X-O system in insects, females carry XX sex chromosomes while males carry a single X (XO).

2. C — In the Z-W sex determination system, females represent the heterogametic sex with ZW chromosomes.

3. B — Males in haploid-diploid systems (such as bees and ants) develop parthenogenetically from unfertilized haploid eggs.

4. B — Female bees develop from fertilized diploid eggs (32 chromosomes), whereas male drones develop from unfertilized haploid eggs (16 chromosomes).

Lesson 81: Sex linked genes

1. How is a sex-linked gene defined in genetics?

A) A gene located on an autosomal chromosome pair
B) A gene located on either sex chromosome
C) A gene that codes exclusively for primary sex organs
D) A gene present only in mitochondrial DNA

2. When a father with an X-linked recessive genetic disorder has children with an unmutated female, the mutant X chromosome is passed:

A) To all of his sons, but none of his daughters
B) To all of his daughters, but none of his sons
C) To 50% of his sons and 50% of his daughters
D) To none of his children

3. If a carrier female for an X-linked recessive trait mates with a normal male, what is the probability that her sons will be affected?

A) 0%
B) 25%
C) 50%
D) 100%

4. Do sex chromosomes carry genes for traits unrelated to sex determination?

A) No, sex chromosomes carry only sex-determining genes
B) Yes, sex chromosomes contain genes for many traits unrelated to sex
C) Only Y chromosomes carry non-sex traits
D) Sex chromosomes carry no functional genes

Answer Key

1. B — A sex-linked gene is defined as any gene located on either sex chromosome (X or Y).

2. B — An affected father passes his single mutant X chromosome to all daughters (making them carriers), but to none of his sons.

3. B — A carrier female (\(X^A X^a\)) has a 50% chance of passing the mutant \(X^a\) allele to each son (\(X^a Y\)).

4. B — Sex chromosomes carry numerous genes responsible for general biological functions unrelated to sex determination.

Lesson 82: Genetic mapping in humans

1. What is the primary purpose of genetic mapping in human medicine?

A) To synthesize custom histones
B) To provide crucial clues about which chromosome carries a disease gene
C) To count chromosomes
D) To measure height

2. Which single-gene human inherited disorders are explicitly listed in Lesson 82 as being identified by genetic mapping?

A) Diabetes and hypertension
B) Cystic fibrosis (and similar single-gene disorders)
C) Common cold
D) Baldness

3. How do geneticists perform human genetic mapping in practice?

A) By exposing human cells to heavy radiation
B) By analyzing DNA isolated from family pedigrees to identify polymorphic markers
C) By karyotyping only
D) By guessing

4. Which genetic markers are most commonly used on human genetic maps according to Lesson 82?

A) Microsatellites and Single Nucleotide Polymorphisms (SNPs)
B) Karyotypes
C) Pedigrees
D) Blood groups

Answer Key

1. B — Genetic mapping provides crucial clues about which chromosome carries a disease gene.
2. B — Genetic mapping successfully located single-gene disorders such as cystic fibrosis.
3. B — Human genetic mapping analyzes DNA isolated from family pedigrees to identify polymorphic markers.
4. A — Microsatellites and Single Nucleotide Polymorphisms (SNPs) represent the most commonly used markers.

Lesson 83: Multiple alleles

1. Multiple alleles are defined as how many alternative forms of a gene occupying the same locus on homologous chromosomes?

A) One
B) Three or more
C) Exactly two
D) Zero

2. What percentage of human genes are di-allelic (existing in two forms) according to Lesson 83?

A) 10%
B) 30%
C) 50%
D) 70%

3. What percentage of human genes exist in only one form (mono-allelic)?

A) 30%
B) 50%
C) 70%
D) 100%

4. Poly-allelic genes in humans are usually associated with which of the following?

A) Ribosome size
B) Tissue types (providing individual genetic identity, e.g., HLA)
C) Hair color only
D) Height only

Answer Key

1. B — Multiple alleles are defined as three or more alternative forms of a gene occupying the same locus.
2. B — The handout states that approximately 30% of human genes exist as di-allelic.
3. C — Roughly 70% of human genes are mono-allelic, existing in only one form.
4. B — Poly-allelic genes are associated with tissue types and provide an individual genetic signature.

Lesson 84: Multiple alleles - blood groups

1. What type of gene controls the ABO blood group system in humans?

A) A mono-allelic gene
B) A di-allelic gene
C) A tri-allelic gene

D) A polygenic chromosome 18 gene

2. How many distinct genotypes can be generated by the three alleles of the ABO blood group system?

A) 3
B) 4
C) 6
D) 10

3. Which antigen is produced on the surface of red blood cells by allele i?

A) Antigen A
B) Antigen B
C) Both Antigen A and B
D) No antigen

4. Which ABO blood types have only one possible genotype each?

A) Blood types A and B
B) Blood types AB and O
C) Blood types A and O
D) Blood types B and AB

Answer Key

1. C — The ABO blood system is controlled by a tri-allelic gene consisting of Allele A, Allele B, and Allele i.

2. C — The three ABO alleles generate a total of 6 genotypes.

3. D — Allele \(I^A\) produces antigen A, Allele \(I^B\) produces antigen B, and allele i produces no antigen.

4. B — Blood types A and B can exist in homozygous or heterozygous forms, whereas blood types AB (\(I^A I^B\)) and O (ii) have only one genotype each.

Lesson 85: Blood groups and Transfusions

1. How does the human immune system interact with different blood group antigens during a blood transfusion?

A) It ignores all blood group antigens
B) It recognizes its own blood type as self and foreign blood types as non-self
C) It destroys all red blood cells regardless of antigen type
D) It converts non-self antigens into self antigens automatically

2. What type of antibodies are present in the plasma of an individual with Type A blood?

A) Antibodies against Type A antigens (anti-A)
B) Antibodies against Type B antigens (anti-B)
C) Both anti-A and anti-B antibodies
D) No antibodies against blood group antigens

3. What reaction occurs when anti-B antibodies in a recipient's plasma interact with donor red blood cells carrying Type B antigens?

A) Hemolysis of white blood cells
B) Agglutination (clumping) of red blood cells
C) Conversion of Type B antigens to Type A
D) Rapid duplication of blood platelets

4. What determines whether a foreign blood cell is targeted by host antibodies during a transfusion?

A) The size of the donor red blood cells
B) The presence of non-self surface antigens on the donor red blood cells
C) The amount of hemoglobin inside host white cells
D) The temperature of the donor blood bag

Answer Key

1. B — The immune system distinguishes self antigens from foreign non-self antigens on red blood cells.
2. B — Individuals with Type A blood produce antibodies against foreign Type B surface antigens.
3. B — Antibody binding to complementary foreign surface antigens causes red blood cell agglutination.
4. B — Host antibodies recognize foreign non-self surface antigens, triggering immune reactions against donor cells.

Lesson 86: Multiple alleles- rabbits

1. In rabbits, fur color is controlled by multiple alleles. Which allele produces the Agouti (dark gray) phenotype?

A) Chinchilla allele
B) Himalayan allele
C) The dominant full-color allele (C)
D) Albino allele

2. What phenotype is produced in a rabbit carrying the Himalayan allele in homozygous or dominant-recessive combination over white?

A) Dark gray (Agouti)
B) White fur with black paws, nose, ears, and tail
C) Light gray (Chinchilla)
D) Pure white

3. What is the correct hierarchy of dominance among the four rabbit fur color alleles?

A) Albino > Himalayan > Chinchilla > Agouti
B) Agouti (C) > Chinchilla (cch) > Himalayan (ch) > Albino (c)
C) All are co-dominant
D) Himalayan > Agouti > Albino > Chinchilla

4. A rabbit with the homozygous double-recessive genotype expresses which coat phenotype?

A) Dark gray (Agouti)
B) Light gray (Chinchilla)
C) White with black points
D) White (albino)

Answer Key

1. C — The dominant full-color allele specifies the dark gray (Agouti) phenotype.
2. B — The Himalayan allele produces white fur with black paws, nose, ears, and tail.
3. B — The dominance hierarchy for rabbit fur color is Agouti > Chinchilla > Himalayan > Albino.
4. D — The double recessive genotype results in a white (albino) coat.

Lesson 87: Alleles and genotypes

1. Which formula is used to calculate the total number of genotypes for a gene locus with n alleles?

A) n^2
B) n(n+1)/2
C) 2n
D) n!

2. How is the number of homozygous genotypes determined for a gene with n alleles?

A) Equal to n (the number of alleles)
B) Equal to n^2
C) Equal to 2n
D) Always equal to 1

3. What formula gives the number of heterozygous genotypes for a locus with n alleles?

A) n
B) n(n-1)/2
C) 2n
D) n^2

4. For the 4 fur color alleles in rabbits, how many total genotypes can be generated?

A) 4
B) 6
C) 10
D) 16

Answer Key

1. B — The total number of genotypes for n alleles is calculated using n(n+1)/2.
2. A — The number of possible homozygous genotypes is equal to the number of alleles, n.
3. B — The number of heterozygous genotypes is given by n(n-1)/2.
4. C — For n = 4 alleles, 4(5)/2 = 10 total genotypes are produced.

Lesson 88: Linkage and crossing over

1. How are linked genes defined in genetics?

A) Genes located on different non-homologous chromosomes
B) Genes located close together on the same chromosome
C) Genes on sex chromosomes only
D) Genes that never express

2. Genetically, linkage is defined as the failure of two genes to undergo which process?

A) DNA replication
B) Independent assortment
C) Transcription
D) Translation

3. During which cellular process do the phenomena of linkage and crossing over take place?

A) Mitotic division

B) Meiotic cell division
C) Binary fission
D) Budding

4. Linked genes tend to be inherited in what manner?

A) Separately on different gametes
B) Together as a unit (on the same physical chromosome)
C) Randomly
D) Only maternally

Answer Key

1. B — Linked genes are defined as genes located close together on the same chromosome.
2. B — Linkage is defined genetically as the failure of two genes to assort independently.
3. B — Linkage and crossing over are phenomena observed during meiotic cell division.
4. B — Because linked genes reside on the same physical chromosome, they tend to inherit together.

Lesson 89: Linked genes

1. What is the relationship between the physical distance separating two linked genes and their crossover frequency?

A) Genes located closer together experience fewer crossover events than genes farther apart
B) Closer genes cross over more
C) Distance has no effect
D) All genes cross over equally

2. On a genetic map, a crossover frequency of 1% corresponds to what distance?

A) 0.1 micrometers
B) 1 map unit (centiMorgan)
C) 1 base pair
D) 100 map units

3. If two genes show a crossover value of 12%, how far apart are they on a genetic map?

A) 1 map unit
B) 12 map units
C) 120 map units
D) 0.12 map units

4. How is crossover frequency used in chromosome mapping?

A) It measures total nuclear volume
B) It directly reflects relative map distance/units along a chromosome
C) It counts ribosomes
D) It measures cell size

Answer Key

1. A — Genes located closer together experience fewer crossover events than genes farther apart.
2. B — A 1% crossover value is defined as equivalent to 1 map unit.
3. B — A 12% crossover frequency indicates two genes are 12 map units apart.
4. B — Crossover frequency directly reflects relative map distance/units along a chromosome.

Lesson 90: Physical mapping

1. How is distance measured on a physical genome map compared to a genetic linkage map?

A) In map units (centiMorgans)
B) In base pairs (bp) or megabases (Mb) representing physical DNA distance
C) In micrometers under light microscopy
D) In number of histone octamers per loop

2. Which of the following is listed in Lesson 90 as a physical mapping technique?

A) Monohybrid cross analysis
B) In situ hybridization and restriction enzyme site mapping
C) Pedigree analysis
D) Feulgen hydrolysis testing

3. What serves as the fundamental basis for constructing a physical map of a chromosome?

A) The frequency of recombination between markers
B) The specific physical locations of landmarks along a DNA molecule
C) The ratio of purines to pyrimidines
D) The rate of cytosine methylation

4. What strategy characterizes top-down physical mapping?

A) Random shotgun sequencing without prior mapping
B) Ordering large-insert clones along a landmark map, selecting minimal overlaps, and subcloning for sequencing
C) Mapping point mutations strictly through pedigree analysis
D) Counting band numbers on metaphase chromosomes

Answer Key

1. B — Physical maps express distances directly in physical DNA units such as base pairs or megabases.

2. B — In situ hybridization, restriction enzyme site mapping, and cytogenetic mapping are physical mapping techniques.

3. B — Physical mapping relies on determining the physical coordinates of specific molecular landmarks along DNA.

4. B — Top-down physical mapping arranges large genomic clones into overlapping contigs before targeted subcloning and sequencing.

Lesson 91: Mapping diseased genes in Humans

1. What primary tools are used in human genetic mapping to locate disease genes in family pedigrees?

A) Karyotyping only
B) Pedigree analysis combined with DNA typing of polymorphic markers
C) Blood tests only
D) X-rays

2. What are the two common strategies used to identify diseased genes in human genetic mapping?

A) Cloning and sequencing only
B) Position-dependent and position-independent methods

C) Karyotyping and pedigrees
D) Drug trials

3. What does the "position-independent" method of mapping disease genes imply?

A) Identifying a gene without prior location information (functional candidacy)
B) Mapping without DNA
C) Using only pedigrees
D) Random selection

4. Why does having a higher density of DNA markers on a genetic map benefit disease gene identification?

A) It looks nicer
B) Dense marker coverage improves the probability of discovering a marker closely linked to the disease gene
C) It reduces cost to zero
D) It eliminates pedigrees

Answer Key

1. B — Human disease gene mapping relies on pedigree analysis combined with DNA typing of markers.
2. B — Two primary strategies for mapping disease genes are position-dependent and position-independent.
3. A — Position-independent mapping identifies disease genes without prior location information.
4. B — Dense marker coverage improves the probability of discovering a marker closely linked to the gene.

Lesson 92: Polygenic inheritance

1. How is polygenic inheritance defined in Lesson 92?

A) A condition where a single gene controls multiple distinct traits
B) A condition when two or more genes influence the expression of one trait
C) A condition where DNA sequences are altered by UV radiation
D) The complete loss of an autosomal chromosome

2. In the pepper color example, what phenotype results from the genotype R-/yy (red pigment present with chlorophyll)?

A) Red
B) Yellow
C) Brown / orange
D) Green

3. Crossing a pure-breeding brown pepper (RRyy) with a yellow pepper (rrYY) produces an F1 generation with which phenotype?

A) All yellow
B) All brown
C) All red
D) All green

4. What proportion of green peppers (rryy) appears in the F2 generation following self-fertilization of F1 red peppers?

A) 9/16
B) 3/16

C) 1/16
D) 1/4

Answer Key

1. B — Polygenic inheritance occurs when two or more genes influence the expression of a single trait.

2. C — Genotype R-/Y- produces red, R-/yy produces brown/orange, rr/Y- produces yellow, and rr/yy produces green.

3. C — Crossing RRyy and rrYY yields F1 hybrids with genotype RrYy, expressing the all-red phenotype.

4. C — Self-fertilizing F1 red peppers yields a 9:3:3:1 F2 phenotypic ratio, resulting in 1/16 green peppers (rryy).

Lesson 93: Examples of polygenic traits

1. Which of the following human traits is listed in Lesson 93 as an example of a polygenic/continuous trait?

A) ABO blood group
B) Eye color
C) Presence of a Barr body
D) Rh factor

2. In chicken comb shapes, what phenotype results from a genotype carrying dominant alleles at both loci (R-P-)?

A) Rose comb
B) Pea comb
C) Single comb
D) Walnut comb

3. What comb phenotype is expressed in chickens with the double homozygous recessive genotype (rrpp)?

A) Walnut comb
B) Rose comb
C) Pea comb
D) Single comb

4. Human hair color is controlled by alleles located on which four chromosomes?

A) Chromosomes 1, 2, 3, and 4
B) Chromosomes 3, 6, 10, and 18
C) Chromosomes 5, 11, 13, and 21
D) X and Y sex chromosomes only

Answer Key

1. B — Eye color, hair color, skin color, stature, shape of face, and fingerprint patterns are listed as polygenic traits.

2. D — Genotype R-P- produces Walnut combs, R-pp produces Rose combs, rrP- produces Pea combs, and rrpp produces Single combs.

3. D — Chickens carrying the double homozygous recessive genotype rrpp express Single comb shape.

4. B — Hair color is governed by alleles on chromosomes 3, 6, 10, and 18, with more dominant alleles yielding darker hair.

Lesson 94: Epistasis and modifier genes

1. How is positive epistasis characterized in Lesson 94?

A) When two mutations together have a smaller effect than expected
B) When a double mutation has a fitter phenotype than either single mutation
C) When a mutation has the opposite effect in the presence of another mutation
D) When two beneficial genes become deleterious together

2. What is negative epistasis?

A) When a double mutation has a fitter phenotype than either single mutation
B) When two mutations together have a smaller effect than expected from their individual effects
C) When a mutation changes an amino acid to a stop codon
D) When cytosine is methylated at carbon-5

3. Sign epistasis occurs when a mutation:

A) Has no effect on protein function
B) Has the opposite effect when in the presence of another mutation
C) Reverts a mutant phenotype back to wild type
D) Causes immediate embryonic lethality

4. Reciprocal epistasis is defined as a situation where:

A) Two beneficial genes become lethal
B) Two deleterious genes are beneficial when together
C) A single gene affects multiple traits
D) A gene is turned off by histone deacetylase

Answer Key

1. B — Positive epistasis between beneficial mutations generates improvements in function, producing a fitter phenotype in double mutants.

2. B — Negative epistasis occurs when two mutations together produce a smaller phenotypic effect than expected from their individual effects.

3. B — Sign epistasis is defined as occurring when one mutation exerts the opposite effect in the presence of another mutation.

4. B — Reciprocal epistasis is the case where two individually deleterious genes are beneficial when combined.

Lesson 95: Recessive Epistasis

1. How is recessive epistasis defined?

A) An epistatic gene exerts its masking effect when present as a homozygous recessive
B) An epistatic gene acts only when dominant
C) It is the same as dominance
D) It involves only one gene

2. In blue-eyed Mary plants, petal color is governed by recessive epistasis. What color are flowers when both enzymes are active?

A) White
B) Magenta
C) Blue (anthocyanin)

D) Yellow

3. In the biochemical pathway of blue-eyed Mary plants, what product accumulates when Enzyme 1 is active?

A) White pigment
B) Precursor 1 (colorless) converts to precursor 2 (magenta)
C) Blue pigment directly
D) Nothing

4. In pigeons, which gene exhibits recessive epistasis over spread color and pattern genes?

A) Ash-red
B) Recessive red
C) Blue
D) Brown

Answer Key

1. A — In recessive epistasis, the epistatic gene masks other loci when present in the homozygous recessive state.

2. C — When both enzymes are active, precursor molecules are converted to blue anthocyanin pigment.

3. B — If Enzyme 1 is active, precursor 1 (colorless) converts to precursor 2 (magenta).

4. B — The recessive red gene in pigeons acts epistatically over both spread color and pattern genes.

Lesson 96: Dominant epistasis

1. How does dominant epistasis differ from recessive epistasis?

A) The epistatic gene exerts its masking effect when present as a single dominant allele
B) It requires two recessive alleles
C) There is no difference
D) It involves cytoplasmic genes

2. In summer squash fruit color, what effect does the dominant allele W have on fruit pigmentation?

A) It produces yellow fruit color
B) It produces green fruit color
C) It inhibits color formation, yielding white fruit
D) It has no effect

3. In summer squash, if a plant lacks the dominant inhibitor (ww) but carries dominant Y, what will be its fruit color phenotype?

A) White
B) Yellow
C) Green
D) Brown

4. In Shepherd's purse (Capsella bursa-pastoris), duplicate dominant epistasis controls fruit shape. What shape results from presence of a dominant allele?

A) Narrow shape
B) Heart (triangular) shape
C) Oval shape

D) Circular shape

Answer Key

1. A — Dominant epistasis occurs when a single dominant allele at the epistatic locus masks another gene.

2. C — The dominant allele W inhibits color formation in summer squash, yielding white fruit.

3. B — In the absence of the dominant inhibitor W, dominant Y produces yellow fruit.

4. B — Presence of a dominant allele yields heart-shaped fruit, whereas double homozygous recessive produces narrow fruit.

Lesson 97: Example of Epistasis

1. In Labrador Retrievers, coat color is determined by two genes (B and E). What role does Gene B play?

A) It controls pigment deposition
B) It determines pigment color: dominant B produces black pigment, while recessive b produces brown pigment
C) It has no role
D) It controls tail length

2. What is the epistatic role of Gene E in Labrador Retriever coat color?

A) Homozygous recessive ee prevents dark pigment deposition, resulting in golden/yellow fur regardless of Gene B
B) Dominant E produces white fur
C) Gene E has no effect on coat color
D) Recessive e forces the coat to become black

3. What coat color phenotype is expressed by a Labrador Retriever with genotype bbE_?

A) Black
B) Brown (Chocolate)
C) Golden (Yellow)
D) Spotted

4. Which of the following genotypes will produce a Golden (Yellow) Labrador Retriever?

A) BBEe
B) bbEE
C) BbEe
D) Any genotype containing homozygous recessive ee (e.g., BBee)

Answer Key

1. B — Gene B determines pigment color: dominant B produces black pigment, while recessive b produces brown pigment.

2. A — Homozygous recessive ee blocks dark pigment deposition in fur, yielding a golden/yellow coat regardless of alleles at Gene B.

3. B — Genotypes bbE_ combine brown pigment alleles (bb) with functional pigment deposition (E_), producing brown fur.

4. D — Any genotype containing homozygous recessive ee results in a golden (yellow) retriever.

Lesson 98: Epigenetics

1. What does the term "epigenetics" literally mean?

A) Below the genetics
B) Above the genetics
C) Outside of the nucleus
D) Within the chromosome

2. How is an epigenetic trait defined in Lesson 98?

A) A permanent change in nuclear base sequence caused by radiation
B) A stable and heritable phenotype resulting from changes in chromosome without alterations in the DNA sequence
C) A numerical abnormality resulting from meiotic non-disjunction
D) A point substitution that changes a purine to a pyrimidine

3. Cytosine methylation involves adding a methyl group to which carbon position on cytosine residues?

A) Carbon-1
B) Carbon-3
C) Carbon-5
D) Carbon-6

4. Does DNA methylation alter the primary base sequence of DNA?

A) Yes, it converts cytosine into thymine permanently
B) No, DNA methylation represents an epigenetic change without altering the DNA sequence
C) Yes, it deletes three consecutive base pairs
D) Yes, it reverses the sequence orientation by 180 degrees

Answer Key

1. B — Epigenetics literally translates to 'above' genetics.

2. B — An epigenetic trait is defined as a stable, heritable phenotype arising from chromosome changes without altering the underlying DNA sequence.

3. C — Cytosine methylation specifically attaches a methyl group to carbon-5 of cytosine residues.

4. B — DNA methylation is an epigenetic modification that regulates gene expression without changing the DNA base sequence.

Lesson 99: Epigenetic Modifications

1. Which of the following is listed in Lesson 99 as one of the major steps/mechanisms of epigenetic modification?

A) DNA replication
B) Cytosine methylation / histone modification
C) Protein denaturation
D) Mitosis

2. At which carbon position on the cytosine ring does DNA methylation attach a methyl group?

A) Carbon-1
B) Carbon-3
C) Carbon-5
D) Carbon-6

3. What effect does histone acetylation (mediated by HAT) typically have on chromatin structure and gene expression?

A) Condenses chromatin, silencing genes
B) Relaxes chromatin into an open conformation, increasing gene expression
C) No effect
D) Destroys histones

4. Which enzymes are responsible for adding and removing acetyl groups on histone tails, respectively?

A) HDAC then HAT
B) HAT (Histone acetyltransferase) adds; HDAC (Histone deacetylase) removes
C) DNA polymerase
D) Ligase and helicase

Answer Key

1. B — Epigenetic modification mechanisms include cytosine methylation, histone modification, and RNA-based mechanisms.

2. C — DNA methylation specifically adds a methyl group to carbon-5 of cytosine residues.

3. B — Histone acetylation relaxes chromatin into an open conformation, increasing gene expression.

4. B — HAT (Histone acetyltransferase) attaches acetyl groups, whereas HDAC (Histone deacetylase) removes them.

Lesson 100: Common Epigenetics regulated phenomena

1. Which phenomenon involves down-regulating gene expression on one female X chromosome via DNA methylation?

A) Genomic imprinting
B) X chromosome inactivation
C) Fragile X syndrome
D) Mitosis

2. What is Genomic Imprinting?

A) Epigenetic marking of a locus based on parental origin, causing monoallelic expression
B) DNA mutation
C) Chromosome loss
D) Protein synthesis

3. Fragile X syndrome is linked to a CGG repeat expansion in the FMR1 gene. Hypermethylation and gene silencing occur beyond how many repeats?

A) 50
B) 100
C) 200 CGG repeats
D) 1000

4. Why do identical twins with identical genetic sequences develop phenotypic differences as they age?

A) Different DNA sequences
B) Environmental differences over time alter twin epigenomes, creating distinct individual patterns
C) Different parents

D) Random mutation only

Answer Key

1. B — X chromosome inactivation silences one female X chromosome via epigenetic marks.

2. A — Genomic imprinting marks gene loci based on parental origin, expressing only the maternal or paternal allele.

3. C — Expansion beyond 200 CGG repeats correlates with hypermethylation at CpG dinucleotides and gene silencing.

4. B — Environmental differences over time alter twin epigenomes, creating distinct individual epigenetic patterns.

Lesson 101: Therapies for epigenetics

1. Unlike genetic sequence mutations, how are epigenetic modifications characterized regarding therapeutic potential?

A) They are completely permanent and irreversible
B) Epigenetic changes can be reversed
C) They affect only mitochondrial DNA bases
D) They permanently destroy histone core proteins

2. What is the mechanism of action of Vorinostat, an FDA-approved drug targeting epigenetics?

A) DNA methyltransferase activator
B) Histone deacetylase inhibitor
C) Ribosomal RNA inhibitor
D) DNA polymerase blocker

3. What effect does inhibiting histone deacetylase (increasing histone acetylation) have on gene expression?

A) Decreases gene expression via chromatin condensation
B) Increases gene expression by relaxing chromatin structure
C) Halts DNA replication completely
D) Promotes non-disjunction during meiosis

4. In ovarian cancer epigenetics, hypermethylation of tumor suppressor genes or hypomethylation of oncogenes can lead to:

A) Enhanced DNA repair mechanisms
B) Inactivation of tumor suppressors or activation of oncogenes leading to carcinogenesis
C) Complete reversal of cellular aging
D) Doubling of autosomal chromosome counts

Answer Key

1. B — In contrast to permanent genetic mutations, epigenetic modifications can be reversed through targeted therapies.

2. B — Vorinostat functions specifically as a histone deacetylase inhibitor.

3. B — Inhibiting deacetylase increases histone acetylation, which relaxes chromatin condensation and increases gene expression.

4. B — Hypermethylation of tumor suppressors or hypomethylation of oncogenes contributes to tumor progression and chemoresistance.

Lesson 102: Environmental factors and Epigenetics

1. According to Lesson 102, which maternal factor can directly influence the epigenome of a developing fetus?

A) Eye color
B) Maternal nutrition and stress hormones
C) Blood type
D) Height

2. What role do lifestyle factors such as social interactions, physical activity, and diet play in epigenetics?

A) No role
B) They are key factors that modify the epigenome
C) They change DNA sequence
D) They prevent all disease

3. How does the study of environmental epigenetics impact the "nature vs. nurture" debate?

A) It proves only nature matters
B) It shows environmental influences directly modify gene expression via epigenetic marks
C) It ends all research
D) It proves nurture is irrelevant

4. Unlike permanent DNA sequence mutations, how are epigenetic modifications characterized regarding reversibility?

A) They are permanent
B) They are dynamic and reversible through targeted pharmacological intervention
C) They cannot be studied
D) They always cause cancer

Answer Key

1. B — Maternal nutrition and stress hormones travel to the fetus and affect its developing epigenome.
2. B — Social interactions, physical activity, diet, and toxin exposure are key factors shaping the epigenome.
3. B — Environmental epigenetics shows that environmental influences directly modify gene expression.
4. B — Epigenetic modifications are dynamic and reversible through targeted pharmacological agents.

Lesson 103: Epigenetics- conclusions

1. What are the two prominent epigenetic mechanisms highlighted in the conclusions of Lesson 103?

A) DNA methylation (gene silencing) and histone acetylation (gene activation)
B) Mitosis and meiosis
C) Replication and transcription
D) Mutation and selection

2. Which statement correctly describes how the epigenome changes over an individual's lifespan?

A) It never changes
B) The epigenome is dynamic across an individual's lifetime, changing with age and environment
C) It changes only at birth

D) It is identical in all tissues always

3. What role do errors in epigenetic patterns play in human health according to Lesson 103?

A) They have no effect
B) Aberrant or errored epigenetic patterns contribute to human disease states, including cancer
C) They improve health
D) They only affect plants

4. What represents a major area of current research in epigenetic therapies?

A) Synthesizing custom histones
B) Developing pharmacological agents/drugs capable of modifying epigenetic marks
C) Gene deletion
D) Cloning

Answer Key

1. A — DNA methylation (gene silencing) and histone acetylation (gene activation) are two prominent mechanisms.

2. B — The epigenome is dynamic across an individual's lifetime, changing with age and environment.

3. B — Aberrant or errored epigenetic patterns contribute to human disease states, including cancer.

4. B — Research actively focuses on developing pharmacological agents/drugs capable of influencing epigenetic patterns.

Lesson 104: Penetrance and Expressivity

1. How is penetrance defined in genetics?

A) The severity of symptoms observed in a single clinical case
B) The proportion of individuals carrying a specific genotype who express the associated phenotype
C) The number of genes involved
D) The rate of mutation

2. What is expressivity defined as?

A) The proportion of gametes carrying a mutant chromosome
B) The extent or degree to which a particular genotype is expressed phenotypically
C) The dominance of an allele
D) The frequency of recombination

3. Reduced or incomplete penetrance (less than 100%) can result from which of the following factors?

A) Genetic background factors (modifiers, epistasis) and environmental influences
B) Nothing; penetrance is always complete
C) Only age
D) Only diet

4. In clinical medicine, the term "variable expressivity" is analogous to:

A) The exact chromosome count
B) Differing degrees or severity of phenotypic expression among individuals with the same genotype
C) Complete penetrance
D) Lethal mutations

Answer Key

1. B — Penetrance is defined as the proportion of individuals carrying a specific genotype who show the phenotype.

2. B — Expressivity describes the extent or degree to which a particular genotype is expressed.

3. A — Incomplete penetrance is influenced by genetic background factors (modifiers, epistasis) and environment.

4. B — Variable expressivity refers to differing degrees or severity of phenotypic expression.

Lesson 105: Types of Penetrance

1. When an allele exhibits complete penetrance, what proportion of individuals carrying the disease-causing mutation express clinical symptoms?

A) All individuals (100%)
B) Fewer than 10% of individuals
C) Only homozygous recessive males
D) Only individuals exposed to specific environmental toxins

2. How is incomplete (or reduced) penetrance defined in Lesson 105?

A) Every individual carrying the allele shows 100% phenotypic severity
B) Some individuals fail to express the trait even though they carry the allele
C) The allele is expressed exclusively in response to soil pH
D) The mutation permanently alters the base sequence of mitochondrial DNA

3. Why is low penetrance particularly challenging for geneticists to analyze?

A) Because it is difficult to distinguish environmental factors from genetic factors
B) Because it deletes both telomeres of the chromosome
C) Because it affects only prokaryotic circular plasmids
D) Because it converts euchromatin into heterochromatin in G0 phase

4. Multiple endocrine neoplasia 1 (MEN 1) is cited as an example of what type of penetrance phenomenon?

A) Soil pH-dependent penetrance
B) Age-related penetrance (7% at age 10, 100% at age 60)
C) Complete non-penetrance across all ages
D) Sex-limited penetrance in females only

Answer Key

1. A — An allele has complete penetrance when all individuals carrying the disease-causing mutation express clinical symptoms.

2. B — Reduced or incomplete penetrance occurs when some individuals carrying the allele fail to express the trait.

3. A — In low penetrance, it is difficult to distinguish environmental from genetic factors.

4. B — MEN 1 is an age-related penetrance disorder, rising from 7% at age 10 to 100% at age 60.

Lesson 106: Chromosomal Aberrations

1. How is a chromosomal aberration defined in Lesson 106?

A) Any point mutation changing arginine to histidine

B) Any change in the normal number or structure of chromosomes
C) A change in flower color brought about by soil pH
D) Cytosine methylation at carbon-5

2. Numerical chromosomal aberrations usually arise from what type of error?

A) De novo errors during meiotic division
B) Dietary protein deficiency in adulthood
C) Histone deacetylase enzyme activation
D) DNA polymerase slippage during mitosis

3. What mechanism explains why chromosomal aberrations cause clinical anomalies in affected individuals?

A) By altering the amounts of gene products and disrupting gene balance
B) By converting linear chromosomes into circular plasmids
C) By destroying all cellular ribosomes
D) By increasing the G-C percentage across the entire genome

4. Chromosomal aberrations occurring post-zygotically and giving rise to different cell lines within an individual result in:

A) Complete penetrance
B) Mosaicism
C) Polygenic epistasis
D) Reciprocal translocation

Answer Key

1. B — A chromosomal aberration is defined as any change in the normal number or structure of chromosomes.

2. A — Numerical chromosomal changes are usually due to de novo errors during meiosis.

3. A — Altered gene product amounts cause anomalies directly or disturb the balance of genes.

4. B — Aberrations in different cell lines occurring post-zygotically result in mosaicism.

Lesson 107: Karyotyping - Nomenclature

1. In human cytogenetic nomenclature, how is a normal male karyotype designated?

A) 46, XX
B) 46, XY
C) 47, XXY
D) 45, X

2. In the karyotype nomenclature "46, XY", what does the number 46 represent?

A) The number of autosomes only
B) The total count of chromosomes
C) The number of genes
D) The patient's age

3. What does the designation "XY" signify in karyotype nomenclature?

A) The sex chromosome constitution
B) The autosome number
C) A disease

D) A band

4. How are chromosomal abnormalities or variants recorded in standardized cytogenetic nomenclature?

A) They are ignored
B) Specific numerical or structural abnormalities are appended after the sex chromosome designation (e.g., 47, XY, +21)
C) Only verbally
D) With colors

Answer Key

1. B — Standard human cytogenetic nomenclature designates a normal male chromosome constitution as 46, XY.

2. B — The leading integer in karyotype notation indicates the total count of chromosomes.

3. A — The letter pair following the chromosome count designates the sex chromosome constitution.

4. B — Specific numerical or structural abnormalities are appended immediately after the basic karyotype designation.

Lesson 108: Defining chromosome regions

1. What microscopic features are used to identify and classify individual chromosomes in a karyotype?

A) Overall size, centromere position, and banding pattern
B) Color only
C) Weight
D) Smell

2. How are chromosome arms designated in cytogenetic mapping?

A) Short arm is 'p' (petite) and long arm is 'q'
B) Short arm is 'q', long arm is 'p'
C) Both arms are 'p'
D) Arms are not designated

3. How are specific sub-regions and bands numbered along a chromosome arm?

A) Numbered sequentially outward from the centromere
B) Randomly
C) From telomere inward only
D) They are not numbered

4. What does the concept of "bands within bands" refer to in cytogenetics?

A) Overlapping histone tails
B) High-resolution cytogenetics resolving major chromosome bands into finer sub-bands and sub-sub-bands
C) Staining errors
D) Broken chromosomes

Answer Key

1. A — Chromosomes are identified and categorized by overall size, centromere position, and banding pattern.

2. A — Standard cytogenetic convention designates the short arm as 'p' (petite) and the long arm as 'q'.

3. A — Region and band numbers increase progressively moving outward from the centromere.

4. B — High-resolution cytogenetics resolves major chromosome bands into finer sub-bands.

Lesson 109: Common numerical abnormalities

1. Which numerical chromosomal abnormality corresponds to Down syndrome?

A) Trisomy 13 (47, XX, +13)
B) Trisomy 18
C) Trisomy 21 (47, XX, +21 or 47, XY, +21)
D) Monosomy X

2. Edwards syndrome and Patau syndrome represent which specific trisomies, respectively?

A) Trisomy 18 and trisomy 13
B) Trisomy 21 and trisomy 18
C) Trisomy 13 and trisomy 21
D) Monosomy and triploidy

3. What is the sex chromosome constitution of Klinefelter syndrome?

A) 45, X
B) 47, XXY
C) 47, XXX
D) 69, XXY

4. Triploidy is a numerical abnormality characterized by a total chromosome count of:

A) 47 chromosomes
B) 69 chromosomes (three complete haploid sets)
C) 92 chromosomes
D) 46 chromosomes

Answer Key

1. C — Down syndrome is caused by trisomy 21, designated as 47, XX, +21 (or 47, XY, +21).

2. A — Edwards syndrome is trisomy 18, whereas Patau syndrome is trisomy 13.

3. B — Klinefelter syndrome is characterized by an extra X chromosome in males, yielding 47, XXY.

4. B — Triploidy involves three complete haploid sets, resulting in 69 total chromosomes.

Lesson 110: Structural Abnormalities

1. Structural chromosome abnormalities result fundamentally from chromosome breakage followed by:

A) Cell death
B) Reunion of broken segments in abnormal configurations
C) DNA replication
D) Protein synthesis

2. How is a "balanced" structural chromosome rearrangement defined?

A) Extra genetic material is present
B) A normal, complete gene complement with rearranged order (no net gain or loss)
C) Missing chromosomes
D) Extra chromosomes

3. An "unbalanced" structural abnormality occurs when there is:

A) An incorrect amount of genetic material (missing or duplicated segments)
B) A normal gene complement
C) No change at all
D) Only inversions

4. Which of the following is listed in Lesson 110 as a type of structural chromosomal abnormality?

A) Translocations, deletions, insertions, inversions, ring chromosomes, and isochromosomes
B) Trisomy only
C) Monosomy only
D) Polyploidy only

Answer Key

1. B — Structural aberrations arise when chromosomes break and their segments reunite in abnormal patterns.

2. B — Balanced structural rearrangements contain a normal, complete gene complement with altered arrangement.

3. A — Unbalanced structural alterations result in missing or duplicated genetic material.

4. A — Translocations, deletions, insertions, inversions, ring chromosomes, and isochromosomes are listed types.

Lesson 111: Translocations

1. How is a translocation defined in cytogenetics?

A) Loss of a single chromosome from a diploid set
B) The transfer of genetic material from one chromosome to another
C) Rotation of a chromosome segment by 180 degrees
D) Doubling of the entire haploid genome

2. What are the two primary structural types of translocations described in Lesson 111?

A) Point and frameshift translocations
B) Reciprocal translocation and Robertsonian translocation
C) Pericentric and paracentric translocations
D) Monosomic and trisomic translocations

3. What defines a "balanced" translocation?

A) A translocation where some genes are deleted or duplicated
B) A translocation where no genetic information is extra or missing
C) A translocation occurring exclusively on sex chromosomes
D) A translocation involving centrosome duplication

4. What occurs during a reciprocal translocation?

A) Two non-homologous chromosomes exchange genetic material between each other
B) An entire chromosome arm is lost and degraded
C) Two acrocentric centromeres fuse permanently
D) A single base substitution converts an amino acid into a stop codon

Answer Key

1. B — A translocation is defined as the transfer of genetic material from one chromosome to another.

2. B — The handout classifies translocations into reciprocal translocations and Robertsonian translocations.

3. B — In a balanced translocation, the chromosome complement is complete with no extra or missing genes.

4. A — Reciprocal translocation involves a mutual exchange of chromosomal material between two different non-homologous chromosomes.

Lesson 112: Non-disjunction

1. What is defined as the failure of two homologous chromosomes or sister chromatids to separate during cell division?

A) Crossing over
B) Non-disjunction
C) Polyploidy
D) Translocation

2. What is the outcome if non-disjunction occurs during the first meiotic division?

A) Only 50% of gametes are abnormal
B) All sperms or ova from primary spermatocytes or oocytes will be abnormal
C) All daughter cells become triploid
D) Sister chromatids dissolve completely

3. What types of daughter cells are produced as a result of mitotic non-disjunction?

A) Only haploid daughter cells
B) Trisomic and monosomic daughter cells
C) Polyploid and octaploid daughter cells
D) Identical diploid daughter cells

4. Which of the following is listed as a cause of non-disjunction?

A) Colchicine treatment during interphase
B) Aging effect on primary oocytes, radiation, and delayed fertilization after ovulation
C) High ambient environmental temperatures
D) Histone acetylation in G1 phase

Answer Key

1. B — Non-disjunction is defined as the failure of homologous chromosomes or sister chromatids to separate during cell division.

2. B — If non-disjunction takes place during the 1st meiotic division, all sperms/ova derived from primary spermatocytes/oocytes will be abnormal.

3. B — Mitotic non-disjunction results in trisomic and monosomic daughter cells.

4. B — Causes of non-disjunction include the aging effect on primary oocytes, radiation exposure, and delayed fertilization after ovulation.

Lesson 113: Trisomy

1. How is trisomy defined in terms of chromosome composition?

A) Having four copies of a particular chromosome
B) Having three copies of a particular chromosome instead of the normal two
C) Gaining an extra complete haploid set of chromosomes

D) Lacking a single sex chromosome

2. Which structural type of trisomy is characterized by an extra chromosome possessing duplicated arms?

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

3. Which type of trisomy occurs when the extra chromosome consists of copies of arms from two other distinct chromosomes?

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

4. What is the incidence rate of Trisomy 21 (Down syndrome) in live births, and what maternal factor is it associated with?

A) 1 in 100 live births; associated with young maternal age
B) 1 in 700 live births; associated with increased maternal age
C) 1 in 5,000 live births; associated with maternal stress
D) 1 in 10,000 live births; associated with low maternal nutrition

Answer Key

1. B — Trisomy is a form of polysomy and aneuploidy where three copies of a chromosome exist instead of the normal two.

2. C — Secondary trisomy occurs when the extra chromosome has duplicated arms.

3. C — Tertiary trisomy occurs when the extra chromosome is composed of copies of arms from two other chromosomes.

4. B — Trisomy 21 occurs in 1 in 700 live births and shows a strong association with increased maternal age.

Lesson 114: Monosomy

1. Monosomy is defined as the loss of:

A) A complete haploid set of chromosomes
B) A single chromosome from a diploid pair (2n - 1)
C) Both homologs
D) The entire genome

2. What is the general developmental outcome of autosomal monosomy in humans?

A) Mild learning disability
B) Incompatible with life (lethal)
C) No effect
D) Enhanced growth

3. Which human syndrome is a viable sex chromosome monosomy?

A) Down syndrome
B) Turner syndrome (45, X / XO)
C) Klinefelter syndrome

D) Edwards syndrome

4. What are the two primary causes of monosomy outlined in Lesson 114?

A) Meiotic/mitotic non-disjunction or chromosome loss during cell division (anaphase lag)
B) Old age only
C) Diet
D) Radiation only

Answer Key

1. B — Monosomy represents the loss of a single chromosome from a diploid pair (2n - 1).
2. B — Monosomy involving any human autosome is incompatible with life and results in lethality.
3. B — Turner syndrome (XO / 45, X) is a viable human condition resulting from sex chromosome monosomy.
4. A — Monosomy arises through meiotic/mitotic non-disjunction or chromosome loss during division.

Lesson 115: Polyploidy

1. How is polyploidy defined in genetics?

A) The loss of an autosome from a diploid set
B) Having chromosome numbers that are multiples of the haploid number
C) A point substitution that converts an amino acid into a stop codon
D) A 180-degree rotation of a chromosome segment

2. What is the survival outcome of a polyploid fetus in humans?

A) It develops into a normal fertile adult
B) In humans, a polyploid fetus does not survive
C) It develops into a viable adult with Klinefelter's syndrome
D) It survives with mild physical anomalies

3. Which of the following is listed as a cause of polyploidy?

A) Cytosine methylation
B) Retention of a polar body, formation of diploid sperms, or di-spermy
C) Histone deacetylase activation
D) Equal meiotic crossing over

4. Which plant species is cited as an example of a hexaploid (6x) polyploid?

A) Watermelon
B) Cotton
C) Wheat
D) Strawberry

Answer Key

1. B — Polyploidy involves chromosome counts that are multiples of the haploid number (such as triploidy or tetraploidy).
2. B — Human polyploid fetuses do not survive.
3. B — Causes of polyploidy include retention of a polar body, formation of diploid sperms, and di-spermy (fertilization by two sperms).
4. C — Wheat (along with oat and kiwifruit) is listed as a hexaploid (6x) plant species.

Lesson 116: Allopolyploidy

1. What defines allopolyploidy compared to autopolyploidy?

A) Allopolyploids have multiple chromosome sets derived from a single species
B) Allopolyploids are polyploids with chromosomes derived from different species
C) Allopolyploids possess only single-stranded RNA genomes
D) Allopolyploids are generated exclusively through mitotic non-disjunction in somatic cells

2. How are offspring resulting from an inter-species allopolyploid cross generally described regarding fertility?

A) Highly fertile
B) Generally sterile
C) Completely asexual
D) Permanently haploid

3. Which chemical agent is used to promote polyploidy in plants?

A) Colchicine
B) Vorinostat
C) Quinacrine
D) Ethidium bromide

4. How does colchicine promote polyploidy at the cellular level?

A) By binding to tubulin, disrupting microtubule formation, and blocking chromosome segregation
B) By acetylating histone H1 tails
C) By cleaving CEN DNA at CDE-III sub-domains
D) By methylating cytosine residues at carbon-5

Answer Key

1. B — Allopolyploids carry chromosomes derived from different species through inter-species hybridization.

2. B — Offspring produced from inter-species crosses in allopolyploidy are generally sterile.

3. A — Colchicine is used to promote polyploidy and allopolyploidy in plants.

4. A — Colchicine binds to tubulin proteins, disrupting spindle microtubules and preventing chromosome segregation.

Lesson 117: Aneuploidy

1. How is aneuploidy defined in contrast to euploidy?

A) Aneuploidy is a change in chromosome number by addition/deletion of a chromosome or part of a chromosome
B) Aneuploidy is the gain of one or more complete sets of chromosomes
C) Aneuploidy refers exclusively to base pair substitutions
D) Aneuploidy is the complete loss of all nuclear DNA

2. Which of the following is classified as a variation in euploidy?

A) Monosomy
B) Trisomy
C) Triploid
D) Nullisomy

3. Which of the following is listed in Lesson 117 as an example of aneuploidy?

A) Triploid
B) Tetraploid
C) Nullisomy
D) Pentaploid

4. What defines euploidy according to the lesson comparison?

A) Loss of a single sex chromosome
B) Gain of one or more complete sets of chromosomes
C) Single nucleotide point substitution
D) Inversion of a gene segment by 180 degrees

Answer Key

1. A — Aneuploidy involves the addition or deletion of individual chromosomes or chromosome parts, altering chromosome number.

2. C — Triploid represents euploidy (gain of a complete set), whereas monosomy, trisomy, and nullisomy are forms of aneuploidy.

3. C — Nullisomy, monosomy, trisomy, and tetrasomy are listed as forms of aneuploidy.

4. B — Euploidy is defined as gaining one or more complete sets of chromosomes (such as triploidy or tetraploidy).

Lesson 118: Chromosomal deletions

1. Deletions of larger chromosomal portions are generally described as:

A) Harmless neutral variations
B) Resulting in substantial loss of essential genes with severe phenotypic consequences
C) Beneficial
D) Unnoticeable

2. What percentage of chromosomal deletions are true de novo deletions vs. resulting from parental rearrangements?

A) 50/50
B) 85-90% true de novo deletions; 10-15% from parental rearrangements
C) 100% inherited
D) 0% de novo

3. How is a "terminal deletion" distinguished from an "interstitial deletion"?

A) Terminal deletions lose a chromosome tip following one break, whereas interstitial deletions lose an internal segment after two breaks
B) They are identical
C) Terminal deletions are larger
D) Interstitial deletions affect telomeres

4. Cri-du-chat syndrome is caused by a terminal deletion on which chromosome?

A) Short arm of chromosome 5 (5p)
B) Chromosome 21
C) X chromosome
D) Chromosome 1

Answer Key

1. B — Large chromosomal deletions result in substantial loss of essential genes and are phenotypically severe.

2. B — The handout specifies that 85-90% are true deletions, while 10-15% stem from parental rearrangements.

3. A — Terminal deletions lose a chromosome tip following one break, whereas interstitial deletions lose an internal segment.

4. A — Cri-du-chat syndrome is clinically associated with a terminal deletion of the short arm of chromosome 5.

Lesson 119: Chromosomal duplication

1. What role does gene duplication play during molecular evolution?

A) It serves as a major mechanism through which new genetic material is generated
B) It eliminates all non-coding intronic sequences
C) It converts linear chromosomes into circular plasmids
D) It prevents meiotic crossing over completely

2. Unequal crossing-over during meiosis between misaligned homologous chromosomes is termed:

A) Ectopic homologous recombination
B) Replication slippage
C) Position-independent mapping
D) Pericentric inversion

3. What error during DNA replication produces duplications of short genetic sequences when DNA polymerase copies DNA?

A) Replication slippage
B) Feulgen hydrolysis
C) Colchicine binding
D) Heterochromatin condensation

4. What can happen to tandem gene duplications over evolutionary time?

A) They can mutate to take on altered roles or become inactive pseudogenes
B) They always cause immediate embryonic lethality
C) They convert into histone octamers
D) They dissolve during cytokinesis

Answer Key

1. A — Chromosomal/gene duplication provides a primary mechanism for generating new genetic material in molecular evolution.

2. A — Duplications commonly arise from ectopic homologous recombination (unequal crossing-over) between misaligned homologous chromosomes.

3. A — Replication slippage is a DNA replication error that duplicates short nucleotide sequences.

4. A — Tandem duplicate copies can mutate to adopt new cellular functions or degenerate into pseudogenes.

Lesson 120: Chromosomal Inversions

1. What structural rearrangement occurs during a chromosomal inversion?

A) A chromosome segment breaks in two places, rotates 180 degrees, and rejoins
B) A segment is deleted
C) A segment is duplicated
D) Two chromosomes fuse

2. What is the key structural difference between a pericentric inversion and a paracentric inversion?

A) Pericentric inversions span across the centromere, whereas paracentric inversions do not include the centromere
B) They are identical
C) Paracentric includes the centromere
D) Neither involves breaks

3. Does a balanced chromosomal inversion involve a net loss or gain of genetic material?

A) Yes, substantial loss
B) No, inversions reorient genetic sequence without adding or subtracting total genomic content
C) Yes, gain
D) Always lethal loss

4. While many inversions have no direct phenotypic consequences for the carrier, they can cause what reproductive issue?

A) Heightened risks of producing unbalanced gametes and offspring with abnormalities
B) Nothing at all
C) Increased fertility
D) Twinning

Answer Key

1. A — Inversions occur when a chromosome segment breaks in two places, rotates 180 degrees, and rejoins.
2. A — Pericentric inversions span across the centromere, whereas paracentric inversions exclude it.
3. B — Inversions reorient genetic sequence without adding or subtracting total genomic content.
4. A — Carriers of balanced inversions face heightened risks of producing unbalanced gametes.

Lesson 121: Ring chromosome

1. How is a ring chromosome formed structurally?

A) When breakage at chromosome ends allows the terminal arms to fuse together forming a ring
B) By duplication
C) By deletion of the centromere
D) By translocation

2. How are ring chromosomes designated in human and Drosophila genetic nomenclature?

A) Lowercase 'r' in human cytogenetics and uppercase 'R' in Drosophila
B) 'R' in both
C) 'r' in both
D) No designation

3. What usually must happen to the ends of a chromosome to enable ring chromosome formation?

A) Loss of terminal caps (telomeres) on both arms, producing reactive ends that fuse

B) Nothing
C) Centromere duplication
D) Arm lengthening

4. What percentage of Turner syndrome cases are caused by a ring X chromosome?

A) 5%
B) 20%
C) 50%
D) 100%

Answer Key

1. A — Ring chromosomes occur when breakage at chromosome ends allows the terminal arms to fuse.
2. A — Cytogenetic notation uses lowercase 'r' for human ring chromosomes and uppercase 'R' in Drosophila.
3. A — Standard ring formation requires loss of terminal caps on both arms, producing reactive ends.
4. B — Approximately 20% of Turner syndrome cases are attributed to a ring X chromosome.

Lesson 122: Mutation

1. How does the definition of "mutation" vary across different scientific disciplines?

A) In general genetics it is interpreted broadly as any sequence change; in clinical contexts it often implies a disease-causing change
B) It is identical everywhere
C) Only viruses mutate
D) Mutations don't exist

2. Why do some geneticists prefer neutral terms like "sequence variant" or "allelic variant" instead of "mutation"?

A) Neutral terminology avoids presuming disease causality
B) They are shorter
C) They sound better
D) No reason

3. What are the potential phenotypic consequences of a gene mutation?

A) Mutations can be harmful, beneficial, or neutral depending on location and functional impact
B) Always lethal
C) Always beneficial
D) No consequences

4. How do mutations in somatic cells compare to mutations in germline cells regarding inheritance?

A) Somatic mutations remain confined to body tissues of the host organism, whereas germline mutations are heritable
B) Both are inherited equally
C) Somatic mutations are inherited
D) Germline mutations disappear

Answer Key

1. A — "Mutation" is interpreted broadly as any sequence change in general genetics, or as disease-causing in clinical usage.

2. A — Neutral terminology ("sequence/allelic variant") avoids presuming disease causality.

3. A — Depending on location and functional impact, mutations may exert harmful, beneficial, or neutral effects.

4. A — Somatic mutations remain confined to body tissues of the host organism, whereas germline mutations can be transmitted to offspring.

Lesson 123: Types of mutation

1. Which of the following is categorized as a type of point mutation involving base pair substitutions in Lesson 123?

A) Translocation
B) Missense mutation
C) Polyploidy
D) Monosomy

2. Under which major category of mutations are frameshift and triplet repeat mutations classified?

A) Point mutations (base pair insertions/deletions)
B) Variations in chromosome number
C) Structural translocations
D) Post-zygotic mosaicism

3. Variations in chromosome number are sub-classified into which two main categories?

A) Silent and missense
B) Aneuploidy and Euploidy
C) Transitions and Transversions
D) Forward and reverse

4. Which of the following structural chromosomal changes is listed under variations in chromosome structure in Lesson 123?

A) Nonsense mutation
B) Inversion
C) Hypoploidy
D) Triploidy

Answer Key

1. B — Silent, missense, and nonsense mutations are categorized as base pair substitutions under point mutations.

2. A — Frameshift and triplet repeat mutations are classified as base pair insertions/deletions under point mutations.

3. B — Variations in chromosome number are categorized into Aneuploidy and Euploidy.

4. B — Deletions, translocations, duplications, and inversions represent variations in chromosome structure.

Lesson 124: Somatic and Germline mutation

1. Where do somatic mutations arise, and how are they propagated to daughter cells within an organism?

A) In non-germline body cells, propagated by mitosis

B) In gametes
C) They are not propagated
D) By meiosis

2. Where do germline mutations occur, and what is their primary evolutionary significance?

A) In gamete-forming lineages, enabling the altered allele to be inherited by offspring
B) In skin cells
C) They have no significance
D) In dead cells

3. In multicellular organisms, when scientists use the unadorned term "mutation" without qualification, what does it conventionally denote?

A) Inherited germline variants
B) Somatic variants only
C) Protein changes
D) Nothing specific

4. Which of the following is listed in Lesson 124 as a method used to classify mutations?

A) On the basis of molecular defect mechanism, phenotypic effect, and location
B) By color
C) By size of organism
D) By age

Answer Key

1. A — Somatic mutations take place in non-germline body cells and divide mitotically among daughter cells.

2. A — Germline mutations occur in reproductive lineages, enabling the altered allele to be passed to offspring.

3. A — Standard genetic convention uses "mutation" to denote inherited germline variants.

4. A — Mutations are categorized systematically by molecular defect mechanism, phenotypic effect, and other criteria.

Lesson 125: Mutation - Forward, Reverse and Neutral

1. How is the "wild type" phenotype defined in Lesson 125?

A) The rarest phenotype observed in a laboratory culture
B) The most common phenotype in natural populations of an organism
C) Any phenotype caused by a lethal chromosomal deletion
D) A phenotype expressed only at elevated environmental temperatures

2. What is a "forward mutation"?

A) A mutation that alters the wild type phenotype into a mutant phenotype
B) A mutation that reverts a mutant phenotype back to wild type
C) A mutation that changes DNA without altering any amino acid
D) A mutation occurring exclusively in mitochondrial tRNA genes

3. A mutation that changes a mutant phenotype back into the original wild type phenotype is called a:

A) Forward mutation
B) Reverse mutation
C) Conditional mutation

D) Dominant negative mutation

4. What defines a "neutral mutation" at the protein level?

A) It converts an amino acid codon into a translation stop codon
B) It alters the amino acid sequence of the protein without changing its function
C) It causes complete loss of gene product
D) It creates an entirely novel enzymatic activity

Answer Key

1. B — The wild type phenotype is defined as the most common phenotype in natural populations of the organism.

2. A — A forward mutation alters the wild type phenotype into a mutant phenotype.

3. B — A reverse mutation changes a mutant phenotype back into the wild type phenotype.

4. B — A neutral mutation alters the amino acid sequence but does not change protein function because the replaced amino acid is chemically similar or has little influence.

Lesson 126: Loss of function, Gain of function

1. How is a loss of function mutation defined, and what is its typical inheritance pattern?

A) It produces a new trait; usually dominant
B) It causes complete or partial loss of normal protein function; typically recessive
C) It has no effect
D) It only affects RNA

2. How is a gain of function mutation characterized according to Lesson 126?

A) It is frequently recessive
B) It produces a novel trait or expresses the gene product in inappropriate tissues/times; often dominant
C) It deletes the gene
D) It silences the gene

3. A temperature-sensitive mutation that causes cell death at high temperatures but has no deleterious effect at low temperatures is an example of:

A) A lethal mutation
B) A conditional mutation (expressed only under certain conditions)
C) A silent mutation
D) A nonsense mutation

4. Which statement regarding lethal mutations is correct according to the source handout?

A) Death must occur at birth
B) Lethal mutations significantly reduce longevity and cause death, which may take many forms/timing
C) Lethal mutations are always recessive
D) Lethal mutations don't exist

Answer Key

1. B — Loss of function mutations cause a complete or partial loss of normal protein function and are typically recessive.

2. B — Gain of function mutations produce a novel trait or express it in inappropriate tissues/times.

3. B — Conditional mutations, such as temperature-sensitive variants, are expressed only under specific conditions.

4. B — Lethal mutations significantly reduce longevity and cause death, which may take many forms.

Lesson 127: Spontaneous and Induced mutation

1. How are spontaneous mutations defined in Lesson 127?

A) Mutations that result from natural changes in DNA
B) Mutations caused exclusively by industrial chemicals
C) Mutations induced by UV and X-ray radiation
D) Mutations created artificially in recombinant plasmids

2. Induced mutations result from DNA changes caused by:

A) Environmental factors, chemicals, and radiation
B) Natural DNA replication proofreading only
C) Normal histone acetylation
D) Complete absence of mutagens

3. Which of the following is an origin of spontaneous mutations mentioned in the lesson?

A) Replication errors and spontaneous DNA damage
B) Exposure to medical X-ray radiation
C) Treatment with alkylating chemical mutagens
D) Colchicine application

4. What distinguishes an induced mutation from a spontaneous mutation?

A) Induced mutations are caused by external environmental, chemical, or radiation agents
B) Induced mutations never alter the nucleotide sequence
C) Spontaneous mutations only occur in artificial cell cultures
D) Spontaneous mutations affect only sex chromosomes

Answer Key

1. A — Spontaneous mutations arise naturally from endogenous cellular processes and natural changes in DNA.

2. A — Induced mutations stem from external mutagens including environmental agents, chemicals, and radiation.

3. A — Spontaneous mutations originate naturally through replication errors or spontaneous DNA damage.

4. A — Induced mutations are triggered by external environmental, chemical, or radiation exposure rather than natural internal processes.

Lesson 128: Suppressor mutation

1. How does a suppressor mutation differ fundamentally from a reverse mutation?

A) Suppressor mutations are identical to reverse mutations
B) A suppressor mutation occurs at a site distinct from the original mutation, whereas a reverse mutation restores the original site
C) There is no difference
D) Suppressor mutations delete genes

2. An organism carrying both an original background mutation and a suppressor mutation is a double mutant that:

A) Shows no change
B) Exhibits the phenotype (partially or fully restored toward wild-type)
C) Always dies
D) Becomes haploid

3. What defines intragenic suppression?

A) A suppressor mutation occurring in a completely different gene
B) Suppressor mutations that occur within the same gene as the original mutation
C) Suppression between species
D) Deletion of the gene

4. Intergenic (extragenic) suppression relieves the effect of a mutation by introducing a second mutation:

A) In the same codon
B) Situated on a different gene
C) That deletes the chromosome
D) In mitochondria only

Answer Key

1. B — A suppressor mutation occurs at a site distinct from the original mutation, whereas a reverse mutation corrects the original site.

2. B — An organism carrying a suppressor mutation is a double mutant that exhibits the phenotype restored toward normal.

3. B — Intragenic suppression results from suppressor mutations that occur within the same gene.

4. B — Intergenic suppression involves a second mutation situated on a different gene.

Lesson 129: Point mutations

1. Point mutations are defined as DNA alterations that:

A) Delete entire chromosome arms
B) Affect single sites on DNA through base substitutions or small additions/deletions
C) Duplicate whole genomes
D) Invert chromosomes

2. What type of base substitution occurs when a purine replaces another purine (e.g., Adenine to Guanine)?

A) Transversion
B) Transition
C) Frameshift
D) Deletion

3. A base substitution where a purine is replaced by a pyrimidine (or vice versa) is termed a:

A) Transition
B) Transversion
C) Silent mutation
D) Duplication

4. Which of the following is listed in Lesson 129 as a potential result of point mutations?

A) Silent, missense, or nonsense mutations at the protein level
B) Whole chromosome loss
C) Polyploidy
D) Ring chromosomes

Answer Key

1. B — Point mutations affect single sites on DNA through base substitutions or small additions/deletions.
2. B — A transition substitution occurs when a purine substitutes for a purine or a pyrimidine for a pyrimidine.
3. B — Transversion refers to a base substitution where a purine substitutes for a pyrimidine or vice versa.
4. A — Point mutations can yield silent, missense, or nonsense mutations at the protein level.

Lesson 130: Silent Mutation

1. How does a silent mutation affect an organism's phenotype?

A) It causes severe disease
B) It has no effect on the protein or phenotype
C) It truncates the protein
D) It duplicates the gene

2. Which characteristic of the genetic code explains why many base substitutions result in silent mutations?

A) Universality
B) Degeneracy (multiple codons encode the same amino acid)
C) Non-overlapping nature
D) Triplet nature

3. In a codon, changes at which nucleotide position are most likely to result in a silent mutation?

A) First base
B) Second base
C) Third base (wobble position)
D) None

4. What happens at the protein level during a silent mutation?

A) A stop codon is created prematurely
B) The DNA base sequence changes while the amino acid sequence remains unchanged
C) The protein is truncated
D) The reading frame shifts

Answer Key

1. B — Silent mutations affect the DNA sequence but have no effect on the protein or phenotype.
2. B — Degeneracy of the genetic code allows multiple different codons to produce the same amino acid.
3. C — Third base changes in a codon often have no effect on the translated amino acid sequence.
4. B — Silent mutations alter the underlying DNA base sequence while leaving the protein unchanged.

Lesson 131: Missense mutation

1. How does a missense mutation affect protein synthesis?

A) It substitutes one amino acid for another in the polypeptide chain
B) It converts an amino acid codon into a premature stop codon
C) It deletes three consecutive triplet base pairs
D) It leaves the amino acid sequence completely unchanged

2. Why do some missense mutations have severe functional consequences while others have minimal effect?

A) Because all missense mutations destroy the nuclear envelope
B) It depends on the location in the protein structure and the chemical difference in the substituted amino acid
C) Because missense mutations only occur in non-coding UTRs
D) Because missense mutations always delete the centromere

3. In the example provided in Lesson 131, which amino acid substitution illustrates a missense mutation?

A) Histidine substituted in place of Arginine
B) Glutamate substituted in place of a stop codon
C) Lysine substituted in place of a poly-A tail
D) Cysteine substituted in place of a promoter

4. Does a missense mutation always alter the functional activity of the resulting protein?

A) Yes, it always renders the protein completely non-functional
B) No, it may change the function of the protein or it may not
C) Yes, it always increases protein activity ten-fold
D) No, because missense mutations never change the amino acid sequence

Answer Key

1. A — Missense mutations substitute one amino acid for another in the resulting protein product.

2. B — The phenotypic effect depends on where the substitution occurs in the protein structure and the magnitude of the amino acid change.

3. A — The lesson illustrates a missense mutation with Histidine substituted in for Arginine.

4. B — A missense mutation produces a change in the amino acid sequence, which may change protein function or may not.

Lesson 132: Nonsense mutation

1. A nonsense mutation is a point mutation that:

A) Replaces one amino acid with a chemically similar one
B) Converts an amino acid-coding codon into a translation stop codon
C) Has no effect
D) Duplicates the gene

2. What is the primary structural effect of a nonsense mutation on the synthesized protein?

A) It lengthens the protein
B) Premature termination, shortening the protein (truncation)
C) It adds amino acids
D) No structural effect

3. Why might some nonsense mutations have relatively little functional impact on a protein?

A) Because all truncations are harmless
B) Truncations near the protein ends may have minimal impact if those regions are not functionally critical
C) Because the protein is repaired
D) Because of splicing

4. What is the most common functional outcome when a nonsense mutation occurs in a crucial coding region?

A) Enhanced function
B) A completely non-functional truncated protein
C) No change
D) Gene duplication

Answer Key

1. B — Nonsense mutations convert an amino acid-coding codon into a translation stop codon.
2. B — Converting a coding codon into a stop codon causes premature termination, shortening the protein.
3. B — Truncations near the protein ends may have minimal impact if those regions are not functionally essential.
4. B — Nonsense mutations frequently yield completely non-functional truncated proteins.

Lesson 133: Additions mutation

1. An addition mutation (insertion) involving non-triplet base counts typically results in what type of mutation?

A) Silent mutation
B) Frameshift mutation
C) Missense only
D) No effect

2. How are addition mutations alternatively named in genetic literature according to Lesson 133?

A) Deletions
B) Insertions
C) Inversions
D) Duplications

3. What is the typical consequence of an addition/insertion frameshift mutation on protein function?

A) Enhanced function
B) Disruption of downstream amino acid sequences, often causing severe loss of function
C) No consequence
D) Increased protein length only

4. What happens to the translational reading frame when a single nucleotide is inserted into a coding sequence?

A) It remains unchanged
B) The reading frame shifts for all subsequent codons downstream
C) It shifts only one codon

D) It reverses

Answer Key

1. B — Addition mutations alter the triplet reading alignment, resulting in a frameshift.
2. B — Lesson 133 specifies that addition mutations are also called insertions.
3. B — Addition mutations disrupt downstream amino acid sequences, often causing severe functional defects.
4. B — Inserting nucleotides shifts the reading frame for all subsequent codons downstream.

Lesson 134: Inversion mutation

1. According to Lesson 134, inversion mutations at the gene level affect:

A) Entire chromosomes spanning millions of bases
B) Only a small part of the gene (a localized segment)
C) Whole genomes
D) Mitochondria only

2. In the nucleotide sequence example provided in Lesson 134 (GGTCCTCTCACGCCA), how does the amino acid change after inversion?

A) Reversing the sequence segment alters the second codon to translate Glycine instead of the original amino acid
B) No amino acid change
C) The protein doubles
D) A stop codon appears at the start

3. How does a small intragenic inversion alter the local nucleotide sequence?

A) By deleting a triplet
B) By reversing the 180-degree orientation of a localized sequence segment
C) By duplicating it
D) It doesn't alter it

4. What distinguishes a small gene inversion from a large chromosomal inversion (Lesson 120 vs. Lesson 134)?

A) Small gene inversions affect localized base sequences within a gene, whereas chromosomal inversions span large segments including the centromere region
B) They are identical
C) Small inversions are always lethal
D) Large inversions affect single bases

Answer Key

1. B — Lesson 134 states that gene-level inversion mutations affect only a small part of the gene.
2. A — Reversing the sequence segment alters the second codon to translate Glycine instead of the original.
3. B — Inversion mutations reverse the 180-degree orientation of a localized sequence segment.
4. A — Small gene inversions affect localized base sequences within a gene, whereas chromosomal inversions affect large segments.

Lesson 135: Deletions Mutation

1. What is the primary effect of a single-nucleotide deletion on the downstream amino acid sequence?

A) No effect
B) All downstream amino acids from the mutation site change (frameshift)
C) Only one amino acid changes
D) The protein lengthens

2. Proteins produced following a frameshift deletion are generally:

A) Hyper-functional
B) Non-functional
C) Longer
D) Unaffected

3. In standard protein mutation nomenclature, how is a deletion of amino acid Lysine at position 2 designated?

A) p.Lys2ins
B) p.Lys2del
C) p.Lys2>del
D) c.2del

4. How is a deletion spanning from Cysteine-28 to Methionine-30 formatted according to Lesson 135 nomenclature?

A) p.Cys28_Met30del
B) p.Cys28del_Met30del
C) c.28_30del
D) p.del28-30

Answer Key

1. B — Deletion frameshifts cause all downstream amino acids from the mutation site to differ.

2. B — Proteins resulting from frameshift deletions are generally non-functional.

3. B — Single amino acid deletions are designated by "del" after the amino acid and position (e.g., p.Lys2del).

4. B — A range of deleted amino acids is indicated by separating the first and last residues (as formatted in the lesson).

Lesson 136: How mutations alter gene function

1. Which functional class of mutant allele results in a complete absence of gene product?

A) Hypomorph
B) Null allele (amorph / loss of function)
C) Hypermorph
D) Neomorph

2. What is a hypomorphic mutation?

A) A mutation producing a completely novel activity
B) A mutation causing decreased (partial loss of) gene product activity
C) A mutation with increased activity
D) A silent mutation

3. An allele whose product actively antagonizes or interferes with the normal wild-type protein product is called:

A) Recessive
B) Dominant negative (antimorph)
C) Silent
D) Neutral

4. A mutation that imparts an entirely novel biochemical activity to a gene product is classified as:

A) Hypomorphic
B) Neomorphic (gain of function)
C) Amorphic
D) Silent

Answer Key

1. B — A null allele (loss of function) produces no gene product whatsoever.
2. B — Hypomorphic mutations result in decreased gene product activity.
3. B — Dominant negative mutations produce a gene product that antagonizes the normal wild-type product.
4. B — Neomorphic mutations bestow a novel functional activity on the gene product.

Lesson 137: Mutation nomenclature

1. According to HGVS mutation nomenclature standards, at what most basic level should all variants be described?

A) Protein level
B) DNA level
C) RNA level
D) Chromosome level

2. What prefix letter indicates that a variant description uses a coding DNA reference sequence?

A) g.
B) c.
C) m.
D) r.

3. Which prefix letter is assigned to mitochondrial DNA reference sequences?

A) c.
B) m.
C) r.
D) g.

4. Official gene symbols used in standard mutation nomenclature must be approved by which authority?

A) WHO
B) HGNC (HUGO Gene Nomenclature Committee, www.genenames.org)
C) FDA
D) UNESCO

Answer Key

1. B — All variants should be described at the most basic level, namely the DNA level.
2. B — The prefix "c." designates a coding DNA reference sequence (e.g., c.76A>T).
3. B — The prefix "m." specifies a mitochondrial sequence (e.g., m.8993T>C).
4. B — Only official HGNC gene symbols (www.genenames.org) should be used when describing variants.

Lesson 138: Salient feature of Mutation nomenclature

1. In coding DNA mutation nomenclature, which specific nucleotide is designated as nucleotide 1?

A) The first nucleotide of the chromosome
B) The 'A' of the ATG translation initiation codon
C) The promoter TATA box
D) The stop codon

2. Is there a nucleotide designated as "0" (zero) in standard mutation nomenclature?

A) Yes, it denotes the promoter
B) No, there is no nucleotide 0
C) Yes, it denotes the start codon
D) Only in mitochondria

3. How are nucleotides located in the 5' untranslated region (upstream of the ATG start codon) numbered?

A) With positive numbers
B) Using negative numbers (-1, -2, ...) counting upstream from the ATG
C) With asterisks
D) They are not numbered

4. How are nucleotides situated in the 3' untranslated region (downstream of the translation stop codon) designated?

A) With an asterisk (*1, *2, ...) counting downstream from the stop codon
B) With negative numbers
C) With zero
D) They are not numbered

Answer Key

1. B — Nucleotide 1 is defined specifically as the 'A' of the ATG-translation initiation codon.
2. B — Salient nomenclature rules explicitly mandate that there is no nucleotide 0.
3. B — Nucleotides 5' of the ATG start codon are designated using negative numbers (-1, -2, ...).
4. A — Nucleotides 3' of the translation stop codon are designated with an asterisk (*1, *2, ...).

Lesson 139: Mutation at DNA, RNA and protein level

1. How are nucleotide letters written when describing mutations at the DNA level versus the RNA level?

A) DNA-level mutations are written in capitals, whereas RNA-level descriptions use lower-case letters
B) Both use capitals

C) Both use lower-case
D) DNA uses numbers only

2. A substitution at the RNA level changing Adenine to Uracil at position 76 is correctly formatted as:

A) c.76A>U
B) r.76a>u
C) p.76A>U
D) m.76A>U

3. How does a protein-level mutation description begin according to HGVS rules?

A) Starting with a number
B) With 'p.' followed by capital letters denoting the amino acid
C) With 'c.'
D) With the gene name

4. Which of the following represents a properly formatted protein substitution changing Lysine at position 2 to Asparagine?

A) c.2A>T
B) p.Lys2Asn
C) r.2a>u
D) g.Lys2Asn

Answer Key

1. A — DNA-level mutations are written in capitals, whereas RNA-level descriptions use lower-case letters.
2. B — RNA-level variants use the 'r.' prefix with lower-case nucleotide letters (e.g., r.76a>u).
3. B — Protein-level variants begin with 'p.' followed by capital letters denoting the amino acid.
4. B — Protein substitutions start with 'p.' followed by the three-letter amino acid codes (e.g., p.Lys2Asn).

Lesson 140: Mutation in intronic sequence

1. How is a mutation located at the beginning of an intron formatted in HGVS coding DNA nomenclature?

A) Using the last nucleotide of the preceding exon, a plus sign, and the intronic offset (e.g., c.76+1)
B) Using only the exon number
C) With a minus sign
D) It cannot be described

2. How is a mutation located near the end of an intron designated?

A) The last nucleotide of the preceding exon with a plus
B) The first nucleotide of the following exon with a minus sign and offset (e.g., c.77-1)
C) With an asterisk
D) With the intron number only

3. In the middle of an intron with an uneven number of nucleotides, how is the central nucleotide described?

A) By the exon position
B) As the last one described from the 5' end (or per the lesson's convention for the central nucleotide)
C) It cannot be described

D) With zero

4. What symbol separates the preceding exon nucleotide position from the relative intronic position?

A) Minus sign
B) A plus sign (+) indicates a position counting downstream into the intron from the exon
C) Underscore
D) Colon

Answer Key

1. A — At the beginning of an intron, notation uses the last nucleotide of the preceding exon plus the intronic offset.

2. B — At the end of an intron, notation uses the first nucleotide of the following exon with a minus offset.

3. B — In an intron with an uneven base count, the central nucleotide is the last one described from the 5' side.

4. B — A plus sign (+) indicates a position counting downstream into the intron from the exon.

Lesson 141: Specific changes in sequence

1. In HGVS DNA mutation nomenclature, what symbol is explicitly used to indicate a base substitution?

A) Underscore (_)
B) Greater-than sign (>)
C) Hyphen (-)
D) Plus (+)

2. How are duplicating insertions described according to standard HGVS nomenclature rules?

A) As insertions (ins)
B) As duplications (dup)
C) As inversions (inv)
D) As substitutions

3. Which symbol is used to specify a range of affected residues between the first and last position?

A) An underscore (_)
B) A hyphen (-)
C) A colon (:)
D) A semicolon (;)

4. What abbreviation is used to denote an inversion of a sequence segment at the DNA level?

A) del
B) ins
C) dup
D) inv

Answer Key

1. B — The ">" symbol explicitly indicates a nucleotide substitution at the DNA level (e.g., c.76A>T).

2. B — Duplicating insertions are described specifically as duplications (dup) rather than insertions (ins).

3. A — An underscore (_) separates the first and last affected residues to indicate a sequence range (e.g., c.76_78delACT).

4. D — The abbreviation "inv" designates a sequence inversion (e.g., c.76_83inv).

Lesson 142: Mutations - Summary

1. In the sentence-analogy summary of mutations, how is a missense mutation represented relative to the original sentence?

A) A word is deleted
B) A single letter/amino acid is altered, changing "RED" to "RAD"
C) The sentence is cut short
D) Words are repeated

2. Which sentence analogy represents a nonsense mutation in the lesson summary?

A) "THE BIG RAD DOG"
B) A premature stop truncating the sentence (e.g., "THE BIG ...")
C) "THE BGR EDD OGR"
D) "THE BIG BIG BIG BIG BIG RED DOG RAN OUT"

3. How is a 3-bp in-frame deletion illustrated in the sentence-analogy summary?

A) "THE BGR EDD OGR"
B) Deleting 3 base pairs (one full word) removes "RED" without shifting the reading frame
C) The sentence is cut in half
D) Letters are swapped

4. The sentence "THE BIG BIG BIG BIG BIG RED DOG RAN OUT" serves as an analogy for which type of mutation?

A) Missense
B) Triplet repeat expansion mutation
C) Nonsense
D) Frameshift deletion

Answer Key

1. B — A missense mutation alters a single letter/amino acid, changing "RED" to "RAD".

2. B — A nonsense mutation introduces a premature stop, truncating the sentence.

3. B — Deleting 3 base pairs (one full word) removes "RED" without shifting the reading frame.

4. B — Repeated copies of the word "BIG" represent a triplet repeat expansion mutation.

Lesson 143: Genetic Disorders

1. What are the five main classes of genetic disorders according to Lesson 143?

A) Multifactorial, single gene, chromosomal, mitochondrial, and somatic-mutation (cancer) disorders
B) Only single gene disorders
C) Only chromosomal disorders
D) Infectious and genetic

2. How are "fully penetrant" genetic disorders characterized?

A) Environmental factors exclusively determine expression

B) Other background genes and environmental conditions have little influence; the genotype almost always produces the phenotype
C) They never manifest
D) They affect only one sex

3. In "low-penetrance" genetic disorders, what determines phenotypic expression?

A) Genes play a small portion of risk along with environmental factors
B) Genes play no role
C) Only environment
D) Only age

4. Cancer is listed under which category of genetic disorders in Lesson 143?

A) Mitochondrial disorders
B) Genetic disorders resulting from somatic mutations
C) Single gene disorders
D) Chromosomal disorders

Answer Key

1. A — Lesson 143 classifies genetic disorders into multifactorial, single gene, chromosomal, mitochondrial, and somatic mutation categories.

2. B — In fully penetrant disorders, other background genes and environmental conditions minimally modify expression.

3. A — Low-penetrance disorders involve genes contributing a small portion of risk along with environment.

4. B — Cancers are classified as genetic disorders resulting from somatic mutations.

Lesson 144: Inheritance patterns of genetic disorders

1. In autosomal dominant genetic disorders, what is the genotype of affected individuals?

A) Heterozygote (one allele is mutated, while the other is normal)
B) Homozygous recessive
C) Hemizygous with no normal allele
D) Nullizygous

2. What is the genetic requirement for expressing an autosomal recessive disorder?

A) Both alleles of the gene must be mutated (homozygous)
B) Only one allele needs to be mutated
C) The mutation must reside on the Y chromosome
D) Environmental factors must be 100% responsible

3. How are multifactorial genetic disorders characterized in Lesson 144?

A) Both genes and the environment contribute to disease manifestation
B) They are caused strictly by a single point mutation in a single gene
C) They affect only mitochondrial DNA
D) They are passed exclusively from father to son

4. How do chromosomal disorders affect an organism compared to single-gene disorders?

A) They involve thousands of genes and affect multiple organ systems at multiple stages of gestation
B) They affect only hair color and eye color
C) They are always single-gene recessive traits

D) They have no impact on embryonic development

Answer Key

1. A — Affected individuals in autosomal dominant inheritance are heterozygotes carrying one mutated allele and one normal allele.

2. A — Autosomal recessive disorders manifest when an individual is homozygous for two mutated alleles.

3. A — Multifactorial disorders arise from the combined contributions of multiple genes and environmental factors.

4. A — Chromosomal disorders involve large numbers of genes, impacting multiple organ systems across gestational stages.

Lesson 145: Autosomal recessive inheritance / diseases

1. In autosomal recessive inheritance, an individual manifests the clinical disease phenotype when:

A) They carry a single mutant allele
B) They possess two mutant alleles (homozygous)
C) They are hemizygous for the X chromosome
D) They have a chromosomal deletion

2. Parents who are carriers for an autosomal recessive condition possess:

A) Two copies of the altered allele
B) One normal allele and one altered allele (heterozygous)
C) No normal alleles at all
D) Three copies of the gene

3. Which of the following phenotypic observations in a pedigree suggests an autosomal mode of inheritance?

A) Only males are affected
B) Equal phenotypic proportions between affected males and females
C) The trait skips all generations
D) Only the eldest child is affected

4. Which of the following is listed in the handout as a common autosomal recessive disorder?

A) Marfan syndrome
B) Cystic fibrosis
C) Huntington disease
D) Achondroplasia

Answer Key

1. B — Autosomal recessive diseases manifest only in individuals who possess two mutant alleles.

2. B — Heterozygous carrier parents possess one normal allele and one altered allele for the gene.

3. B — Equal phenotypic proportions between affected males and females indicate an autosomal inheritance pattern.

4. B — Cystic fibrosis is listed as a common autosomal recessive disease (alongside Bloom syndrome and others).

Lesson 146: Properties of Autosomal recessive inheritance

1. What term describes mating between individuals who share common ancestors, which increases the likelihood of autosomal recessive disease in offspring?

A) Random mating
B) Consanguinity
C) Outbreeding
D) Cloning

2. When two heterozygous carrier parents for an autosomal recessive disorder have children, what is the probability that each child will be affected?

A) 50% (1 in 2)
B) 25% (1 in 4)
C) 100%
D) 0%

3. Why does consanguinity increase the risk of offspring inheriting an autosomal recessive disease?

A) Sharing common ancestors raises the likelihood that both parents inherited and carry the same mutant allele
B) It causes new mutations in every generation
C) It eliminates all dominant alleles
D) It doubles the number of chromosomes

4. What is the expected proportion of unaffected carrier children born to two heterozygous carrier parents?

A) 25% (1 in 4)
B) 50% (2 in 4)
C) 75% (3 in 4)
D) 100%

Answer Key

1. B — Consanguinity refers to mating between parents with common ancestors, raising the risk of recessive disease.

2. B — Each sibling has a 25% (1 in 4) chance of inheriting two mutant alleles from heterozygous carrier parents.

3. A — Sharing common ancestors raises the likelihood that both parents inherited and carry the same rare mutant allele.

4. B — Crossing two carrier parents yields a 50% (2 in 4) probability of offspring being unaffected carriers.

Lesson 147: Autosomal dominant inheritance/ disorders

1. In autosomal dominant disorders, what is the relationship between the normal allele and the abnormal allele?

A) The normal allele is dominant
B) The abnormal allele exerts a dominant effect over the normal allele
C) Both alleles are recessive
D) The alleles are co-dominant

2. What proportion of children born to an affected individual (heterozygous for an autosomal dominant disorder) and an unaffected partner will inherit the disorder?

A) 25%
B) 50%
C) 75%
D) 100%

3. Which pedigree feature is a hallmark clue for identifying autosomal dominant inheritance?

A) The trait skips generations
B) The trait appears in every generation, with each affected person having an affected parent
C) Only males are affected
D) The trait appears only in twins

4. Which of the following conditions is listed as an autosomal dominant disorder in Lesson 147?

A) Cystic fibrosis
B) Marfan syndrome
C) Hemophilia A
D) Color blindness

Answer Key

1. B — In autosomal dominant conditions, the abnormal allele exerts a dominant effect over the normal allele.

2. B — An affected heterozygous parent has a 50% chance of transmitting the dominant disorder allele to each child.

3. B — Autosomal dominant traits characteristically appear in every generation, with each affected individual having an affected parent.

4. B — Marfan syndrome (along with Huntington's, Retinoblastoma, Achondroplasia, etc.) is listed as an autosomal dominant disorder.

Lesson 148: Variations in Autosomal dominant inheritance

1. What defines "incomplete or reduced penetrance" as a variation in autosomal dominant inheritance?

A) Everyone with the genotype shows the trait
B) Individuals with a disease-causing genotype do not always express the phenotype
C) Only males express it
D) It is the same as expressivity

2. Variable expressivity in autosomal dominant inheritance refers to differences in:

A) Whether the trait appears at all
B) Varying degrees of clinical severity among individuals with the same genotype
C) Chromosome number
D) Gender ratio

3. What term describes a single gene producing multiple distinct phenotypic effects?

A) Penetrance
B) Expressivity
C) Pleiotropy
D) Epistasis

4. In a typical autosomal dominant pedigree, what is the expected parental status of an affected person?

A) Both parents normal
B) Every affected individual typically has at least one affected parent
C) Only the mother is affected
D) Parents are always carriers

Answer Key

1. B — Incomplete penetrance occurs when individuals with a disease-causing genotype do not express the trait.

2. B — Variable expressivity denotes varying degrees of clinical severity among individuals with the same genotype.

3. C — Pleiotropy refers to a single gene exerting impacts on multiple distinct phenotypes.

4. B — In standard autosomal dominant inheritance, every affected individual typically has an affected parent.

Lesson 149: Dominance and Recessiveness

1. According to Lesson 149, dominance and recessiveness are fundamental properties of:

A) Individual alleles in isolation
B) Physical characters/traits rather than genes themselves
C) Chromosomes as a whole
D) Mitochondrial DNA only

2. How is a character defined as dominant in genetics?

A) It is expressed only when homozygous
B) It is expressed in a heterozygous individual
C) It never appears in offspring
D) It is always lethal

3. Why is Cystic fibrosis classified as a recessive trait?

A) Because only homozygotes manifest the disease (two mutant alleles required)
B) Because it is carried on the Y chromosome
C) Because it affects only females
D) Because it is caused by the environment

4. What term describes human males having only a single copy of gene loci present on the X and Y chromosomes?

A) Homozygous
B) Heterozygous
C) Hemizygous
D) Nullizygous

Answer Key

1. B — Dominance and recessiveness describe properties of physical characters/traits rather than the genes themselves.

2. B — A trait is defined as dominant if it manifests in a heterozygous individual.

3. A — Cystic fibrosis is recessive because two mutant alleles (homozygosity) are required for disease expression.

4. C — Males possess a single X and Y chromosome, making them hemizygous for sex-linked gene loci.

Lesson 150: X-linked recessive inheritance and disorders

1. Why are males significantly more frequently affected by X-linked recessive disorders than females?

A) Males have two X chromosomes
B) Being hemizygous (XY), males express X-linked recessive traits whenever their single X carries the mutant allele
C) Females lack X chromosomes
D) The Y chromosome protects females

2. In a pedigree showing X-linked recessive inheritance, how does transmission occur from an affected father?

A) He passes the trait to all his sons
B) Fathers pass their Y chromosome to sons, so affected fathers never transmit X-linked traits to sons (but pass the mutant X to all daughters)
C) He passes the trait to 50% of children randomly
D) He cannot have children

3. Which of the following is a general characteristic of X-linked recessive traits in family pedigrees?

A) Traits never skip generations
B) X-linked recessive traits characteristically skip generations and predominantly affect males
C) Only females are ever affected
D) Traits appear in every generation

4. Which of the following conditions is listed as an X-linked recessive disorder in Lesson 150?

A) Achondroplasia
B) Hemophilia A
C) Marfan syndrome
D) Huntington disease

Answer Key

1. B — Being hemizygous (XY), males express X-linked recessive traits whenever their single X chromosome carries the mutation.

2. B — Fathers pass their Y chromosome to sons, so affected fathers never transmit X-linked traits to sons.

3. B — X-linked recessive traits characteristically skip generations and predominantly affect males.

4. B — Hemophilia A (along with Hemophilia B, Duchenne Muscular Dystrophy, Color Blindness) is listed as an X-linked recessive disorder.

Lesson 151: X-linked dominant inheritance and disorders

1. In X-linked dominant inheritance, what is the pattern of transmission from an affected father?

A) He passes the trait to all his sons
B) An affected father passes his single dominant mutant X chromosome to all daughters (but none to sons)
C) He passes the trait to no children
D) He passes the trait only to his father

2. What is the expected inheritance outcome when an affected heterozygous female mates with an unaffected male?

A) All children will be affected
B) A heterozygous female (\(X^A X^a\)) has a 50% chance of transmitting the dominant mutant allele to any child, male or female
C) No children will be affected
D) Only sons will be affected

3. How does X-linked dominant inheritance differ from X-linked recessive inheritance regarding female expression?

A) Females are never affected in X-linked dominant inheritance
B) In X-linked dominant inheritance, a single mutant allele causes disease expression in females
C) There is no difference
D) X-linked dominant traits skip generations

4. Which of the following diseases is classified as an X-linked dominant disorder in Lesson 151?

A) Rett syndrome
B) Hemophilia A
C) Cystic fibrosis
D) Sickle cell anemia

Answer Key

1. B — An affected father passes his single dominant mutant X chromosome to all daughters.

2. B — A heterozygous female (\(X^A X^a\)) has a 50% chance of transmitting the dominant mutant allele to any child, male or female.

3. B — In X-linked dominant inheritance, a single mutant allele causes disease expression in heterozygous females.

4. A — Rett syndrome (along with Alport syndrome, Goltz syndrome, and Fragile-X) is an X-linked dominant disorder.

Lesson 152: Maternal inheritance of mitochondrial DNA

1. How is mitochondrial DNA (mtDNA) transmitted across human generations?

A) Exclusively through sperm
B) Exclusively through the ovum (maternal inheritance)
C) Equally from both parents
D) Only to sons

2. What is the expected pedigree outcome when a father carries a disease-causing mitochondrial DNA mutation?

A) All his children will inherit it
B) Because sperm do not contribute mitochondrial DNA to the zygote, affected fathers never transmit mtDNA diseases to offspring
C) Only his daughters inherit it
D) Only his sons inherit it

3. What term describes the presence of a mixture of normal and mutant mitochondrial DNA copies within a cell?

A) Homoplasmy
B) Heteroplasmy
C) Aneuploidy
D) Polyploidy

4. Which of the following conditions is listed as a mitochondrial disease in Lesson 152?

A) Leber hereditary optic neuropathy (LHON)
B) Cystic fibrosis
C) Huntington disease
D) Down syndrome

Answer Key

1. B — Mitochondrial DNA is inherited through the ovum, resulting in strict maternal inheritance.

2. B — Because sperm do not contribute mitochondrial DNA to the zygote, affected fathers never pass mtDNA mutations to children.

3. B — Heteroplasmy refers to co-existing wild-type and mutant mtDNA copies within a cell.

4. A — Leber hereditary optic neuropathy (LHON) is a classic example of a maternally inherited mitochondrial disorder.

Lesson 153: Multifactorial inheritance and disorders

1. How are multifactorial diseases defined in genetics?

A) Disorders caused strictly by a single point mutation in a single gene
B) Disorders arising from polygenic genetic susceptibility interacting with environmental factors
C) Disorders caused only by the environment
D) Disorders affecting only one organ

2. Unlike Mendelian single-gene disorders, how do risk and recurrence rates behave in multifactorial conditions?

A) They follow strict 3:1 ratios
B) Multifactorial conditions lack discrete Mendelian pedigree ratios (like 3:1 or 1:1)
C) They affect 100% of offspring
D) They never recur in families

3. Which of the following lists contains common human diseases classified as multifactorial in Lesson 153?

A) Diabetes, Asthma, Heart diseases, and Hypertension
B) Cystic fibrosis and Sickle cell anemia
C) Down syndrome and Turner syndrome
D) Hemophilia and Color blindness

4. In the spectrum of disease causality, multifactorial traits are characterized as:

A) Completely unaffected by the environment
B) Combining polygenic genetic factors with external environmental influences
C) Caused by a single dominant allele
D) Always lethal before birth

Answer Key

1. B — Multifactorial diseases arise from polygenic genetic susceptibility interacting with environmental factors.

2. B — Multifactorial conditions lack discrete Mendelian pedigree ratios (like 3:1 or 1:1).

3. A — Diabetes, Asthma, Heart diseases, and Hypertension are classic examples of multifactorial disorders.

4. B — Multifactorial traits combine polygenic genetic factors with external environmental influences.

Lesson 154: Frequency of genetic disorders

1. What is the estimated frequency of autosomal dominant disorders per 1,000 individuals according to Lesson 154?

A) 0.5 – 1 per 1,000
B) 2 – 3 per 1,000
C) 3 – 9.5 per 1,000
D) 15 – 20 per 1,000

2. According to the source handout, what is the frequency range of autosomal recessive disorders per 1,000 individuals?

A) 0.1 – 0.5 per 1,000
B) 2 – 2.5 per 1,000
C) 3 – 9.5 per 1,000
D) 10 – 15 per 1,000

3. Which category of genetic disorders has a reported frequency of 3 – 9.5 per 1,000 individuals?

A) Autosomal recessive disorders
B) Autosomal dominant disorders
C) X-linked disorders
D) Mitochondrial disorders

4. Comparing the frequencies provided in Lesson 154, how does the population frequency of autosomal dominant disorders relate to that of autosomal recessive disorders?

A) Autosomal recessive disorders are more frequent
B) Autosomal dominant disorders (3–9.5 per 1,000) have a higher overall population frequency than autosomal recessive disorders (2–2.5 per 1,000)
C) Both have identical frequencies
D) Frequencies cannot be compared

Answer Key

1. C — Lesson 154 states that the frequency of autosomal dominant disorders varies between 3 and 9.5 per 1,000 individuals.

2. B — The frequency of autosomal recessive disorders is specified as being between 2 and 2.5 per 1,000 individuals.

3. B — Autosomal dominant disorders occur at a frequency of 3 to 9.5 per 1,000 individuals.

4. B — Autosomal dominant disorders (3–9.5 per 1,000) have a higher overall population frequency than autosomal recessive disorders (2–2.5 per 1,000).

Lesson 155: Prenatal diagnosis

1. At how many weeks of gestation can amniotic fluid analysis be performed to detect genetic and chromosomal disorders?

A) 4 – 6 weeks
B) 8 – 10 weeks
C) 14 – 16 weeks
D) 30 – 32 weeks

2. Approximately how many different genetic diseases can be detected through amniotic fluid analysis?

A) Fewer than 10
B) About 50
C) More than 200
D) Exactly 1,000

3. Which prenatal diagnostic technique is specifically used to determine structural malformations of the fetus?

A) Amniocentesis
B) Ultrasonography of the fetus
C) Maternal blood analysis
D) Chorionic villus sampling

4. Which of the following is listed in Lesson 155 as a method used to observe an abnormal fetus?

A) Karyotyping of parents
B) Maternal blood analysis
C) Pedigree drawing
D) DNA fingerprinting

Answer Key

1. C — Analysis of amniotic fluid to determine genetic and chromosomal disorders is performed at 14–16 weeks of gestation.

2. C — More than 200 various genetic diseases can be easily detected via amniotic fluid analysis.

3. B — Ultrasonography of the fetus determines physical malformations of the head, internal organs, and limbs.

4. B — Maternal blood analysis is highlighted as a diagnostic approach to observe an abnormal fetus.

Lesson 156: Genetic Counseling

1. What is typically the first step taken by a genetic counselor during an evaluation?

A) Performing amniocentesis
B) Taking a complete family history of both prospective parents
C) Ordering DNA sequencing
D) Prescribing medication

2. How is gene therapy defined in Lesson 156?

A) The microscopic counting of G-banded chromosomes
B) A procedure involving the identification, manipulation, and reintroduction of genes to treat disease
C) A type of prenatal diagnosis
D) A method of pedigree analysis

3. What is the primary functional objective of gene therapy?

A) To convert linear chromosomes into circular plasmids
B) To replace defective genes and restore desired genetic activities
C) To increase the number of chromosomes
D) To prevent all mutations

4. Why is taking a complete background history of parents crucial in genetic counseling?

A) To calculate the exact date of conception
B) A complete family history allows counselors to evaluate inherited risks and genetic patterns
C) To determine the parents' blood types only
D) It is not important

Answer Key

1. B — A genetic counselor usually begins with a complete family history of both prospective parents.

2. B — Gene therapy is defined as a procedure involving the identification, manipulation, and reintroduction of genes into cells.

3. B — Gene therapy aims to replace defective genes and restore desired genetic activities.

4. B — A complete family history allows counselors to evaluate inherited risks and genetic patterns in the family.

Lesson 157: Complications in basic inheritance pattern

1. Which of the following is listed in Lesson 157 as a single-gene non-Mendelian complication?

A) Codominance (also: incomplete dominance and overdominance)
B) Independent assortment
C) Segregation
D) Dominance

2. How can multiple gene interactions complicate basic inheritance patterns?

A) Through epistasis and polygenic interactions
B) They cannot
C) Only through mutation
D) Only through environment

3. Which situation illustrates a pedigree complication where a recessive trait mimics a dominant pattern?

A) X-linkage
B) A common recessive trait appearing in every generation, falsely resembling dominant inheritance
C) Mitochondrial inheritance
D) Y-linkage

4. Sex-influenced traits and incomplete penetrance represent complications arising from interaction between:

A) Genes and sex/environmental context
B) Two Y chromosomes
C) Nothing
D) Cytoplasm only

Answer Key

1. A — Codominance, incomplete dominance, and overdominance are single-gene variations that complicate Mendelian patterns.

2. A — Multiple gene interactions produce complex inheritance through epistasis and polygenic effects.

3. B — A common recessive trait can appear in every generation, falsely resembling a dominant pattern.

4. A — Sex-influenced traits and incomplete penetrance illustrate complications stemming from gene-sex and gene-environment interactions.

Lesson 158: Drawing pedigree

1. In a standard pedigree diagram, how are generations designated?

A) Using lowercase English letters
B) Numbered with Roman numerals (I, II, III...), starting at the top
C) With Arabic numerals from the bottom
D) They are not designated

2. How are individual members within each generation numbered in a pedigree?

A) Across the line from left to right
B) Randomly
C) Top to bottom
D) They are not numbered

3. What is the primary purpose of drawing a family pedigree in genetics?

A) To measure the exact length of chromosomes
B) To trace and determine the mode of inheritance of traits/diseases
C) To count family members
D) For decoration

4. Where is generation I positioned on a pedigree chart?

A) At the bottom of the diagram
B) At the top (the top-most parental generation)
C) In the middle
D) On the left side

Answer Key

1. B — Generations are numbered with Roman numerals (I, II, III...), starting at the top.

2. A — Members within a single generation line are numbered sequentially from left to right.

3. B — Drawing pedigrees allows geneticists and counselors to trace and determine the mode of inheritance.

4. B — Generation I represents the top-most parental generation in a pedigree chart.

Lesson 159: Pedigree analysis

1. What are the two primary goals of pedigree analysis as outlined in Lesson 159?

A) To determine cell size and shape
B) To determine the mode of inheritance and calculate the probability of inheritance
C) To count chromosomes under a microscope
D) To measure DNA content

2. In pedigree diagrams, what geometric symbol is used to represent an unaffected male?

A) A filled circle
B) An open square
C) A filled square
D) An open circle

3. In a pedigree chart, what does an arrow pointing to a specific symbol indicate?

A) Consanguineous mating
B) The proband (propositus) — the individual through whom the family was identified
C) A deceased individual
D) An adopted individual

4. Which symbol represents consanguineous mating in a pedigree chart?

A) A single horizontal line between partners
B) A double horizontal line joining a male and female
C) A vertical line
D) A circle

Answer Key

1. B — Pedigree analysis aims to determine the mode of inheritance and calculate the probability of disease transmission.

2. B — Standard pedigree notation uses an open square for an unaffected male.

3. B — An arrow pointing to an individual in a pedigree identifies the proband (propositus).

4. B — Consanguineous mating is indicated by a double horizontal line joining a male and female partner.

Lesson 160: DNA polymorphism

1. How is a DNA polymorphism defined relative to a reference standard?

A) A sequence difference present in at least 1% of the population compared to a reference standard
B) A sequence difference compared to a reference standard
C) A mutation causing disease in all carriers
D) An identical sequence in all individuals

2. What proportion of DNA base pairs are identical among all humans?

A) 50%
B) 90%
C) 99.9%
D) 100%

3. What percentage of the human genomic sequence accounts for all genetically determined variability between individuals?

A) 0.1%
B) 1%
C) 10%
D) 50%

4. What size range can a DNA polymorphism span?

A) Strictly 10 to 12 base pairs
B) From a single nucleotide change to variations spanning large segments
C) Exactly one chromosome

D) Only whole genes

Answer Key

1. B — DNA polymorphism is defined as a sequence difference compared to a reference standard.

2. C — In humans, 99.9% of genomic DNA base pairs are identical across individuals.

3. A — The remaining 0.1% of the genomic sequence accounts for unique differences and variability between individuals.

4. B — DNA polymorphisms range in scale from a single nucleotide change to variations spanning large segments.

Lesson 161: Types of Polymorphic DNA Sequences

1. Which of the following is classified as a single locus molecular marker in Lesson 161?

A) DNA Fingerprinting
B) RFLP
C) RAPD
D) AFLP

2. Which of the following molecular markers is categorized as a multi-locus marker?

A) RFLP
B) Microsatellites
C) STS
D) RAPD

3. Why is the study of DNA polymorphisms essential in genetics?

A) To measure cellular water content
B) For analyzing inheritance, mapping phenotypes, and understanding genetic diversity
C) To count the number of cells
D) To determine cell size

4. Which application utilizes polymorphic DNA markers in livestock and plant breeding?

A) Feulgen hydrolysis
B) Marker-assisted selection (MAS)
C) Karyotyping
D) Blood grouping

Answer Key

1. B — RFLP, Microsatellites, and STS are classified as single locus molecular markers.

2. D — RAPD, AFLP, and DNA Fingerprinting are categorized as multi-locus markers.

3. B — Studying polymorphisms is essential for analyzing inheritance, mapping phenotypes, and understanding diversity.

4. B — Polymorphic DNA markers enable marker-assisted selection (MAS) in breed development.

Lesson 162: Restriction Fragment Length Polymorphism

1. What is Restriction Fragment Length Polymorphism (RFLP)?

A) A difference in homologous DNA sequences detected through differing restriction fragment lengths
B) A type of mutation

C) A sequencing method
D) A PCR technique

2. In RFLP methodology, what is a labeled RFLP probe used for?

A) To cut DNA at specific palindromic sites
B) To hybridize to target digested DNA fragments on membranes after gel electrophoresis (Southern blot)
C) To amplify DNA
D) To sequence DNA

3. Which radioactive isotope is explicitly mentioned in Lesson 162 for labeling probes in Southern blotting?

A) Carbon-14
B) Phosphorus-32 (32P)
C) Sulfur-35 (35S)
D) Hydrogen-3 (3H)

4. Which human inherited diseases can be detected using RFLP mutation analysis according to Lesson 162?

A) Huntington's disease, cystic fibrosis (among others listed)
B) Common cold
C) Flu
D) None

Answer Key

1. A — RFLP detects homologous DNA sequence variations through differing restriction fragment lengths.
2. B — Labeled probes hybridize to target digested DNA fragments on membranes after gel electrophoresis.
3. B — Probes are labeled with Phosphorus-32 (32P) for autoradiographic detection on X-ray film.
4. A — RFLP mutation detection is explicitly listed for Huntington's disease, cystic fibrosis, and others.

Lesson 163: Variable Number Tandem Repeats

1. What is the typical size range of the repeating unit sequence in Variable Number Tandem Repeats (VNTRs)?

A) 1 to 8 base pairs
B) 7 (or 8) to a few tens (or >50) of base pairs
C) 100 to 1000 base pairs
D) Single nucleotides only

2. How are tandem repeats physically arranged on a chromosome?

A) Clustered together and oriented in the same direction (contiguous blocks)
B) Scattered randomly
C) On different chromosomes
D) Inverted alternately

3. Under basic genetic principles for VNTR data analysis, what does "Inheritance Matching" specify?

A) A child inherits one matching VNTR allele from each parent
B) Children inherit only from mothers

C) No inheritance pattern
D) Random inheritance

4. What two methods can be used to extract or amplify VNTR blocks prior to gel electrophoresis?

A) Fluorescence microscopy
B) Restriction digestion (RFLP) or PCR amplification
C) Karyotyping
D) Centrifugation only

Answer Key

1. B — VNTR repeat units range in length from 7 (or 8) to a few tens (or >50) of base pairs.
2. A — Tandem repeats are clustered contiguous blocks oriented in the same spatial direction.
3. A — Inheritance matching dictates that a child inherits one matching VNTR allele from each parent.
4. B — VNTR fragments are extracted via restriction digestion (RFLP) or amplified using PCR.

Lesson 164: Short Tandem Repeat Polymorphism

1. What is the size range of the repeating unit sequence in Short Tandem Repeats (STRs)?

A) 1 to 8 base pairs
B) 7 to 50 base pairs
C) 100 to 200 base pairs
D) 1000 base pairs

2. In STR analysis, how do the repeat region and the flanking regions compare between individuals?

A) STR repeat counts vary between individuals, whereas flanking sequences remain constant
B) Both vary equally
C) Neither varies
D) Flanking regions vary more

3. An individual carrying two STR alleles of different repeat lengths at a locus is designated as a:

A) Homozygote
B) Heterozygote (two distinct alleles)
C) Hemizygote
D) Null

4. STR markers are widely utilized in which major applications according to Lesson 164?

A) DNA forensics and genetic linkage mapping
B) Protein synthesis
C) Karyotyping only
D) Pedigree drawing

Answer Key

1. A — STRs consist of short repeating nucleotide motifs ranging from 1 to 8 base pairs.
2. A — STR repeat counts vary between individuals, whereas flanking sequences remain constant.
3. B — Differing repeat lengths on homologous chromosomes represent two distinct alleles (heterozygous).

4. A — STR markers are standard tools in DNA forensics and genetic linkage mapping.

Lesson 165: Random Amplified Polymorphic DNA & Amplified Fragment Length Polymorphism

1. What type of primer is used in Random Amplified Polymorphic DNA (RAPD) PCR amplification?

A) Sequence-specific long primers
B) Arbitrarily designed short PCR primers (10-12 bp) for random genomic amplification
C) Single-stranded DNA probes
D) RNA primers

2. Why does RAPD suffer from poor repeatability in laboratory testing?

A) Because of unstable primer annealing during random amplification
B) Because agarose gels destroy DNA fragments
C) Because it uses single-stranded DNA probes
D) Because of high cost

3. What initial step is performed in Amplified Fragment Length Polymorphism (AFLP) before adaptor ligation?

A) Restriction endonuclease digestion of genomic DNA
B) PCR amplification
C) Gel electrophoresis
D) Southern blotting

4. How does AFLP compare to RAPD regarding amplification stability and repeatability?

A) AFLP has lower stability
B) AFLP combines restriction digestion and specific PCR to yield stable, repeatable amplification
C) They are identical
D) RAPD is more stable

Answer Key

1. B — RAPD utilizes arbitrarily designed short PCR primers (10-12 bp) for random genomic amplification.

2. A — Unstable primer annealing during random amplification leads to poor repeatability.

3. A — AFLP methodology begins with restriction endonuclease digestion of genomic DNA, followed by adaptor ligation.

4. B — AFLP combines restriction digestion and specific PCR to yield stable amplification.

Lesson 166: Distribution of SNP

1. What is a Single Nucleotide Polymorphism (SNP)?

A) A deletion of an entire chromosome arm
B) A genetic variation resulting from the alteration of a single nucleotide base
C) A duplication of a whole genome
D) An inversion of a chromosome segment

2. Which detection method uses sequence-specific primers and PCR amplification for SNP analysis?

A) RFLP

B) PCR with sequence-specific primers
C) Karyotyping
D) Pedigree analysis

3. According to the comparison table in Lesson 166, what degree of polymorphism is exhibited by SNPs and STRs?

A) Low
B) Moderate
C) High (both SNPs and STRs display a high degree of polymorphism)
D) None

4. Which molecular marker technique relies on hybridization and requires radioactive probes, unlike PCR-based SNP assays?

A) Microsatellites
B) STS
C) RFLP
D) RAPD

Answer Key

1. B — A SNP is defined as a genetic variation resulting from the alteration of a single nucleotide.
2. B — SNP analysis utilizes PCR with sequence-specific primers.
3. C — Both SNPs and STRs display a high degree of polymorphism.
4. C — RFLP relies on hybridization and requires radioactivity, whereas SNP assays utilize PCR-based methods.

Lesson 167: SNP- Screening and importance

1. How frequently do Single Nucleotide Polymorphisms (SNPs) occur across the human genome?

A) 1 in 10 bases
B) Roughly 1 in 100 to 300 bases (up to 1 in 1,000 bases)
C) 1 in 1 million bases
D) 1 in 10 million bases

2. Where are SNPs distributed within genomic DNA?

A) Exclusively in coding exons
B) Exclusively in telomeres
C) In both coding regions and, mostly, non-coding regions of the genome
D) Only in mitochondrial DNA

3. What are the two main screening strategies used for SNP analysis according to Lesson 167?

A) High-throughput sequencing only
B) Analyzing many SNPs in a few individuals, or analyzing a few SNPs in many individuals
C) Karyotyping and pedigree analysis
D) Blood grouping and fingerprinting

4. How can human populations be categorized using individual genomic SNP patterns?

A) Based on their eye color only

B) Individual genomic SNP patterns/haplotypes allow people to be categorized into distinct population groups
C) Based on height only
D) They cannot be categorized

Answer Key

1. B — SNPs occur with high frequency, roughly 1 in 100 to 300 bases (to 1 in 1,000 bases).

2. C — SNPs are located in both coding regions and, mostly, non-coding regions of the genome.

3. B — The two SNP screening strategies are analyzing many SNPs in a few individuals, or a few SNPs in many individuals.

4. B — Individual genomic SNP patterns/haplotypes allow people to be categorized into distinct groups.

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