**Use one of the above terms to best complete each sentence #1-15 below. (2 pts. each)**

1. Purine bases commonly found in DNA are guanine and **adenine**.

2. The normal phenotype that is typical of most individuals in a population is called **wild type**.

3. A mutation of an enzyme-encoding gene that completely abolishes activity of the enzyme is called a **null** mutation.

4. Small, circular chromosomes in bacteria that often carry drug-resistance genes are called **plasmid**.

5. A **auxotrophic / mutant** strain of Neurospora is one that requires a particular medium additive which is not required by wildtype mold.

6. **Eukaryote** are organisms whose cells have nuclei and membrane-bound structures.

7. **Replication** is another term for DNA-dependent DNA synthesis.

8. Phenotypic variation within a species can be due to environmental effects, developmental noise and **genotype**.

9. **Anaphase II** is a stage of meiosis in which the sister chromatids separate to opposite poles of the meiotic spindle.

10. If a functional protein is composed of more than one polypeptide chain, we refer to this higher order of protein structure as its **quaternary** structure.
11. **topoisomerase** is a protein found ahead of the DNA replication fork that relaxes supercoiling which develops ahead of the advancing DNA polymerase.

12. The Meselson & Stahl experiments with *E. coli* showed that DNA is synthesized by a **semi-conservative** process.

13. Processing of pre-mRNA in eukaryotes includes polyadenylation (polyA addition) at the **3'** end of the molecule.

14. Chiasmata are visible during the **prophase I / metaphase I** stage of meiosis.

15. **nucleosome** are a basic organizational structure of eukaryotic chromosomes, consisting of DNA wrapped around a histone protein core.

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**Fill-in the blanks of questions #16-21 with the best term or number (2 pts. for each blank):**

16. The diploid chromosome number in voles is 2n=14. In the space provided, give the number of indicated structures that should be present in a single cell at the indicated time during oogenesis:
   - a. chromosomes in a Metaphase I cell ________14__________
   - b. centromeres in a Prophase II cell ________7__________
   - c. chromatids in a Prophase II cell ________14__________
   - d. chromosomes in a Metaphase II cell ________7__________

17. By freely substituting bases within a nine-nucleotide segment of RNA (three codons), how many different peptide sequences could be encoded? **20³ = 8000** (or nonsense→fewer)

18. In mRNA, UUA codes for leucine. What anticodon sequence must occur in leucyl-tRNA to recognize this codon? **UAA**

19. How many centromeres are there in a human lymphocyte in metaphase of mitosis? **46**

20. Name three types of noncovalent chemical interactions that contribute to the stability of the double-stranded helix formed by DNA.
   - a. **hydrogen bonds between bases**
   - b. **hydrophobic interactions between bases**
   - c. **hydrophilic interactions of PO₄ and water**
21. Consider the following piece of messenger RNA and respond to each question (3 pts. each):

5’-GGGCAGCAAUACUUUUAA-3’

a) Draw both strands of the segment of DNA from which this mRNA was transcribed, and identify the ends of each strand.

3’-CCCG TCG T TATGAAAATT-5’
5’-GGGCAGCAAT ACT T TTAA-3’

b) Indicate which of the DNA strands served as template for RNA synthesis.

upper

c) Using the codon chart, give the amino acid sequence of the protein that would be produced by translation of the mRNA, assuming that the ribosome moved along the mRNA from left to right, beginning with the leftmost nucleotide.

GlyGlnGlnTyrPhe(STOP)

d) Label the amino and carboxyl ends of this amino acid chain.

amino left, carboxyl right

22. A plant is heterozygous Aa Bb at two unlinked genes. Answer each of the following: (4 points each) 

8 FREE POINTS

a) For a given pollen grain, what is the probability that it is A b?

½ X ½ = ¼

b) If the plant is allowed to self-pollinate, what proportion of seeds do you expect to be Aa Bb?

chance of Aa = ½; chance of Bb = ½; chance of Aa Bb = ½ X ½ = ¼

23. Barley is a self-fertilizing plant that can be cross-fertilized and you are given two strains with pale green leaves. In strain A, the trait is caused by a chloroplast gene; in strain B, the trait is caused by a recessive nuclear gene. Predict the phenotypes and proportions that will result from the following crosses: (2 points each)

a) strain A egg with strain B pollen. All pale (maternal effect)

b) strain B egg with pollen from the zygote resulting from the previous cross (a)

Bb X Bb → ½ pale, ½ dark (chloroplast pale gene in pollen will not affect progeny)

c) strain B egg with strain B pollen. bb X bb → all pale
24. In domestic fowl (*Gallus domesticus*) the gene for plumage color is sex-linked and females are the heterogametic sex (ZW) while males are homogametic (ZZ). The dominant allele \( G \) determines gold coloration and its recessive allele \( g \) determines silver plumage. A cross is made between a silver male and a gold female, then the progeny are allowed to mate, producing an F2 generation. Give the genotypes, phenotypes and proportions you expect for among the F1 and F2 animals (1 point each):

<table>
<thead>
<tr>
<th>Genotype(s)</th>
<th>Phenotype(s)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1 males</td>
<td>Gg</td>
<td>gold</td>
</tr>
<tr>
<td>F1 females</td>
<td>g</td>
<td>silver</td>
</tr>
<tr>
<td>F2 males</td>
<td>Gg, gg</td>
<td>gold, silver</td>
</tr>
<tr>
<td>F2 females</td>
<td>G, g</td>
<td>gold, silver</td>
</tr>
</tbody>
</table>

23. Consider the following human pedigree of the rare condition *microphthalmia* (small, nonfunctional eyes), which occurs equally frequently in males and females within the general population. In responding to the questions below, assume that all people marrying into the pedigree do not carry the abnormal allele. (3 pts. each)

- **a)** What is the mode of inheritance of this trait (e.g., linkage, dominant/recessive)?
  - autosomal, recessive

- **b)** If individuals A and B have a child, what is the probability that the child will be microphthalmic?
  - probability that A is heterozygous = \( \frac{1}{2} \); probability that B is heterozygous = \( \frac{1}{2} \)
  - If both are heterozygous, probability that child is homozygous recessive = \( \frac{1}{4} \)
  - Overall: \( \frac{1}{2} \times \frac{1}{2} \times \frac{1}{4} = \frac{1}{16} \)

- **c)** If the first child of A × B is normal, what is the probability that their second child will be microphthalmic?
  - Same as b, 1/16

- **d)** If the first child of A × B has the disease, what is the probability that their second child will be microphthalmic? Now you know that A and B are heterozygous; 1/4