1. **Who received the Nobel Prize in Chemistry in 2020 for developing CRISPR-Cas9?**
   a) James Watson and Francis Crick
   b) Emmanuelle Charpentier and Jennifer A. Doudna
   c) Rosalind Franklin and Maurice Wilkins
   d) Gregor Mendel and Hugo de Vries
   Answer: b) Emmanuelle Charpentier and Jennifer A. Doudna
   Explanation: They were awarded for their work on CRISPR-Cas9, a precise gene-editing tool.

2. **Where is DNA primarily located in a eukaryotic cell?**
   a) Cytoplasm
   b) Nucleus
   c) Mitochondria
   d) Ribosomes
   Answer: b) Nucleus
   Explanation: DNA is found in the nucleus, within chromosomes, in eukaryotic cells.

3. **What is the basic structural unit of a chromosome?**
   a) Nucleotide
   b) Nucleosome
   c) Centromere
   d) Allele
   Answer: b) Nucleosome
   Explanation: A nucleosome is DNA wound around a histone octamer, forming the basis of chromosome structure.

4. **Which scientist provided critical X-ray diffraction data for DNA's structure?**
   a) Emmanuelle Charpentier
   b) Rosalind Franklin
   c) Jennifer A. Doudna
   d) Francis Crick
   Answer: b) Rosalind Franklin
   Explanation: Her "Photo 51" was pivotal for Watson and Crick's double helix model.

5. **Which nitrogenous base pairs with adenine in DNA?**
   a) Guanine
   b) Cytosine
   c) Thymine
   d) Uracil
   Answer: c) Thymine
   Explanation: Adenine pairs with thymine via hydrogen bonds in DNA.

6. **What is the sugar component of a DNA nucleotide?**
   a) Ribose
   b) Deoxyribose
   c) Glucose
   d) Fructose
   Answer: b) Deoxyribose
   Explanation: DNA nucleotides contain deoxyribose sugar.

7. **How many chromosomes are present in a human somatic cell?**
   a) 23
   b) 46
   c) 44
   d) 48
   Answer: b) 46
   Explanation: Humans have 46 chromosomes (23 pairs) in somatic cells.

8. **Which gene on the Y chromosome determines male sex?**
   a) XIST
   b) SRY
   c) TDF
   d) HBB
   Answer: b) SRY
   Explanation: The SRY gene triggers testis development, leading to male characteristics.

9. **What is the genetic constitution of an individual with Turner syndrome?**
   a) 44 + XXY
   b) 44 + X0
   c) 44 + XXX
   d) 44 + XYY
   Answer: b) 44 + X0
   Explanation: Turner syndrome involves a single X chromosome, resulting in 45 total chromosomes.

10. **What is a gene?**
    a) A protein molecule
    b) A segment of DNA coding for a protein
    c) A type of RNA
    d) A chromosome pair
    Answer: b) A segment of DNA coding for a protein
    Explanation: Genes are DNA sequences that code for proteins, controlling traits.

11. **Where does transcription occur in a eukaryotic cell?**
    a) Cytoplasm
    b) Ribosomes
    c) Nucleus
    d) Mitochondria
    Answer: c) Nucleus
    Explanation: Transcription, where mRNA is synthesized from DNA, occurs in the nucleus.

12. **Which RNA molecule delivers amino acids during translation?**
    a) mRNA
    b) tRNA
    c) rRNA
    d) snRNA
    Answer: b) tRNA
    Explanation: tRNA transfers specific amino acids to ribosomes based on mRNA codons.

13. **What is heredity?**
    a) Variation in traits
    b) Transmission of traits from parents to offspring
    c) Mutation in DNA
    d) Protein synthesis
    Answer: b) Transmission of traits from parents to offspring
    Explanation: Heredity involves passing genetic traits to offspring.

14. **Who is considered the father of genetics?**
    a) Charles Darwin
    b) Gregor Mendel
    c) James Watson
    d) Hugo de Vries
    Answer: b) Gregor Mendel
    Explanation: Mendel's pea plant experiments established the principles of inheritance.

15. **What is the phenotypic ratio in the F2 generation of a monohybrid cross?**
    a) 1:2:1
    b) 3:1
    c) 9:3:3:1
    d) 1:1
    Answer: b) 3:1
    Explanation: In a monohybrid cross, the F2 generation shows a 3:1 dominant-to-recessive ratio.

16. **Why are no intermediate phenotypes observed in Mendel's monohybrid cross?**
    a) Incomplete dominance
    b) Co-dominance
    c) Complete dominance
    d) Polygenic inheritance
    Answer: c) Complete dominance
    Explanation: The dominant allele fully masks the recessive allele, preventing intermediate traits.

17. **What is the phenotypic ratio in the F2 generation of a dihybrid cross?**
    a) 3:1
    b) 1:2:1
    c) 9:3:3:1
    d) 1:1:1:1
    Answer: c) 9:3:3:1
    Explanation: This ratio results from independent assortment of two traits.

18. **Which inheritance pattern results in an intermediate phenotype?**
    a) Complete dominance
    b) Incomplete dominance
    c) Co-dominance
    d) Multiple allelism
    Answer: b) Incomplete dominance

Explanation: Neither allele is fully dominant, producing a blended phenotype (e.g., pink flowers).

19. **What is an example of co-dominance?**
    a) Pink flowers in four o'clock plants
    b) Roan coat in cattle
    c) Skin color in humans
    d) Height in pea plants
    Answer: b) Roan coat in cattle
    Explanation: Both red and white alleles are expressed, resulting in a mix of red and white hairs.

20. **Which alleles control the ABO blood group system?**
    a) A, B, O
    b) IA, IB, i
    c) T, t
    d) R, r
    Answer: b) IA, IB, i
    Explanation: These three alleles determine the four blood types (A, B, AB, O).

21. **What process during meiosis creates new allele combinations?**
    a) Mutation
    b) Crossing over
    c) Transcription
    d) Translation
    Answer: b) Crossing over
    Explanation: Crossing over exchanges segments between homologous chromosomes, increasing variation.

22. **What is a mutation?**
    a) Protein synthesis
    b) Sudden change in genetic material
    c) Independent assortment
    d) Gene editing
    Answer: b) Sudden change in genetic material
    Explanation: Mutations alter DNA, potentially introducing new traits or disorders.

23. **Which pigment primarily determines skin color?**
    a) Hemoglobin
    b) Melanin
    c) Carotene
    d) Chlorophyll
    Answer: b) Melanin
    Explanation: Melanin, controlled by multiple genes, determines skin color variation.

24. **Application: If a tall pea plant (Tt) is crossed with a dwarf plant (tt), what is the probability of tall offspring?**
    a) 25%
    b) 50%

c) 75%
d) 100%
Answer: b) 50%
Explanation: The cross (Tt × tt) produces 50% Tt (tall) and 50% tt (dwarf) offspring.

25. **Application: In a dihybrid cross (TtRr × TtRr), what is the probability of offspring with both recessive traits?**
a) 1/16
b) 3/16
c) 9/16
d) 6/16
Answer: a) 1/16
Explanation: The probability of ttrr (dwarf, wrinkled) is 1/4 (tt) × 1/4 (rr) = 1/16.

26. **Application: A couple has blood types A (IAi) and B (IBi). What is the probability of their child having type O blood?**
a) 0%
b) 25%
c) 50%
d) 75%
Answer: b) 25%
Explanation: The cross (IAi × IBi) yields 25% ii (type O) offspring.

27. **Application: If a mutation occurs in a skin color gene, what might be the effect?**
a) No change in skin color
b) Altered melanin production
c) Change in blood type
d) Modified height
Answer: b) Altered melanin production
Explanation: Skin color is polygenic, and a mutation could affect melanin, altering skin tone.

28. **Application: In Klinefelter syndrome (44 + XXY), what is the primary cause of symptoms?**
a) Missing X chromosome
b) Extra X chromosome
c) Extra Y chromosome
d) Missing Y chromosome
Answer: b) Extra X chromosome
Explanation: The extra X chromosome causes male individuals to develop some female traits.

29. **Application: Why might crossing over be important in plant breeding?**
a) It prevents variation
b) It creates new trait combinations
c) It stops mutations
d) It reduces chromosome number
Answer: b) It creates new trait combinations
Explanation: Crossing over generates diversity, useful for breeding plants with desired traits.

30. **Application: How can knowledge of the ABO blood group system help in medical practice?**
    a) Predicting height
    b) Ensuring safe blood transfusions
    c) Determining eye color
    d) Preventing mutations
    Answer: b) Ensuring safe blood transfusions
    Explanation: Matching blood types prevents adverse reactions during transfusions.