GENETICS 310
EXAM 3
June 30, 2016

I. Which of the following enzymes or cloning tools would be used for the specific steps listed below? Put the code(s) provided in each blank as appropriate.

**RE**, restriction endonuclease, **RT**, reverse transcriptase **H**, RNAase H
**L**, DNA Ligase, **T** primer made of all Ts, **B**, beads with T tails,
**TdT** terminal deoxynucleotide transferase, **P**, DNA polymerase

a) cDNA clone preparation
   ___ B ____ Collecting eukaryotic mRNAs from ground tissue
   ___ RT ____ Making a cDNA copy of the messages
   **H**, **RT** or **P** ____ Replacing the RNA strand with a second strand of DNA
   ____ TdT ____ Adding A tails to the double stranded cDNAs

b) Shotgun cloning step
   ____ RE ____ Fragmenting donor DNA
   ____ L ____ Inserting fragments into a linearized pUC vector

II. Given the sequence below describe how you could make millions of copies in a short period of time. For simplicity, use arrows to indicate primers 1 and 2 that are just 7 bases long:

\[
5'\text{ACCGTCAACTGCAATGCGCGCTAGAATCGTTGCATGATGG}\ 3'
3'\text{TGGCAGTTGACGTTACGCGCGATCTTAGCAACGTACTACC}\ 5'
\]

**Name of process?** Polymerase Chain Reaction

**Enzyme used?** TAQ polymerase **Source?** Hot springs bacterium

III. Cross out the maize plants below that would not produce pollen based on their genotype (in the nucleus)/cytotype combinations?
IV. A) RB gene defects appear to be inherited as dominant, but not everyone who gets a defective copy develops retinoblastoma. **Tumor Suppressor**

2. What is the normal function of such genes? **Turn off cell division**

3. Why do some individuals with a defective RB gene escape getting retinoblastoma? *It requires a mutation in the remaining copy of a somatic cell*

B) The SRC gene was originally discovered to cause sarcomas in chickens following infection with Rous Sarcoma virus.

1. What type of gene is SRC in terms of cancer? **Oncogene**

2. What is the normal function of such genes? **Turn on cell division**

3. What general type of virus is RSV? **Retrovirus**

4. What is unusual about the RSV particles that cause sarcomas? *They carry an onc gene incorporated from a host genome*

5. How do we know that humans also have a SRC gene? 
   *DNA hybridization to the cloned chicken gene*

C) At least 3 DNA viruses are associated with increased risk of cancer in humans. List 2 of them.

   **Epstein Barr** & **Hepatitis B or HPV**

V. A) Check the following that are found in or as a part of eukaryotic but not prokaryotic chromosomes:

   _____DNA  _____RNA  X_____histones  _____lipids
   X_____centromeres  X_____teleomeres  _____mitomeres

B) Why do the chromosomes in a typical human karyotype appear doubled?

   *They are taken from cells trapped at metaphase of mitosis*
VI. Fill in **affected** individuals assuming a perfect segregation ratio for each trait:

- Mom is heterozygous for Duchene MD
- Dad is colorblind, mom is heterozygous
- Dad has a defect in one copy of the ‘Prader-Willi’ genes which should remain active in sperm
- Mom has MERRF, a mitochondrial defect
- Mom is heterozygous for complete androgen sensitivity (testicular feminization)
- What does affected mean in this case? **XY female**
- Mom is heterozygous for a dominant sex-linked gene

VII. Give an example of:

- A holandric gene **Sry = tdf, HY antigen**
- A visible consequence of the Lyon Hypothesis **calico cats**
- A sex-limited trait **lactation**
- A sex-influenced trait **horns in sheep, pattern baldness**
- A maternal effects trait **left/right coiling in snails**
- What force alters allele frequencies in small populations **drift (chance)**
VIII. Place the **letter or letters** of each of the following syndromes in all appropriate blanks:

<table>
<thead>
<tr>
<th>Syndrome</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) Angelman's</td>
<td>47 chromosomes, D, J, K, X</td>
</tr>
<tr>
<td>C) Cri-du-chat</td>
<td>Some IQ loss, A, C, D, J, K, (T), X</td>
</tr>
<tr>
<td>D) Down's</td>
<td>Female (always), T, X</td>
</tr>
<tr>
<td>J) Jacobs</td>
<td>Abnormal sex chromosome number, J, K, T, X</td>
</tr>
<tr>
<td>K) Klinefelter's</td>
<td>Normal fertility, J, X</td>
</tr>
<tr>
<td>T) Turner's</td>
<td>45 chromosomes, T</td>
</tr>
<tr>
<td>X) Triplo X</td>
<td>Genomic imprinting, A</td>
</tr>
<tr>
<td></td>
<td>Tall for family expectation, J, K</td>
</tr>
<tr>
<td></td>
<td>Deletion, C</td>
</tr>
</tbody>
</table>

IX. In cattle C_ animals are normal and cc develop cataracts. A DNA based polymorphism detected by PCR is just 4 map units from the cataracts gene. It's alleles are designated A35 or A50 for the size of the amplified product. Suppose a bull has the genotype

\[ C A35/c A50 \]

What fraction of the sperm he produces will have the following gene arrangements:

\[ C A35 \quad 48\% \quad C A50 \quad 2\% \quad c A35 \quad 2\% \quad c A50 \quad 48\% \]?

What genotype would be optimal in the cows if a rancher wanted to use PCR tests to cull calves with the cataracts c allele from his herd before they were allowed to reproduce?

\[ C A35/C A35 \]

X. a) Two factors are known to lead to significant increase in the risk of trisomy 21. What are they?

\[ \text{Aged mother} \quad \& \quad \text{Translocation of 21 to another} \]

b) 1. How are the seeds used to grow seedless watermelons produced?

\[ 4N \times 2N \text{ crosses} \]

b) 2. Why are they seedless?

\[ \text{Gametes will not have balanced sets of chromosomes and will not function} \]
c) 1. A mouse homozygous for the gene arrangement ‘A B C • D E’ is crossed to another with the arrangement ‘a b d • c e’
Capital and small letters are used just to aid in the following drawing. Show synopsis (with the genes labeled) in meiosis of the **F1 hybrid** between the two animals.

![Drawing of meiosis](image)

---

**c) 2.** What is the name of the chromosomal aberration? **Prericentric inversion**

**c) 3.** What % fertility is expected in the F1 males and females? **Males 50%** **females 50%**

---

**XI.** Although other genes may modify the actual colors, in many breeds of sheep white wool is dominant (W_) and black is recessive (ww). In a large random mating flock 16% of the lambs are black. What are the allele frequencies of W and w?

\[ P = f(W) = 0.6; \quad q = f(w) = 0.4 \]

What are the predicted genotypic frequencies in the flock?

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>WW</td>
<td>36</td>
</tr>
<tr>
<td>Ww</td>
<td>48</td>
</tr>
<tr>
<td>ww</td>
<td>16</td>
</tr>
</tbody>
</table>

Suppose the shepherd sold off all the black lambs born one year, and kept the rest to start a new flock. What ‘force’ would be involved in changing allele frequencies?

**Selection**

If there were 100 lambs and the black ones were sold, what will the W and w allele frequencies be in this new flock once they are gone?

\[ F(W) = \frac{(2 \times 36 + 48)}{168} \quad f(w) = 48/168 \]