DIRECTIONS: Read each question carefully at the beginning of the exam period. Ask for help if the question is unclear. The number in parentheses by each question is the points for that question. Enough space is given for each question for a complete answer. **Partial credit is given for partial answers. Please fill in your name and student ID now!!**

1. (8) The following are some modes of regulation for **Prokaryotes**. For each, indicate whether the description is **Positive Control or Negative**, and whether the description is **Repressible or Inducible**.

<table>
<thead>
<tr>
<th>Description</th>
<th>Positive/Negative</th>
<th>Repressible/Inducible</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) High concentration of trigger helps to start transcription</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>b) Low concentration of trigger helps blocks transcription</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>c) The classic Tryp Operon</td>
<td>P</td>
<td>I</td>
</tr>
<tr>
<td>d) Catabolite Repression</td>
<td>P</td>
<td>I</td>
</tr>
</tbody>
</table>

2. (5) Carefully read the following description of a problem involving the use of DNA fingerprinting.

A couple (Couple A) is unable to conceive a child normally and has contracted with a fertility clinic for an **in vitro** fertilization procedure. The eggs and sperm are donated by this same couple. The woman becomes pregnant with twins. After birth, they notice that one of the babies has different racial features than either of the two parents. They suspect the fertility clinic has done something wrong, and have identified another couple (Couple B) who had the same procedure at the same time. They obtain the following DNA fingerprints for all six individuals involved:

![DNA fingerprint diagram]

Lanes: 1 = Mother A  4 = Child 2  
2 = Father A  5 = Mother B  
3 = Child 1  6 = Father B

Base your answers only on these data and the above description.

a) Based on this evidence (Circle **ONE**):

i) Child 1 is Couple A’s biological child.

ii) Child 2 is Couple A’s biological child.

b) Consider the other child from the one you chose in part a). Based on the description of the problem and the DNA evidence, select the **strongest** statement about child 2’s parentage.

i) **The Child was fertilized using Couple B’s egg & sperm but was mistakenly put implanted into Mother A.**

ii) The Child was fertilized using Mother A’s egg and Father B’s sperm.

iii) The Child was fertilized using Mother B’s egg and Father A’s sperm.

iv) The Child is unrelated to either Couple A or Couple B.

v) We don’t know how, but we are sure that somehow Bill Clinton is involved.
3. (5) Consider the differences between a cDNA library and a Genomic library. **Circle ALL**
   structures/sequences/ets that are found in a cDNA library.
   a) tRNA
   [ ] Poly-A
   [ ] Intron
   [ ] Cis-Acting Factor
   [ ] Stop Codon

4. (4) We are looking for expression of a certain gene (Gene X) in ground squirrel mid-brain. We think that it is expressed during hibernation, but not at other times. We have developed a probe for this gene. Circle the technique that is the **best** to use to detect the difference between expression during hibernation vs. expression when not hibernating.
   a) Eastern Blot
   [ ] Northern Blot
   [ ] Southern Blot
   [ ] Western Blot
   [ ] North by Northwest Blot

5. (6) The following is a diagram showing a single replication fork during replication in a Prokaryote.

   ![Diagram of replication fork]

   a) Label **ALL** the 5' and 3' ends (10 total).
   b) The **direction** this fork moves is (Circle **ONE**): [ ] Left to Right [ ] Right to Left
   c) Indicate the **direction of synthesis** on each new strand on the diagram (three arrows).

6. (5) The following is the upstream noncoding (untranslated) region of a Eukaryotic Gene.


   **N**-Met Arg Pro Asp His Gly Thr Asp His - **C**

   a) Indicate the **Reading Frame**.
   b) On the space given, list the amino acid sequence for the protein that would be translated by the ribosome. Label the N and C Termini.
7. (12) The following are some genetic processes and systems we have studied in class:

Processes Systems
a) Transcription 1) Eukaryotes Only
b) Translation 2) Prokaryotes Only
c) Replication 3) Both Prokaryotes and Eukaryotes
d) Replication and Transcription

For the following sequences or chemicals circle:
The process where it is found (one only).
The system where it is found (one only).
Circle **whether it is involved with Initiation, Elongation, or Termination (one only)**.

<table>
<thead>
<tr>
<th>Sequence/Chemical</th>
<th>Process</th>
<th>System</th>
<th>Stage of Involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>TATAA</td>
<td>a</td>
<td>b c d</td>
<td>1 2 3</td>
</tr>
<tr>
<td>Palindrome</td>
<td>a</td>
<td>b c d</td>
<td>1 2 3</td>
</tr>
<tr>
<td>Rho</td>
<td>a</td>
<td>b c d</td>
<td>1 2 3</td>
</tr>
<tr>
<td>Formylmethionine</td>
<td>a b c d</td>
<td>1 2 3</td>
<td>Initiation Elongation Termination</td>
</tr>
</tbody>
</table>

8. (5) We are interested in incorporating a small piece of DNA into a plasmid vector, then inserting the plasmid into a bacterial cell. We make a series of plates, one with just Minimal Media (MM), another with MM + Ampicillin, a third with MM + Tetracycline, and the last with MM + Ampicillin + Tetracycline. The following diagram shows the results of replica plating. The colored in circles represent bacterial colonies that survive.

![Diagram of replica plating with different plates and restriction sites](image)

a) Use all four plates to determine which colonies have the plasmid and which have our insert. On the first plate (MM), circle those colonies that have the insert.

b) The cloning plasmid vector we used is shown. We could have used PstI, BamHI, or EcoRI as the restriction enzyme. Based on the results of this experiment, circle the enzyme we did use.

- [ ] PstI
- [ ] BamHI
- [ ] EcoRI
9. (8) The following is a small piece of DNA (only the coding part is given for this gene; the gene goes from left to right, starting with the leftmost base).

\[
\begin{align*}
5' & \quad A \quad T \quad G \quad G \quad C \quad A \quad T \quad T \quad T \quad T \quad C \quad G \quad A \quad C \quad C \quad A \quad T \quad G \quad A \quad 3' \\
3' & \quad T \quad A \quad C \quad C \quad G \quad T \quad A \quad A \quad A \quad G \quad C \quad T \quad G \quad G \quad T \quad A \quad C \quad T \quad 5'
\end{align*}
\]

Consider mutations with this DNA sequence. Each of the following represents a single mutation (with line around). For each mutation, circle the molecular basis (choose from a) and the effect on the protein (choose from b). If your answer to the first part is “Frameshift”, do not answer the second part.

- **Frameshift**
- **Base Substitution (Specify: Transition Transversion)**
- **Nonsense**
- **Missense**
- **Silent**

9. (4) This picture shows a portion of DNA actively being transcribed.

\[
\begin{align*}
5' & \quad A \quad T \quad G \quad G \quad C \quad A \quad T \quad T \quad T \quad T \quad C \quad G \quad A \quad C \quad C \quad G \quad C \quad 3' \\
3' & \quad T \quad A \quad C \quad C \quad G \quad T \quad A \quad A \quad A \quad G \quad C \quad T \quad G \quad G \quad T \quad A \quad C \quad T \quad 5'
\end{align*}
\]

On this diagram, clearly label the following. If it appears more than one time, label ALL copies.

Coding Strand \hspace{1cm} Template Strand \hspace{1cm} RNA \hspace{1cm} ALL 5’ and 3’ ends.
10. (4) Listed are some level in the developmental cascade. Indicate the order these genes are turn on by labeling them at 1 (First) to 5 (Last).

1. Bicoid
2. Gap
3. Homeotic
4. Pair Rule
5. Polarity

11. (10) This section refers to Eukaryotic Development. Fill in the number of the term best described by each phrase. Each number is used at most once.

1) Developmental Fate  6) RNA Splicing
2) Genomic Equivalence  7) Gap
3) Central Dogma  8) Segment Polarity
4) Transdetermination  9) Homeotic
5) Hox  10) Bicoid

2. White blood cells don't follow these rules.
7. First zygotically transcribed genes.
9. Antennapedia, for example.
6. Class switching is an example.
10. Maternally expressed.

12. (4) Xeroderma Pigmentosum is an example of someone who (Circle ALL that apply)

a) Cannot do excision repair.
b) Has excessive photoreactivity.
c) Gets thymine dimers more than normal individuals.
d) Must avoid sunlight.
e) Has a compromised immunosystem, and is unable to deal with tumor cells.
13. (10) This question deals with cancer and their causes.
   1. Retinoblastoma is an example of a defect in this type of gene.
   2. When this gene is turned on at inappropriate times it causes tumors.
   3. BRCA1 is an example of a defect in this type of gene.
   4. Regulates cell division.
   5. Genes of this type follow the “Two-Hit” Model.

   For each type of gene, circle ALL attributes that are true for that type. Each attribute can be used more than one time.
   a) Tumor Supresser Genes
      1  2  3  4  5
   b) Proto-Oncogenes
      1  2  3  4  5

14. (6) For the following story about Eukaryotic Regulation, fill in the blanks with the appropriate word or phrase from the words/phrases given.

   Zinc  Homeodomain  Leucine  Methylation  Transposition
   Masking  Codon Usage  Poly-A Tail  Euchromatin  Heterochromatin

   In order for a gene to be expressed, the DNA must first be activated. This requires the DNA supercoiling to be in a state called euchromatin. Simple modifications of the DNA bases are possible which will enhance initiation of transcription, such as methylation. Once the gene is activated, it is up to Transcription Factors to help initiated transcription. Among the many transcription factors, we discussed zinc fingers and leucine zippers, which are DNA binding proteins. After transcription, the only way to stop the production of the protein is through the use of masking, which hinders initiation of translation, although codon usage will affect the rate of translation.

15. (4) The “Two Hit” rule is
   a) Similar to the infield fly rule in baseball.
   b) How much you can get away with in a fight with your brother/sister before your parents intervene.
   c) Two mutations are required to get a tumor.
   d) High insurance rates + High deductible.
   e) BCH 451 and GN 411 final exams on the same day!

(5 Points Extra Credit)

Course Evaluation

Please take a minimum of 10 minutes to complete the Faculty-Course Evaluation. In addition to answering the multiple choice items, please make written comments on the back of the form. Generally, the written comments are the most useful to us, so please elaborate!! NOTE: Make sure you have no identifying marks (e.g., name) on the course evaluations. Circle the option you have chosen:
   a) I will complete the CALS evaluation as soon as I turn in the exam.
   b) I am leaving now and will not complete the CALS evaluation. I forfeit the extra credit.