1. (2) Once you finish this exam, you will be a geneticist. A well-paying company in Raleigh hires you to look for genes in bovine (cows). They are interested in finding genes that are expressed in the liver. For this, we might construct and search in (choose the most appropriate):
   (a) a genomic library.
   b) a cDNA library.

2. (4) The following are some statements concerning population genetics. For each, indicate if they are TRUE or FALSE.

   TRUE FALSE In stabilizing selection, the fitness of the heterozygotes is smaller than both homozygotes.
   TRUE FALSE In order for a population to be in Hardy-Weinberg equilibrium, the following assumptions must be true: no mutation, no migration, no selection, random mating, and finite population size.
   TRUE FALSE Inbreeding does not change the allele frequency.
   TRUE FALSE A population can have Hardy-Weinberg proportions and not be in Hardy-Weinberg equilibrium.

3. (8) Consider sex determination in Drosophila, which involves the genes sxl, tra, and dsx. Circle the putative sex of the fly (normally diploid, otherwise) that would be produced if:

   Male Female The fly has two X chromosomes and no mutations.
   Male Female The fly has a mutation in sxl where it is always expressed.
   Male Female The fly has a mutation in tra which renders it nonfunctional.
   Male Female The fly has a mutation in both sxl and tra which renders both nonfunctional.

4. (3) A sex limited trait would be best described as
   a) a trait linked to the X or Y chromosome.
   b) a trait that determines if the organism is male or female.
   c) a trait that is expressed differently in males and females.
   d) a trait that determines the sex of the offspring.
   e) a trait that is only expressed on one of the sexes.
   f) a trait that is expressed by the mother, but used by the offspring.
5. (5) The following genes relate to the developmental cascade in *Drosophila*. Match each gene with the statement that best describes it. If more than one answer seems to apply, choose the best answer. Number can be used more than one time.

1. Maternally expressed.
2. Gap genes.
3. Pair-rule genes.
4. Segment polarity genes
5. homeotic genes
6. hunchback

3. Alternately expressed in the bands.

3. Even Skipped is an example of a gene of this type.

1. Expression has to do with identifying the anterior/posterior axis.

6. The first nonmaternal gene turned on.

5. Have to do with segment Identity.

6. (3) Circle ALL those traits exhibiting Lyonization.
   a) Androgen Insensitivity
   b) Tortoise Shell Cat
   c) Bicoid Deficiency
   d) Mitochondrial Myopathy

7. (3) If a DNA molecule consists of 18% Adenine, what percent of the DNA is:
   32% Guanine
   18% Thymine
   32% Cytosine

8. (5) For the following pedigree, which of the following modes of inheritance could explain this type of inheritance? CIRCLE ALL THAT APPLY.

   a) Mitochondrial
   b) Autosomal Dominant
   c) Autosomal Recessive
   d) X-linked Recessive
   e) X-linked Dominant
9. (4) To say that two strands of DNA are "anti-parallel" means that
   a) Each strand has the same sequence when on strand is read from 3' to 5' and the other strands is read from 5' to 3'.
   b) Each strand has the same sequence when both are read from 5' to 3'.
   c) The two strands have opposite polarity.
   d) The strands have complimentary sequences when one is read form 5' to 3' and the other is read from 3' to 5'.
   e) The strands have complimentary sequences when both are read from 3' to 5'.

10. (2) DNA sequencing techniques are based on the lack of a portion of the normal replication machinery/molecules. Circle the normal portion of DNA replication that is modified for DNA sequencing.
   a) Free nucleotide base
   b) DNA polymerase
   c) Nucleoside Triphosphate
   d) Free 3' end.

11. (4) Along with the ABO locus, there is a separate locus, Se, which control secretion of antigens into the saliva. People who have the genotype se se do not secrete any blood antigens. If two individuals are crossed (AOSe se X BOSe se), what is the probability that their first child will have antigens in it's saliva?

   \[ \frac{9}{16} \] (Answer)

12. (6) There is some indication that cone shape in Piñon Pine is controlled by two independent loci with single recessive epistasis (9:3:4). In order to test this, we set up the usual dihybrid cross and classify the F2. The following data were collected.

<table>
<thead>
<tr>
<th>Phenotype</th>
<th>Observed</th>
<th>Expected</th>
<th>Chi-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wide</td>
<td>435</td>
<td>356.06</td>
<td>Do Not Calculate</td>
</tr>
<tr>
<td>Medium Width</td>
<td>91</td>
<td>118.69</td>
<td>Do Not Calculate</td>
</tr>
<tr>
<td>Narrow</td>
<td>107</td>
<td>58.25</td>
<td>Do Not Calculate</td>
</tr>
<tr>
<td>Total</td>
<td>633</td>
<td>X</td>
<td>Do Not Calculate</td>
</tr>
</tbody>
</table>

a) \[ \frac{2}{2} \] How many degrees of freedom for this test?

b) Complete the table.

c) What is the genetic conclusion for this experiment if \( \chi^2 = 2.94 \)? That is, how would you report this experiment to other Piñon breeders?

   The data for cone shape in Piñon Pines are consistent with single recessive epistasis inheritance.

13. (2) The cross of an two individuals who are heterozygous for two traits is called a
   a) pure-breeding strain
   b) mono-hybrid cross
   c) testcross
   d) dihybrid cross
14. (4) Match these flower development modes:

\[ \begin{array}{cccc}
\text{B} & \text{Sepal} & \text{Sepal} & \text{Carpel} & \text{Carpel} \\
\text{O} & \text{Sepal} & \text{Petal} & \text{Stamen} & \text{Carpel} \\
\text{A} & \text{Sepal} & \text{Petal} & \text{Petal} & \text{Sepal} \\
\text{C} & \text{Sepal} & \text{Stamen} & \text{Stamen} & \text{Carpel} \\
\end{array} \]

a) C class gene knockout mutation
b) B class gene is expressed nowhere
c) B class gene now suppresses A class gene
d) wild type

15. (4) The Lesser Alpine Cactus has been studied extensively by geneticists. They have developed a genetic map of spine characteristics. The linkage map is given below. The coefficient of coincidence was determined to be 0.8. In an experiment with these cacti, a true breeding strain with Sharp Long Red Spines is crossed with a true breeding strain with Blunt Short Yellow Spines. The F₁ is testcrossed. Give the expected frequency of the given types among the test cross offspring.

<table>
<thead>
<tr>
<th>Sharpness</th>
<th>Length</th>
<th>Color</th>
<th>Dominant</th>
<th>Recessive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharp</td>
<td>Long</td>
<td>Yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blunt</td>
<td>Short</td>
<td>Red</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \begin{array}{ccc}
\text{5} & \text{3} \\
\end{array} \]

a) 0.025 Blunt Long Spines
b) 0.0388 Blunt Red Spines

16. (6) The following is a normal chromosome

\[ \begin{array}{ccccccc}
A & B & C & D & E & F \\
\end{array} \]

An inversion has occurred and the inverted chromosome is

\[ \begin{array}{ccccccc}
A & D & C & B & E & F \\
\end{array} \]

An individual is heterozygous for this chromosome (that is, they have one normal and one inverted chromosome).

a) This inversion is
i) paracentric
ii) pericentric
b) Diagram the tetrad for this individual during synapsis. Show all four chromatids.

\[ \begin{array}{ccc}
A & B & C & D & E & F \\
\end{array} \]

c) If recombination occurs between regions C and B, give the four DNA strands which are the result.

\[ \begin{array}{ccc}
\text{ABCDEF} \\
\text{ABCD}EF \\
\text{ABCD}EF \\
\text{FEODC}REF \\
\end{array} \]
17. (4) Match the terms with the correct summation of prokaryotic regulation modes. It is possible to use a summation more than one time.

A  Positive  a) Concentration of trigger determines if there is initiation of transcriptions
B  Inducible  b) High Concentration of the trigger allows for production of the protein
D  Negative  c) Low Concentration of the trigger allows for production of the protein.
C  Repressive  d) Physical blockage of transcription.

18. (6) We are interested in increasing the yield of **Broccoli**. For this, we will be using a mass selection scheme. The following diagram shows the basics for mass selection.

![Diagram showing mass selection process]

a) **Circle** the letter that best represents the **TRUNCATION SELECTION POINT**.
   A B C D E F G H

b) **Circle** the letter that best represents the **SELECTION DIFFERENTIAL**.
   A B C D E F G H

19. (5) Fill in the number of the term **best** described by each phrase. Each number is used at most once.

<table>
<thead>
<tr>
<th></th>
<th>allopolyploid</th>
<th>7</th>
<th>inversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>aneuploid</td>
<td>8</td>
<td>Klinefelter Syndrome</td>
</tr>
<tr>
<td>2</td>
<td>autopolyploid</td>
<td>9</td>
<td>molecular hybridization</td>
</tr>
<tr>
<td>3</td>
<td>endosymbiont theory</td>
<td>10</td>
<td>testicular feminization</td>
</tr>
<tr>
<td>4</td>
<td>gene deletion</td>
<td>11</td>
<td>translocation</td>
</tr>
<tr>
<td>5</td>
<td>gene duplication</td>
<td>12</td>
<td>Turner Syndrome</td>
</tr>
</tbody>
</table>

11
1
9
12

Cause of familial Down Syndrome (Robertsonian).
May not affect an individual who has this, but can affect their offspring if recombination occurs.
Mode of evolution of the β-globin genes.
Wheat, for example.
XO female.
20. (3) Consider the following Pedigree for an sickle cell anemia (an autosomal recessive trait). Assume **ALL** individuals coming into the pedigree are homozygous normal, unless there is evidence to the contrary. 

![Pedigree Diagram]

a) \[ \frac{1}{24} \] What is the chance that individual III-1 will have the disease?

b) Can this be a sex-linked trait?
   i) Yes
   ii) No
   iii) Not enough information to decide.

21. (9) The first two processes of the Central Dogma are Replication and Transcription.

1. Initiation by RNA polymerase.
2. Uses an RNA primer.
3. Uses Polymerase III
4. 5' to 3' elongation.
5. Enhancer Region.

For each part of the Central Dogma, circle **ALL** attributes that are true for that part. *Each attribute can be used more than one time.*

a) DNA Replication
   ![Circle Options]

b) Eukaryotic Transcription
   ![Circle Options]

c) Prokaryotic Transcription
   ![Circle Options]
22. (5) In Joyce Kilmer Woods, there is a species of peccaries that has been studied extensively. In the experiments designed to map the third chromosome, researchers did the usual F1, then the testcross. They raised and scored piglets from the testcross. The results of the experiment were:

<table>
<thead>
<tr>
<th>Tusk</th>
<th>Hair</th>
<th>Tail</th>
<th>Number Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra Long</td>
<td>Short</td>
<td>Normal</td>
<td>36</td>
</tr>
<tr>
<td>Normal</td>
<td>Normal</td>
<td>Bushy</td>
<td>40</td>
</tr>
<tr>
<td>Normal</td>
<td>Short</td>
<td>Normal</td>
<td>2</td>
</tr>
<tr>
<td>Extra Long</td>
<td>Normal</td>
<td>Bushy</td>
<td>3</td>
</tr>
<tr>
<td>Extra Long</td>
<td>Normal</td>
<td>Normal</td>
<td>912</td>
</tr>
<tr>
<td>Normal</td>
<td>Short</td>
<td>Bushy</td>
<td>831</td>
</tr>
<tr>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>83</td>
</tr>
<tr>
<td>Extra Long</td>
<td>Short</td>
<td>Bushy</td>
<td>93</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>2,000</strong></td>
</tr>
</tbody>
</table>

The order of the loci on the chromosome is known to be: ExLong  Normal  Normal

Use the order as given. What is the map distance between the Tail and Hair genes.

\[
\frac{34 + 7 + 40 + 3}{2000} = \frac{81}{2000} = .0405
\]

23. (1) My favorite topic from GN 411 this semester is ____________________________

24. (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.