

VU Learning HUB

BIO505T Quiz File

Chapter-wise Solved MCQs

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Lesson 1: What is Genetics?

Q1. How is the discipline of genetics defined in the course handouts?

- A) The study of cellular energy production and respiration
- B) The study of genes, heredity, and variation in living organisms
- C) The classification and nomenclature of plant species
- D) The chemical synthesis of synthetic proteins

Q2. In what year did Gregor Mendel explain the fundamental principles of heredity?

- A) 1859
- B) 1866
- C) 1900
- D) 1953

Q3. Which organism did Gregor Mendel use as his experimental plant to formulate the laws of inheritance?

- A) Fruit fly (*Drosophila melanogaster*)
- B) *Neurospora* bread mold
- C) Garden pea
- D) Snapdragons

Q4. What distinguishes Reverse Genetics from Classical (Forward) Genetics?

- A) Reverse genetics begins with an observed phenotype and searches for the underlying gene.
- B) Reverse genetics selects a gene first and generates a null mutant to observe the phenotype.
- C) Reverse genetics relies exclusively on pedigree analysis in humans.
- D) Classical genetics uses site-directed mutagenesis to modify DNA sequences.

Answer Key

Q1: B -- Genetics is formally defined as the field of biology studying genes, heredity, and variation.

Q2: B -- Gregor Mendel explained the principles of heredity in 1866.

Q3: C -- Mendel utilized the garden pea as his experimental plant for formulating inheritance laws.

Q4: B -- Classical genetics moves from phenotype to genotype, whereas reverse genetics selects a gene to create a mutant and determine its phenotype.

Lesson 4: Mendel's Law of Dominance

Q1. According to Mendel's Law of Dominance, what occurs when two parents pure for contrasting traits are crossed?

- A) Both traits blend equally in the F1 generation.
- B) Only one form of the trait appears in the next generation.
- C) The recessive trait is permanently destroyed in the offspring.
- D) A 1:2:1 phenotypic ratio appears in the F1 generation.

Q2. In Mendel's monohybrid cross between true-breeding purple-flowered and white-flowered pea plants, what was the phenotype of all F1 plants?

- A) All white flowers
- B) 50% purple and 50% white flowers
- C) All purple flowers
- D) All light pink flowers

Q3. What conclusion was drawn regarding the flower color alleles in the pea plant monohybrid cross?

- A) White color is dominant over purple color.
- B) Purple color is completely dominant to white color.
- C) Purple and white alleles are codominant.
- D) Flower color is determined by environmental temperature.

Q4. What happens to the recessive trait during the F1 generation of a monohybrid cross?

- A) It is expressed in 25% of the offspring.
- B) It disappears phenotypically in the F1 generation.
- C) It undergoes a reverse mutation back to wild type.
- D) It is physically deleted from the chromosome.

Answer Key

Q1: B -- In a cross of parents pure for contrasting traits, only the dominant version of the trait appears in the F1 generation.

Q2: C -- Crossing true-breeding purple and white pea plants yields 100% purple-flowered plants in the F1 generation.

Q3: B -- The appearance of purple flowers in all F1 hybrids proves that purple is completely dominant over white.

Q4: B -- In a classic monohybrid cross, the recessive allele is hidden/disappears phenotypically in the F1 generation.

Lesson 6: Law of Segregation

Q1. What happens to the two alleles responsible for a trait during the formation of gametes according to the Law of Segregation?

- A) They duplicate into four copies.
- B) They separate (segregate) from each other.
- C) They fuse permanently into a single gene.
- D) They interchange chromosomal positions randomly.

Q2. When are the separated alleles recombined back into paired states?

- A) During meiotic prophase
- B) During the process of fertilization
- C) During DNA replication in S phase
- D) During cytokinesis

Q3. What phenotypic ratio is characteristically observed in the F2 generation of a Mendelian monohybrid cross?

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

Q4. What genotypic ratio results from selfing heterozygous F1 monohybrids (Pp x Pp)?

- A) 3 dominant : 1 recessive
- B) 1 PP : 2 Pp : 1 pp
- C) All heterozygous Pp

D) 9 PP : 3 Pp : 1 pp

Answer Key

Q1: B -- The Law of Segregation states that the two members of a gene pair segregate from each other during gamete formation.

Q2: B -- Segregated alleles in gametes are recombined when male and female gametes combine during fertilization.

Q3: C -- Self-pollination or crossing of F1 monohybrids yields a 3:1 phenotypic ratio in the F2 generation.

Q4: B -- The genotypic breakdown of an F1 monohybrid cross is 1 homozygous dominant (PP) : 2 heterozygous (Pp) : 1 homozygous recessive (pp).

Lesson 8: Modern Genetics Concepts and Law of Independent Assortment

Q1. What hypothesis was supported when Mendel observed a 9:3:3:1 phenotypic ratio in dihybrid crosses?

- A) Blending inheritance
- B) Incomplete dominance
- C) Independent assortment
- D) Gene linkage

Q2. In a dihybrid cross tracking seed color and seed shape, how do the alleles for these two traits sort into gametes?

- A) They sort as an inseparable package.
- B) They sort independently of one another.
- C) Seed shape always dictates seed color.
- D) They sort only during mitotic division.

Q3. Under modern genetic concepts, when do two genes assort independently?

- A) When they are located close together on the same chromosome.
- B) When they are located on different chromosomes or far apart on the same chromosome.
- C) Only when they undergo non-disjunction.
- D) When one gene undergoes a lethal mutation.

Q4. Which F2 phenotypic class represents the double homozygous recessive class in a 9:3:3:1 dihybrid ratio?

- A) 9/16
- B) 3/16
- C) 1/16
- D) 1/4

Answer Key

Q1: C -- Mendel's 9:3:3:1 F2 dihybrid ratio supported the hypothesis of independent assortment.

Q2: B -- The alleles for seed color and seed shape sort into gametes independently of each other.

Q3: B -- Genes on different chromosomes or far apart behave independently according to Mendel's third law.

Q4: C -- In a dihybrid cross (SsYy x SsYy), the double recessive phenotype (ssyy) constitutes 1/16 of the offspring.

Lesson 9: Importance of Genetics

Q1. Which three terms define the fundamental characteristics of human genetic data according to the handout?

- A) Temporary, Public, and Variable
- B) Personal, Permanent, and Predictive
- C) Subjective, Modifiable, and Ephemeral
- D) Diagnostic, Treatment, and Surgical

Q2. How does genetics assist individualized clinical medicine?

- A) Through environmental therapy
- B) Through pharmacogenetics
- C) Through cytological staining
- D) Through karyotype counting

Q3. Which of the following is listed as a major diagnostic/screening application of genetics?

- A) Screening selected populations, newborns, and carriers
- B) Modifying embryonic tissue manually
- C) Predicting environmental weather conditions
- D) Altering cellular water content

Q4. What long-term societal area is influenced by personal genetic information according to Lesson 9?

- A) Atmospheric pressure
- B) Insurance, employment, and disability
- C) Soil nitrogen levels
- D) Bacterial binary fission rates

Answer Key

Q1: B -- Genetic data possesses three distinct core characteristics: it is personal, permanent, and predictive.

Q2: B -- Pharmacogenetics allows individualized medical selection and customized drug treatments.

Q3: A -- Genetic screening applies to newborn populations, selected communities, and carrier detection.

Q4: B -- Predictive genetic data directly impacts long-term life areas including insurance, employment, medical care, and lifestyle.

Lesson 12: Genetic and Acquired Variation

Q1. How are inherited variations generated in organisms?

- A) From nutrient absorption during adult life
- B) From the activity of genes
- C) From physical exercise and training
- D) From seasonal weather shifts

Q2. Which of the following is an example of an inherited variation in humans?

- A) Athletic language ability
- B) Blood groups and fingerprints
- C) Suntan intensity
- D) Nutritional obesity

Q3. What causes acquired variations in an individual during their lifetime?

- A) Direct changes to the germline DNA sequence
- B) Individual activities, nutrition, or environmental conditions
- C) Meiotic non-disjunction events
- D) Reciprocal translocations

Q4. Why do acquired variations play no role in evolution by natural selection?

- A) Because they are always lethal to the organism.
- B) Because acquired characteristics cannot be inherited by offspring.
- C) Because they only occur in prokaryotic organisms.
- D) Because they alter histone protein charges.

Answer Key

Q1: B -- Inherited variations result directly from gene activity and genetic makeup.

Q2: B -- Human blood groups, fingerprints, and gender are genetically controlled inherited variations.

Q3: B -- Acquired variations stem from personal habits, environmental exposure, or dietary nutrition throughout life.

Q4: B -- Acquired characteristics are not encoded in heritable DNA and thus are not acted upon by natural selection.

Lesson 20: Co-dominance**Q1. How is co-dominance defined in genetics?**

- A) A scenario where the heterozygous phenotype is an intermediate blend of both alleles.
- B) A scenario where both alleles are fully expressed in a heterozygous individual.
- C) A scenario where one allele completely suppresses the expression of another gene locus.
- D) A scenario where a single gene causes cell death.

Q2. In the human ABO blood group system, which allele combination demonstrates co-dominance?

- A) I^Ai
- B) I^Bi
- C) I^AI^B
- D) ii

Q3. What coat color phenotype results when cattle inherit one red hair allele and one white hair allele?

- A) Pure red coat
- B) Pure white coat
- C) Roan coat (mix of red and white hairs)
- D) Brown coat

Q4. What is the genotype of a roan coat cow?

- A) crcr
- B) cwcw
- C) crcw
- D) CC

Answer Key

Q1: B -- Co-dominance occurs when both alleles in a heterozygote are expressed simultaneously without blending.

Q2: C -- Individuals with genotype IAIB express both A and B antigens on red blood cells, exhibiting co-dominance.

Q3: C -- Heterozygous cattle display a roan coat consisting of an interspersed mixture of red and white hairs.

Q4: C -- The roan coat phenotype specifically corresponds to the heterozygous genotype.

Lesson 22: Epistasis

Q1. What occurs during epistasis between two gene loci?

- A) Two non-allelic genes blend to create a new polypeptide.
- B) Alleles at one gene locus hide or prevent the expression of alleles at a second locus.
- C) One allele mutates into a stop codon.
- D) Chromosomes fail to separate during meiotic anaphase.

Q2. In Labrador retrievers, what role does the second gene locus (E/e) play regarding coat color?

- A) It determines eye color intensity.
- B) It controls whether eumelanin pigment is deposited in the fur.
- C) It causes lethal albino mutations.
- D) It regulates tail length.

Q3. What coat color will a Labrador retriever have if its genotype is homozygous recessive (ee) at the pigment deposition locus?

- A) Black fur
- B) Brown fur
- C) Yellow fur regardless of the B/b locus
- D) Spotted roan fur

Q4. If a Labrador retriever has the genotype B_E_, what phenotype will it exhibit?

- A) Yellow fur
- B) Brown (chocolate) fur
- C) Black fur
- D) White fur

Answer Key

Q1: B -- Epistasis is defined as the masking or prevention of gene expression at one locus by alleles at another locus.

Q2: B -- The E/e locus in Labradors determines whether dark pigment (eumelanin) is deposited into the hair shaft.

Q3: C -- Dogs with ee cannot deposit dark pigment in fur, resulting in yellow fur regardless of B or b alleles.

Q4: C -- The dominant B allele (black) combined with functional pigment deposition (E_) produces a black Labrador.

Lesson 25: What are Chromosomes

Q1. How are chromosomes structurally described in the cell nucleus?

- A) Circular double-stranded RNA rings

- B) Rod-shaped, filamentous bodies that carry genes
- C) Unfolded histone octamers without nucleic acid
- D) Dissolved cytoplasmic lipid droplets

Q2. Who first described chromosomes in 1875?

- A) Waldeyer
- B) Gregor Mendel
- C) Strausberger
- D) Thomas Hunt Morgan

Q3. Who coined the term "chromosome" in 1888?

- A) Strausberger
- B) Waldeyer
- C) Watson and Crick
- D) Chargaff

Q4. During which phase of cell division can chromosome numbers be counted most easily?

- A) Interphase G1 stage
- B) Mitotic metaphase
- C) Meiotic telophase II
- D) Cytokinesis

Answer Key

Q1: B -- Chromosomes are rod-shaped, filamentous nuclear bodies containing chromatin and genes.

Q2: C -- Chromosomes were originally described by Strausberger in 1875.

Q3: B -- The word "chromosome" (Chromo = color, Soma = body) was coined by Waldeyer in 1888.

Q4: B -- Chromosomes condense maximally and align at the metaphase plate, making metaphase the ideal stage for counting.

Lesson 28: Chromosomes in Prokaryotes and Eukaryotes

Q1. What is the typical structure and number of chromosomes in prokaryotic cells?

- A) Multiple linear chromosomes bound to histone octamers
- B) A single circular chromosome plus optional plasmids
- C) 46 paired linear chromosomes enclosed in a nuclear membrane
- D) Single-stranded RNA loops without DNA

Q2. Where is chromosomal DNA located within a prokaryotic cell?

- A) Inside a double-membraned nucleus
- B) Floating freely in the cytoplasm (nucleoid region)
- C) Inside the lumen of the endoplasmic reticulum
- D) Embedded in the peptidoglycan cell wall

Q3. What protein component is present in eukaryotic chromosomes but absent in prokaryotes?

- A) Peptidoglycan
- B) Histone proteins
- C) DNA polymerase
- D) Chitin

Q4. How do prokaryotic cells divide after copying their single chromosome?

- A) Through mitosis and cytokinesis
- B) By immediately dividing after replication (binary fission)
- C) Through two sequential meiotic divisions
- D) By forming a cell plate

Answer Key

Q1: B -- Prokaryotes contain a single circular main chromosome along with small plasmid DNA rings.

Q2: B -- Prokaryotes lack a membrane-bound nucleus; their DNA resides directly in the cytoplasm.

Q3: B -- Eukaryotic DNA is packaged around basic histone proteins, whereas prokaryotic chromosomes consist only of DNA without histones.

Q4: B -- Prokaryotic cells copy their circular DNA molecule and divide immediately afterwards.

Lesson 32: What are Telomeres**Q1. What are telomeres?**

- A) The constricted regions where sister chromatids attach
- B) The two physical ends of a chromosome
- C) The enzyme complexes that synthesize RNA primers
- D) The dark bands located inside the cell nucleolus

Q2. What structural analogy is used in Lesson 32 to explain telomere function?

- A) Beads on a string
- B) Plastic caps at the ends of shoestrings
- C) Hooks on a fishing rod
- D) Coiled telephone cords

Q3. What happens if telomeres are damaged or removed due to chromosome breakage?

- A) The chromosome duplicates four times.
- B) Broken ends become sticky and readily fuse with other broken chromosome ends.
- C) The cell immediately converts into a prokaryote.
- D) Histone proteins lose their positive electrical charge.

Q4. What essential cellular roles do intact telomeres perform?

- A) Suppressing translation at the ribosome
- B) Replicating mitochondrial plasmids
- C) Ensuring chromosome stability and proper replication
- D) Forming the cleavage furrow during cytokinesis

Answer Key

Q1: B -- Telomeres are defined as the specialized terminal ends of linear chromosomes.

Q2: B -- Telomeres act like the protective tips of shoestrings to keep chromosome ends from fraying or fusing.

Q3: B -- Normal ends are non-sticky, but damaged ends lacking telomeres become sticky and readily fuse together.

Q4: C -- Telomeres are required for complete end-replication and overall chromosome structural stability.

Lesson 36: Chromatin and Chromosomes

Q1. What is chromatin?

- A) Pure double-stranded RNA found in ribosomes
- B) The complex between eukaryotic DNA and packaging proteins
- C) The fluid matrix surrounding cytoplasm
- D) A type of non-coding lipid

Q2. What are the major basic proteins present in eukaryotic chromatin?

- A) Albumin and globulin
- B) Histones
- C) Tubulin and actin
- D) Transferrin and ferritin

Q3. Which basic amino acids are present in high proportions in histone proteins?

- A) Alanine and valine
- B) Arginine and lysine
- C) Leucine and isoleucine
- D) Cysteine and methionine

Q4. What are the five primary types of abundant histones found in chromatin?

- A) H1, H2A, H2B, H3, and H4
- B) H1, H2, H3, H4, and H5
- C) Alpha, Beta, Gamma, Delta, and Epsilon
- D) DNMT1, DNMT2, DNMT3, HAT, and HDAC

Answer Key

Q1: B -- Chromatin refers to the complex composed of eukaryotic genomic DNA and associated proteins.

Q2: B -- Histones represent the primary structural proteins associated with DNA in eukaryotic chromatin.

Q3: B -- Histones contain a high percentage of basic amino acids, specifically arginine and lysine, granting them a positive charge.

Q4: A -- The five abundant histone classes in eukaryotic cells are H1, H2A, H2B, H3, and H4.

Lesson 42: Sex Chromosomes and Sex Determination

Q1. In mammals and fruit flies (Drosophila), which sex is heterogametic?

- A) Female (XX)
- B) Male (XY)
- C) Female (ZW)
- D) Male (ZZ)

Q2. Which sex determination system operates in birds, butterflies, and reptiles?

- A) XX female / XY male
- B) XX female / XO male
- C) ZW female / ZZ male
- D) Single gene haplo-diploidy

Q3. What is the chromosomal sex determination system found in grasshoppers?

- A) Male XX / Female XY
- B) Female XX / Male XO
- C) Female ZZ / Male ZW

D) Diploid female / Haploid male

Q4. What determines maleness in humans and mammals?

- A) Presence of two X chromosomes
- B) Absence of autosomal autosomes
- C) Presence of the Y chromosome
- D) Environmental incubation temperature

Answer Key

Q1: B -- In mammals and Drosophila, males are heterogametic (XY) producing two types of gametes, while females are homogametic (XX).

Q2: C -- Birds, reptiles, and butterflies utilize the ZW system, where females are heterogametic (ZW) and males are homogametic (ZZ).

Q3: B -- Grasshoppers use the XO system where females possess two X chromosomes (XX) and males have only one X chromosome (XO).

Q4: C -- In mammals, the presence of the Y chromosome specifies male development.

Lesson 44: Nucleotide Structure

Q1. What three chemical components make up a single nucleotide monomer?

- A) Amino acid, fatty acid, and glycerol
- B) 5-carbon pentose sugar, nitrogenous base, and phosphate group
- C) Hexose sugar, triacylglycerol, and histone protein
- D) Purine ring, pyrimidine ring, and water molecule

Q2. How does a nucleoside differ from a nucleotide?

- A) A nucleoside contains RNA instead of DNA.
- B) A nucleoside consists only of a pentose sugar and a nitrogenous base (lacks phosphate).
- C) A nucleoside lacks a nitrogenous base.
- D) A nucleoside contains three phosphate groups attached to amino acids.

Q3. Which nucleic acid polymer is classified as an "oligonucleotide"?

- A) A polymer with more than 10,000 base pairs
- B) A short polymer containing fewer than 10 nucleotide units
- C) A circular bacterial plasmid
- D) A polytene chromosome

Q4. Which nitrogenous base is present exclusively in RNA nucleotides in place of thymine?

- A) Adenine
- B) Cytosine
- C) Guanine
- D) Uracil

Answer Key

Q1: B -- Every nucleotide is composed of three subunits: a 5-carbon sugar, a nitrogenous base, and a phosphate group.

Q2: B -- A nucleoside is a monomer formed by sugar + base only, without a phosphate group.

Q3: B -- Oligonucleotides are short nucleotide chains containing fewer than 10 subunits.

Q4: D -- Uracil (U) replaces thymine (T) as the pyrimidine base in RNA.

Lesson 50: Cell Cycle Overview

Q1. What two major phases constitute the eukaryotic cell cycle?

- A) Prophase and Anaphase
- B) Interphase and Mitotic (M) phase
- C) Binary fission and Cytokinesis
- D) S phase and G0 phase

Q2. What is the G0 phase of the cell cycle?

- A) The active DNA synthesis phase
- B) A post-mitotic resting state entered from G1
- C) The phase where chromosomes align at the equator
- D) The final stage of meiotic division

Q3. What are the three sequential sub-stages of Interphase?

- A) Prophase, Metaphase, and Telophase
- B) G1 stage, S stage, and G2 stage
- C) Leptotene, Zygotene, and Pachytene
- D) M1, M2, and Cytokinesis

Q4. During which sub-stage of interphase does DNA replication take place?

- A) G1 stage
- B) S (Synthesis) stage
- C) G2 stage
- D) G0 stage

Answer Key

Q1: B -- The cell cycle consists of Interphase (preparatory phase) and Mitotic phase (division).

Q2: B -- G0 is a post-mitotic resting phase that cells enter from G1 when not actively dividing.

Q3: B -- Interphase proceeds sequentially through G1 (growth), S (DNA replication), and G2 (final growth/preparation).

Q4: B -- Synthesis of new DNA for daughter cells takes place exclusively during the S stage.

Lesson 54: Prophase of Mitosis

Q1. Which of the following key events characterizes Prophase of mitosis?

- A) Sister chromatids split and move to opposite poles.
- B) Chromosomes condense and nuclear membrane disappears.
- C) Cell plate forms in the middle of the cell.
- D) Chromosomes uncoil back into thin chromatin threads.

Q2. What happens to the centrioles during meiotic/mitotic prophase in animal cells?

- A) They dissolve completely into the nucleolus.
- B) They separate and take positions on opposite poles of the cell.
- C) They attach to the centromeres directly.
- D) They replicate DNA molecules.

Q3. What structural structures form and radiate toward the center of the cell during prophase?

- A) Cleavage furrows
- B) Spindle fibers
- C) Histone octamers
- D) Restriction fragment bands

Q4. Why do chromosomes become visible under a light microscope during prophase?

- A) Because nuclear water content increases 100-fold.
- B) Because DNA tightly wraps around histones and condenses.
- C) Because telomeres fuse together.
- D) Because RNA primers bind to all promoter regions.

Answer Key

Q1: B -- Prophase is marked by chromosome condensation, disappearance of the nuclear envelope, centriole migration, and spindle formation.

Q2: B -- Centrioles separate and migrate to opposite cellular poles during prophase.

Q3: B -- Microtubular spindle fibers form and extend from centrioles toward the cell equator.

Q4: B -- Chromosomes condense at start of mitosis as DNA wraps tightly around histone scaffolding.

Lesson 58: Cytokinesis

Q1. What is cytokinesis?

- A) The division of the nucleus into two daughter nuclei
- B) The replication of nuclear chromosomal DNA
- C) The division of the cytoplasm into two individual daughter cells
- D) The pairing of homologous chromosomes

Q2. How does cytokinesis occur in animal cells?

- A) A rigid cell plate forms in the cell middle.
- B) A cleavage furrow forms in the cell membrane and pinches the cell into two.
- C) Plasmids construct a new peptidoglycan wall.
- D) Telomeres dissolve to release cytoplasm.

Q3. How does cytokinesis take place in plant cells?

- A) By forming a cleavage furrow from outside inward
- B) By constructing a cell plate midway between the two daughter nuclei
- C) By destroying the cell wall with lysozyme
- D) By pinching centrioles in half

Q4. What does each daughter cell receive upon completion of cytokinesis?

- A) Its own nucleus, cytoplasm, and organelle complement
- B) Two sets of unfused sister chromatids attached at centromeres
- C) Unreplicated single-stranded RNA chromosomes
- D) Four Barr bodies

Answer Key

Q1: C -- Cytokinesis is the physical division of cytoplasmic content into two distinct cells.

Q2: B -- In animal cells, a contractile ring forms a cleavage furrow that pinches the membrane inward.

Q3: B -- Due to rigid cell walls, plant cells construct a central cell plate that expands outward to divide the cell.

Q4: A -- Cytokinesis equips both daughter cells with identical genetic material and adequate cytoplasm/organelles.

Lesson 62: Meiosis Overview

Q1. What is the primary biological outcome of Meiosis?

- A) Diploid somatic cells divide into two identical diploid daughter cells.
- B) Diploid germline cells are reduced to form four haploid gametes.
- C) Unicellular bacteria replicate plasmids.
- D) Damaged telomeres are repaired.

Q2. How many cell divisions occur during the complete meiotic process?

- A) One division
- B) Two sequential divisions (Meiosis I and Meiosis II)
- C) Three divisions
- D) Four divisions

Q3. What event occurs during Meiosis I that does NOT occur in Mitosis?

- A) Separation of sister chromatids
- B) Synapsis and crossing over between homologous chromosomes
- C) Alignment of individual chromosomes along the equator
- D) Breakdown of nuclear envelope

Q4. Is there chromosome replication between the end of Meiosis I and the start of Meiosis II?

- A) Yes, full S-phase replication occurs.
- B) No, chromosomes are already replicated and do not re-replicate.
- C) Yes, plasmid DNA replicates.
- D) Only telomeres replicate.

Answer Key

Q1: B -- Meiosis reduces the chromosome number by half, converting diploid (2n) germ cells into haploid (n) gametes.

Q2: B -- Meiosis comprises two nuclear divisions: Meiosis I (reductional) and Meiosis II (equational).

Q3: B -- Synapsis of homologous pairs and crossing over are unique features of meiotic Prophase I.

Q4: B -- There is no interphase DNA replication between Meiosis I and Meiosis II.

Lesson 75: Experiment of T. H. Morgan

Q1. What landmark concept did Thomas Hunt Morgan prove using *Drosophila melanogaster*?

- A) DNA is a double helix held by hydrogen bonds.
- B) Eye color trait is linked to the sex (X chromosome) of *Drosophila*.
- C) Cytosine methylation causes gene silencing.
- D) Bacterial transformation requires plasmids.

Q2. In Morgan's initial cross, what phenotypes were present in the parents?

- A) Mutant white-eyed female x wild-type red-eyed male
- B) Mutant white-eyed male x wild-type red-eyed female
- C) Two heterozygous pink-eyed flies
- D) Two true-breeding white-eyed flies

Q3. What eye color phenotype was observed in 100% of the F1 progeny?

- A) All white eyes
- B) All red eyes
- C) 50% red eyes and 50% white eyes
- D) Pink eyes

Q4. In the F2 generation, which group exclusively exhibited the mutant white-eye phenotype?

- A) Female flies only
- B) Male flies only
- C) 50% of females and 50% of males
- D) Neither males nor females

Answer Key

Q1: B -- T. H. Morgan demonstrated sex-linked inheritance by showing the white-eye gene resides on the X chromosome.

Q2: B -- Morgan crossed a mutant white-eyed male fly with a wild-type red-eyed female fly.

Q3: B -- All F1 offspring possessed red eyes, showing red eye color is dominant.

Q4: B -- In the F2 generation (3:1 ratio), all white-eyed flies were males, proving X-linkage.

Lesson 84: Multiple Alleles - Human ABO Blood Groups

Q1. How many primary alleles control the human ABO blood group system?

- A) 2 alleles (A and B)
- B) 3 alleles (IA, IB, and i)
- C) 4 alleles
- D) 6 alleles

Q2. How many distinct genotypes can be produced by the three ABO blood group alleles?

- A) 3 genotypes
- B) 4 genotypes
- C) 6 genotypes
- D) 8 genotypes

Q3. What relationship exists between the IA and IB alleles relative to the i allele?

- A) IA and IB are both recessive to i.
- B) IA and IB are codominant to each other and dominant over i.
- C) i is completely dominant over both IA and IB.
- D) IA is dominant to IB, which is dominant to i.

Q4. What is the phenotype of an individual carrying the homozygous ii genotype?

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

Answer Key

Q1: B -- Human ABO blood type is governed by a tri-allelic gene system (IA, IB, i).

Q2: C -- Three alleles yield 6 possible genotypes: IAIA, IAi, IBIB, IBi, IAIB, and ii.

Q3: B -- IA and IB display co-dominance with each other, while both are dominant over recessive i.

Q4: D -- Homozygous recessive ii produces red blood cells without A or B antigens, resulting in Type O blood.

Lesson 87: Alleles and Genotypes Formula

Q1. What mathematical formula determines the total number of possible genotypes for a gene with n alleles?

- A) n squared
- B) 2 to the power n
- C) $n(n+1)/2$
- D) $n(n-1)/2$

Q2. How many homozygous genotypes exist for a gene with n alleles?

- A) n
- B) 2n
- C) n-1
- D) $n/2$

Q3. What formula calculates the total number of heterozygous genotypes for n alleles?

- A) $n(n+1)$
- B) $n(n-1)/2$
- C) n squared - 1
- D) 2 to the power n - n

Q4. Using the formula $n(n+1)/2$, how many genotypes exist for the rabbit coat color gene which has 4 alleles?

- A) 4 genotypes
- B) 6 genotypes
- C) 10 genotypes
- D) 16 genotypes

Answer Key

Q1: C -- Total genotypes for n alleles is calculated using $n(n+1)/2$.

Q2: A -- The number of possible homozygous genotypes equals the number of alleles n.

Q3: B -- Heterozygous genotype combinations are determined by $n(n-1)/2$.

Q4: C -- Substituting $n=4$ yields $4(5)/2=10$ total genotypes.

Lesson 98: Epigenetics Definition and Mechanisms

Q1. What does the term "epigenetics" literally translate to?

- A) Changing the genetic code
- B) Above genetics
- C) Before DNA replication
- D) Chromosomal destruction

Q2. How is an epigenetic trait defined?

- A) A permanent change in nucleotide sequence caused by mutagens.
- B) A stable and heritable phenotype resulting from changes in chromosomes without alterations in DNA sequence.

- C) A lethal deletion of telomeres.
- D) A non-heritable acquired physical injury.

Q3. What chemical reaction occurs during DNA cytosine methylation?

- A) Addition of an amino group to adenine
- B) Addition of a methyl group to Carbon-5 of cytosine residues
- C) Removal of phosphate from the sugar-phosphate backbone
- D) Cleavage of hydrogen bonds between A and T

Q4. Where in the gene region does cytosine methylation predominantly take place?

- A) Inside the poly-A tail
- B) In promoter regions upstream of genes
- C) At the kinetochore attachment site
- D) At the telomere tips

Answer Key

Q1: B -- Epigenetics literally translates to "above" or "in addition to" genetics.

Q2: B -- Epigenetic traits represent heritable changes in gene expression/phenotype without modifying the underlying DNA sequence.

Q3: B -- DNA methylation involves covalently adding a methyl group to carbon-5 of cytosine.

Q4: B -- Cytosine methylation occurs mainly at CpG dinucleotides in promoter regions upstream of genes, causing gene silencing.

Lesson 109: Common Numerical Chromosomal Abnormalities

Q1. What is the clinical karyotype designation for Down syndrome?

- A) 45,X
- B) 47,XXY
- C) Trisomy 21 (47,XX/XY,+21)
- D) 47,XX/XY,+18

Q2. Which numerical abnormality represents Turner syndrome?

- A) 47,XXY
- B) Monosomy X (45,X)
- C) Trisomy 13
- D) Triploidy (69,XXX)

Q3. What is the sex chromosome composition in Klinefelter syndrome?

- A) 45,X
- B) 47,XXY
- C) 47,XYY
- D) 46,XX

Q4. What factor correlates with an increased incidence of Trisomy 21 nondisjunction?

- A) Paternal athletic activity
- B) Increasing maternal age
- C) High protein diet
- D) Bacterial transformation rates

Answer Key

- Q1: C -- Down syndrome is caused by an extra copy of chromosome 21, designated 47,XX/XY,+21.
- Q2: B -- Turner syndrome is a sex chromosome monosomy characterized by a 45,X karyotype.
- Q3: B -- Klinefelter syndrome patients are males carrying an extra X chromosome (47,XXY).
- Q4: B -- The frequency of meiotic nondisjunction leading to Trisomy 21 increases significantly with advanced maternal age.

Lesson 120: Chromosomal Inversions

Q1. What structural rearrangement occurs during a chromosomal inversion?

- A) A chromosome segment is transferred to a non-homologous chromosome.
- B) A chromosome segment breaks at two points, flips 180 degrees, and reattaches.
- C) A segment is duplicated side-by-side.
- D) Both ends of a chromosome fuse into a ring.

Q2. How does a pericentric inversion differ from a paracentric inversion?

- A) Pericentric inversion involves the centromere; paracentric involves only one arm.
- B) Pericentric inversion loses genetic material; paracentric gains extra material.
- C) Paracentric inversion involves non-homologous autosomes.
- D) Pericentric inversion occurs only in prokaryotes.

Q3. Is there a net loss or gain of genetic information in a balanced chromosomal inversion?

- A) Yes, 50% of genes are lost.
- B) No, there is no overall loss or gain of genetic material.
- C) Yes, telomeres are duplicated.
- D) Yes, double-stranded breaks introduce foreign plasmids.

Q4. What clinical complication can be associated with carriers of inversion inv(9)(p12q13)?

- A) Down syndrome
- B) Increased risk for miscarriage or infertility
- C) Sickle cell anemia
- D) Albinism

Answer Key

- Q1: B -- An inversion occurs when two breaks take place in a chromosome and the intervening segment is reversed.
- Q2: A -- Pericentric inversions span across the centromere, whereas paracentric inversions occur entirely within one chromosome arm.
- Q3: B -- Inversions rearrange sequence order without changing the total quantity of genetic material.
- Q4: B -- Common pericentric inversion of chromosome 9 is generally benign but may elevate risks of reproductive loss or infertility.

Lesson 123: Types of Mutation

Q1. What three major categories are used to classify mutations in Lesson 123?

- A) Forward, Reverse, and Neutral
- B) Point mutations, variations in chromosome number, and variations in chromosome structure
- C) Somatic, Germline, and Epigenetic

D) Silent, Missense, and Nonsense

Q2. Which of the following is classified as a Point Mutation?

- A) Reciprocal translocation
- B) Base pair substitution (silent, missense, nonsense)
- C) Trisomy 21
- D) Pericentric inversion

Q3. Which alteration represents a variation in chromosome structure?

- A) Aneuploidy
- B) Deletions, duplications, inversions, and translocations
- C) Triploidy
- D) Single nucleotide substitution

Q4. What type of point mutation shifts the entire downstream reading frame of a gene?

- A) Silent substitution
- B) Frameshift mutation (insertion or deletion not in multiples of 3)
- C) Neutral missense mutation
- D) Synonymous substitution

Answer Key

Q1: B -- Major structural/scale mutation classes comprise point mutations, numerical chromosomal variations, and structural chromosomal variations.

Q2: B -- Point mutations include base pair substitutions, single base insertions/deletions, and triplet repeat expansions.

Q3: B -- Structural variations encompass large-scale deletions, duplications, inversions, and translocations.

Q4: B -- Inserting or deleting base pairs disrupts the triplet reading codon alignment, creating a frameshift.

Lesson 124: Somatic and Germline Mutations

Q1. Where do somatic mutations arise in multicellular organisms?

- A) In gamete-producing cell lines
- B) In non-reproductive somatic body cells
- C) Only in mitochondrial plasmid DNA
- D) In zygotic polar bodies

Q2. How are somatic mutations transmitted to daughter cells within an individual?

- A) Through meiotic crossing over
- B) Through the process of mitosis
- C) Through fertilization
- D) Through viral transduction

Q3. Are somatic mutations passed on to future offspring generations?

- A) Yes, they are always inherited by all progeny.
- B) No, they affect only the individual in which they occur and are not passed to offspring.
- C) Yes, via X-linked dominant inheritance.
- D) Only if the individual is homozygous recessive.

Q4. Which mutations are inherited by future generations in multicellular organisms?

- A) Acquired environmental mutations
- B) Germline mutations occurring in cells that produce gametes
- C) Somatic skin cell mutations
- D) Epigenetic histone acetylation tags

Answer Key

- Q1: B -- Somatic mutations occur specifically in non-germline body tissues.
- Q2: B -- Somatic mutant cells divide and propagate locally within tissues via mitotic division.
- Q3: B -- Somatic mutations are confined to the host organism's somatic tissues and cannot enter gametes.
- Q4: B -- Germline mutations occur in reproductive cells (sperm/egg precursors) and are transmitted to offspring.

Lesson 132: Nonsense Mutations

Q1. What specific sequence change occurs in a Nonsense Mutation?

- A) An amino acid codon is converted into a STOP codon.
- B) One amino acid is substituted for a chemically similar amino acid.
- C) A purine is replaced by another purine without changing the protein.
- D) An entire intron is deleted.

Q2. What is the immediate effect of a nonsense mutation on the resulting protein chain?

- A) It lengthens the protein chain by 100 amino acids.
- B) It truncates (shortens) the protein prematurely.
- C) It converts the protein into an RNA primer.
- D) It increases enzymatic activity 10-fold.

Q3. Why do nonsense mutations frequently result in completely non-functional proteins?

- A) Because they alter the sugar-phosphate backbone charge.
- B) Because essential C-terminal or catalytic domains are truncated and lost.
- C) Because they prevent transcription factors from binding.
- D) Because they convert DNA into B-DNA conformation.

Q4. Which of the following triplet codons serves as a translational STOP codon in mRNA?

- A) AUG
- B) UAA (also UAG, UGA)
- C) UUU
- D) GGG

Answer Key

- Q1: A -- Nonsense mutations replace a sense amino acid codon with a stop translation signal.
- Q2: B -- Premature termination stops translation early, generating a truncated polypeptide.
- Q3: B -- Loss of downstream amino acids usually disrupts proper folding and functional domains, making the protein non-functional.
- Q4: B -- Standard stop codons in mRNA include UAA, UAG, and UGA.

Lesson 138: Mutation Nomenclature Standards

Q1. In HGVS standardized mutation nomenclature, what rule applies to nucleotide number 0?

- A) Nucleotide 0 designates the centromere.
- B) There is no nucleotide 0 (zero).
- C) Nucleotide 0 refers to the poly-A tail.
- D) Nucleotide 0 marks the beginning of the first intron.

Q2. Which specific nucleotide is defined as Nucleotide +1?

- A) The first nucleotide of the 5' UTR
- B) The A of the ATG translation initiation codon
- C) The central nucleotide of the first intron
- D) The last nucleotide of the stop codon

Q3. How are nucleotides located in the 5' Unconverted Transcribed Region (5' UTR) numbered?

- A) Using positive numbers preceded by a plus sign
- B) Using negative numbers
- C) Using Roman numerals
- D) Using lower-case letters

Q4. How are nucleotides located in the 3' UTR numbered downstream of the stop codon?

- A) Using negative numbers
- B) Preceded by an asterisk
- C) Preceded by the letter p.
- D) Enclosed in brackets

Answer Key

Q1: B -- Nomenclature guidelines explicitly state that there is no nucleotide 0 in coding DNA sequence numbering.

Q2: B -- Nucleotide +1 is defined as the Adenine (A) of the ATG translation start site.

Q3: B -- Sequences upstream of the ATG start codon in the 5' UTR are assigned negative numbers.

Q4: B -- Nucleotides downstream of the translation termination codon are designated with an asterisk.

Lesson 139: Mutation Nomenclature at DNA, RNA, and Protein Levels

Q1. How is a DNA-level substitution formatted in standard nomenclature?

- A) Lowercase letters starting with r.
- B) Uppercase letters starting with c. or g.
- C) Prefixed with p. and three-letter amino acid codes
- D) Written with Roman numerals

Q2. How are RNA-level sequence changes represented?

- A) In lower-case letters starting with prefix r.
- B) In capital letters with prefix d.
- C) Using Greek letter symbols
- D) With minus signs exclusively

Q3. What prefix denotes a mutation described at the protein level?

- A) c.
- B) g.
- C) r.
- D) p.

Q4. What does the description p.Arg534Gln signify?

- A) A substitution of Guanine for Adenine at nucleotide 534
- B) An Arginine-to-Glutamine substitution at codon position 534
- C) A deletion of 534 amino acids
- D) An inversion on chromosome 5

Answer Key

Q1: B -- DNA level changes use uppercase letters and prefixes like c. (coding) or g. (genomic).

Q2: A -- RNA level mutations are designated in lowercase using the r. prefix.

Q3: D -- Protein level alterations are prefixed with p. followed by three-letter amino acid designations.

Q4: B -- p.Arg534Gln denotes that Arginine at codon position 534 is replaced by Glutamine.

Lesson 160: DNA Polymorphism

Q1. What is a DNA polymorphism?

- A) A disease-causing chromosome deletion found in a single patient.
- B) A sequence difference compared to a reference standard present in at least 1-2% of a population.
- C) A lethal mutation that prevents cellular division.
- D) A temporary chemical modification of RNA primers.

Q2. What percentage of DNA base pairs are identical among all humans?

- A) 50.0%
- B) 90.0%
- C) 99.9%
- D) 100%

Q3. What percentage of human genomic DNA sequence accounts for individual uniqueness?

- A) 0.1%
- B) 1.0%
- C) 10.0%
- D) 25.0%

Q4. What range of size can DNA polymorphisms span?

- A) Exclusively single base pair substitutions
- B) From a single nucleotide variation up to thousands of bases
- C) Exactly 30 nm loops
- D) Only whole chromosome duplications

Answer Key

Q1: B -- A DNA polymorphism is a germline genomic sequence variant occurring at a frequency of at least 1-2% in a population.

Q2: C -- Humans share 99.9% of their genomic DNA sequence in common.

Q3: A -- The remaining 0.1% of the genome accounts for all individual genetic variation and uniqueness.

Q4: B -- Polymorphisms vary in scale from Single Nucleotide Polymorphisms (SNPs) to large structural copy number variations.

Lesson 162: Restriction Fragment Length Polymorphism (RFLP)

Q1. What is Restriction Fragment Length Polymorphism (RFLP)?

- A) A method for measuring histone acetylation levels.
- B) A difference in homologous DNA sequences detected as fragments of different lengths after digestion with restriction enzymes.
- C) A procedure for synthesizing synthetic primers.
- D) An inversion of chromosome 9.

Q2. How are DNA fragments generated in RFLP analysis?

- A) By heating DNA to 100 degrees C
- B) By digesting DNA samples with restriction endonucleases
- C) By mechanical shearing with acoustic sound waves
- D) By treating cells with colchicine

Q3. What property characterizes most RFLP genetic markers?

- A) They are homozygous and species-nonspecific.
- B) They are heterozygous and highly locus-specific.
- C) They are found only on mitochondrial plasmids.
- D) They dissolve during agarose gel electrophoresis.

Q4. Which diagnostic application utilizes RFLP markers?

- A) Detecting particular disease-causing mutations (e.g., Huntington, Cystic Fibrosis, Sickle Cell Anemia)
- B) Measuring cytoplasmic volume
- C) Counting centrioles during prophase
- D) Determining soil nutrient composition

Answer Key

Q1: B -- RFLP detects variation in DNA restriction sites, yielding distinct fragment length patterns upon digestion.

Q2: B -- Restriction endonucleases cleave DNA at specific recognition sequences to produce restriction fragments.

Q3: B -- RFLP markers show high locus-specificity and high heterozygosity in populations.

Q4: A -- RFLP mapping detects specific gene mutations associated with inherited disorders like Sickle Cell Anemia and Cystic Fibrosis.

Lesson 166: Single Nucleotide Polymorphism (SNP)**Q1. What is a Single Nucleotide Polymorphism (SNP)?**

- A) A deletion of an entire chromosome arm.
- B) A genetic variation occurring when a single nucleotide in the genome is altered.
- C) A tandem repeat of a 70 bp sequence.
- D) A reciprocal translocation between chromosomes 9 and 22.

Q2. What is the minimum allele frequency required for a single base change to be classified as a SNP in a population?

- A) 0.001%
- B) At least 1%
- C) 25%
- D) 50%

Q3. How are SNPs primarily detected in modern molecular genetics?

- A) Through Feulgen staining
- B) Through Polymerase Chain Reaction (PCR) and high-throughput sequencing
- C) By counting Barr bodies
- D) By measuring shoe-string lengths

Q4. Why are SNPs valuable markers in human genetics?

- A) They occur abundantly throughout the genome and are used in genome-wide association studies (GWAS) and disease mapping.
- B) They only occur in prokaryotic plasmids.
- C) They convert all euchromatin into heterochromatin.
- D) They prevent DNA replication during S phase.

Answer Key

Q1: B -- A SNP represents a single base position in the DNA sequence where different alternative bases exist in a population.

Q2: B -- By standard definition, the rarest allele must occur at a frequency of at least 1% in the population.

Q3: B -- SNP detection relies on PCR amplification, sequence-specific primers, and automated DNA sequencing/microarrays.

Q4: A -- High density across the genome makes SNPs ideal markers for association studies, pedigree mapping, and personalized medicine.

End of Quiz

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