1. (18) Short Answer. Answer each of the following questions in the space provided. You will be counted off for explanations that are not succinct.

a) Define what is meant by developmental cascade?

The sequence of transcription factors, each affecting others down the line, lead to the variety of expression of developmentally sensitive genes.

b) What is the difference between facultative and constitutive heterochromatin?

Constitutive heterochromatin is always in action.
Facultative heterochromatin represents a region that is sometimes active ( euchromatic).

c) What is the endosymbiont theory?

Early pre-bakteriocyte cells were infected by prokaryotes that developed a symbiotic relationship with the cell.

d) What is meant by maternally expressed? Give an example from class.

Genes are expressed (transcribed) and the mRNA (or protein) are inserted into the egg. Bicoid or nanos are examples.

e) What is a base analog?

A chemical that is similar to a nitrogenous base, and can be incorporated into DNA.

f) What is the purpose of biotin linkers in DNA sequencing?

To visualize the separate bases, so we can identify them during sequencing.
2. (8) Identify floral structure in the 4 whorls for a flower (what do they look like) when the B gene cannot be expressed when A is expressed, but every other gene is expressed normally.
Whorl 1 (outside): \textit{Sepal}
Whorl 2: \textit{Sepal}
Whorl 3: \textit{Stamen}
Whorl 4 (inside): \textit{Carpel}

3. (12) The following is a small piece of DNA (only the coding strand is given for this gene; the gene goes from left to right, starting with the leftmost base).

```
5' A T T G C A C T T T A A 3'
```

Consider mutations with this DNA sequence. Each of the following represents a single mutation (shown with a line around it). For each mutation, circle the molecular basis (choose from the first line) and the effect on the protein (choose from the second).

a) Transition Transversion
Nonsense Missense Silent Readthrough

```
5' A T T G \underline{T} A C T T T A A 3'
```

b) Transition Transversion
Nonsense Missense Silent Readthrough

```
5' A T T G C \underline{T} C T T T A A 3'
```

c) Transition Transversion
Nonsense Missense Silent Readthrough

```
5' A T T G C A C T T \underline{G} A A 3'
```

d) Transition Transversion
Nonsense Missense Silent Readthrough

```
5' A T T G C A C \underline{C} T T A A 3'
```

4. (2) (Thought question) Describe what kind of single base substitution mutation can cause an addition/deletion mutation involving many bases.

Cryptic mutations lead to transcripts that are either too long or too short.

5. (4) What is meant by the two hit model?

Cancer is caused when neither allele functions. This can happen either:
1) Two spontaneous somatic mutations
2) Inherit one mutation and get a second somatic mutation
6. (6) The following is a DNA sequencing gel.

![DNA Sequencing Gel]

a) Give the DNA double strand sequence for this region. Label the DNA as 5' and 3'.

```
5' ATACGGGC 3'
3' TATGCCC 5' Template
```

b) Label the Template Strand in a).

7. (10) These are several statements about recombination in bacteria.
1. Can only recombine a small fraction of the genome (<20kb).
2. Can be used in the lab to move plasmids into a bacteria (or from one bacteria to another).
3. The process itself kills the donor cell.
4. Cannot transfer DNA from one species to a vastly different species.
5. Requires physical contact of the donor cell and the recipient cell.

For each type of bacterial recombination, circle the number for ALL statements that are true for that type. Each statement can be used more than one time.

a) Specialized Transduction 1 2 3 4 5
b) Generalized Transduction 1 2 3 4 5
c) Conjugation 1 2 3 4 5
d) Transformation 1 2 3 4 5

8. (3) The following are some levels of packaging in Eukaryotes. Circle ALL that can be found in transcriptionally active genes.

- Nucleosome
- Solenoid
- Supercoiling
- Heterochromatin
9. (5) We have set up an experiment for conjugation mapping. We use interrupted mating experiments to create the following table for 6 different genes from our bacteria.

<table>
<thead>
<tr>
<th>Strain</th>
<th>Earliest</th>
<th>Latest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>2</td>
<td>D</td>
<td>F</td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>F</td>
</tr>
<tr>
<td>4</td>
<td>E</td>
<td>D</td>
</tr>
</tbody>
</table>

From these data, reconstruct the conjugation map for these traits with this species.

10. (6) Draw the hnRNA (before any processing) for the Kappa Light Chain Antibody gene which is specific for LV2 J4 C. The genomic sequence for this species has 7 LV regions and 8 J regions. **Be sure to distinguish between introns and exons.**

11. (2) An exception to the concept of genomic equivalence is
   a) Mitochondria
   b) Inversion
   c) Immunoglobulins
   d) Bicoid

12. (10) We are interested in placing a small piece of DNA into a plasmid vector, then placing the plasmid into a bacterial cell. We will use PstI as the restriction endonuclease to insert out DNA into this plasmid.
   a) Why do we have the Amp' gene in the plasmid (i.e., what is its function)?
   To select cells that have the plasmid.

   b) Why do we have the LacZ gene in the plasmid (i.e., what is its function)?
   To identify cells that have the insert (our DNA)
13. (5) Prior to Fall Semester, the GN 411 TAs and your instructor met to plot out the semester. Someone brought some doughnuts. While in the meeting, the fire alarm was set off and we all evacuated. While we were gone, the doughnuts were eaten. I am convinced it was one of the TAs. While they were not looking, I took some samples of their DNA (from saliva on coffee cups) and analyzed the samples plus a sample from the lone paper napkin that was used. Two VNTR loci were probed using a Southern Blot for each of six samples (five suspects and napkin sample). The results are given below. We assume that whoever used the napkin also ate the doughnuts.

\[
\begin{array}{c|c|c|c|c|c|c}
\text{D2S193} & 1 & 2 & 3 & 4 & 5 & 6 \\
\hline
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\end{array}
\quad
\begin{array}{c|c|c|c|c|c|c}
\text{D7S182} & 1 & 2 & 3 & 4 & 5 & 6 \\
\hline
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\end{array}
\]

1 = Napkin
2 = Jenni
3 = Katie
4 = Lisa
5 = David
6 = Muk

Circle ALL the TAs that can be excluded based on just this evidence (ignore their shady personalities).

\[\bigcirc\text{Jenni} \quad \bigcirc\text{Katie} \quad \bigcirc\text{Lisa} \quad \bigcirc\text{David} \quad \bigcirc\text{Muk}\]

14. (6) The following are the four types of genes found in early *drosophila* development we covered in class. Match the names with the attributes. Match the number for the type of recombination with the statement. **Numbers can be used more than one time, but only one number per answer.**


\[
\begin{align*}
\text{1} & \quad \text{Genes used for front/back orientation.} \\
\text{2} & \quad \text{Genes are expressed in the front and back of each segment} \\
\text{4} & \quad \text{Hunchback is one gene in this family}
\end{align*}
\]