Important note: This review was written by your Biology Peer Mentors (not the lab instructors)! It is designed to help you test yourself on topics and concepts covered in lab and should not in any way be considered a “preview” of the actual exam.

You are encouraged to attempt to complete this review without the lab manual, text book, your notes, or the internet. The peer mentors are available while you are working to help you with any questions that cause you difficulties.

Structured Study Session information
Mondays 3:00-4:20pm – Murray G3 (Mars)
Tuesdays 8:30-9:50am – Murray 102 (Cameron)
Tuesdays 2:30-3:50pm – Murray 145 (Amnah)
Wednesdays 10:00-11:20am – Murray G3 (Raphael)
Thursdays 4:30-5:50pm – Murray 102 (Justin)
Friday 1:30-2:50pm – Murray G3 (Tara)
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>No</td>
</tr>
<tr>
<td>2.</td>
<td>GD, Gd, gD, and gd</td>
</tr>
<tr>
<td>3.</td>
<td>Anaphase II</td>
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<tr>
<td>4.</td>
<td>Antheridium/Sperm</td>
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<td>5.</td>
<td>Archegonium/Egg/Ovum</td>
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<td>6.</td>
<td>Rhizoids</td>
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<tr>
<td>7.</td>
<td>Two X chromosomes</td>
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<tr>
<td>8.</td>
<td>Klinefelter Syndrome</td>
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<tr>
<td>9.</td>
<td>Lots</td>
</tr>
<tr>
<td>10.</td>
<td>Loop and Whorl</td>
</tr>
<tr>
<td>11.</td>
<td>Dermatoglyphics</td>
</tr>
<tr>
<td>12.</td>
<td>Haploid</td>
</tr>
<tr>
<td>13.</td>
<td>Restriction Fragment Analysis</td>
</tr>
<tr>
<td>14.</td>
<td>Gary</td>
</tr>
<tr>
<td>15.</td>
<td>Dad 3, because he is the only one who could be the source of DNA fragments that the child has that the mother does not.</td>
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Short Answer

1. Fill in the blanks

   a. In ferns, cells inside the ___sporangia_________ undergo meiosis to produce __spores_______

   b. The fern gametophyte can also be called a __prothallus________.

   c. In animals two haploid cells called __gametes______ combine together to form a diploid cell called a _zygote________ in the process known as ___fertilization______.

   d. Crossing over occurs during _Prophase 1______ of meiosis and the region where this occurs is called the _Chiasma____.

   e. Female mice produce gametes called __eggs___ in their _ovaries___ and male mice produce gametes called __sperm____ in their _testes____.

2. White Heifer Disease is a congenital reproductive abnormality in white female offspring (heifers) in certain breeds of cattle, such as Belgian Blue and Shorthorn. WHD is actually the result of two genes- white fur color is inherited as an autosomal recessive trait (h), which is linked with an autosomal recessive gene that causes defects in the female reproductive tract (r).

   a. Draw a Punnett square for a cow heterozygous for both traits being bred to a bull that is also heterozygous for both. Assume no crossing over occurs.

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<tbody>
<tr>
<td>HR</td>
<td>HHRR</td>
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<tr>
<td>hr</td>
<td>HhRr</td>
<td>hhrr</td>
</tr>
</tbody>
</table>

   b. What is the genotypic frequency of this cross?

   0.5 HhRr, 0.25 HHRR, 0.25 hhrr

   c. If the heterozygous bull and the heterozygous cow had only female offspring what proportion would have normal reproductive systems?

   75%
d. University of Saskatchewan geneticists discovered that the genes for coat color and reproductive system are 1 map unit apart. If 200 heterozygous cows were bred to a homozygous recessive bull, how many calves would have white coats and normal reproductive systems? Assume that all offspring are female, and that each cow has only one calf.

<table>
<thead>
<tr>
<th>Parental</th>
<th>Recombinant</th>
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<tbody>
<tr>
<td>HR</td>
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<tr>
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<td>HhRr</td>
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<tr>
<td>hhrr</td>
<td>HhRr</td>
</tr>
<tr>
<td>49.5</td>
<td>49.5</td>
</tr>
<tr>
<td>0.5</td>
<td>0.5</td>
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</tbody>
</table>

1 calf would have a white coat and normal reproductive system.

e. Draw a chromosome diagram for a cell of the bull in Anaphase I of Meiosis. Assume that no crossing over occurs.

3. Another genetic disease affecting Belgian Blue cattle is double muscling. It is caused by a single gene mutation that reduces or eliminates the activity of the myostatin protein.

Use D to represent the allele responsible for the normal phenotype and d to represent the allele leading to the double muscling phenotype.

A Belgian Blue breeder kept track of her heard using a pedigree chart.

```
Normal Female             Double Muscled Female             Normal Male             Double Muscled Male
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a. Based on the pedigree, is this likely a sex-linked trait? No

b. Give the genotypes for each of the following individuals:

1. Dd
2. Dd
3. DD
4. Dd
5. Dd
6. dd
7. dd
8. dd
9. dd
10. DD

c. What proportion of the offspring in the third generation are heterozygous? 75%
4. In domestic cats, an orange coat color is caused by an X-linked gene that is dominant to a black coat colour.

   a. An orange female cat had a litter of 9 kittens: 5 orange females, 2 orange males, and 2 black males. What is the genotype of the mother cat?

      \[ X^A X^a \]

   b. You have two male cats that could have sired this litter of kittens. One is orange and one is black. Is it possible to tell which one of these cats is the father based on the phenotypes of the kittens? If so, which was most likely the sire?

      Yes, the Orange male is most likely the father

5. Domestic cats can have very unique phenotypes. One such phenotype is heterochromia; that is when the cat’s eyes are two different colors. Another unique phenotype that can occur in cats is called polydactyly; that means that the cat has an extra digit on each of its paws.

   A female cat that was homozygous normal for both traits had a litter of kittens sired by a male cat that was homozygous for both polydactyly and heterochromia. All of the cats in the litter had eyes that were different colors and extra digits.

   a. Is the gene for polydactyly X-linked or autosomal? Autosomal

      Is the gene for heterochromia X-linked or autosomal? Autosomal

   b. Is the allele for polydactyly dominant or recessive? Dominant

      Is the allele for heterochromia dominant or recessive? Dominant

Mittens was a polydactyl cat with heterochromia. Her mother was a normal cat in regards to both eye color and number of digits. Mittens had kittens with a cat named Boots, who had the normal number of digits and eyes of the same color.

   c. What is Boots’ genotype? \( aabb \)

   d. What is the genotype of Mittens’ mother? \( aabb \)

   e. What is Mittens’ genotype? \( AaBb \)

   f. If the genes for polydactyl and heterochromia are 16.667 map units apart and Mittens and Boots have two litters for a total of 24 kittens, what is the phenotypic ratio of their offspring?

      4.6 polydactyl, heterochromia: 4.6 normal: 1 polydactyl, normal eye: 1 normal digit, heterochromia

   g. Draw a chromosome diagram for Mittens’ cell in Telophase II of Meiosis. Assume no crossing over has occurred.

\[ \text{Diagram of chromosome diagram} \]
6. Circle the material best suited for DNA extraction and explain why:
   Urine    Hair    Red Blood Cells
   Urine: hair must have a follicle, and red blood cells lack nuclei

7. What role do these solutions have in the DNA extraction you performed:
   a. Sports drink – keeps cells intact because it is isotonic to the cheek cell’s environment
   b. Detergent – cell lysis, disrupts the lipid and protein bonds that make the membranes, releasing the DNA
   c. 70% ethanol – DNA is insoluble in alcohol and will therefore precipitate in the ethanol

8. What does PCR stand for?
   polymerase chain reaction

9. What are the four ingredients required for PCR?
   i. _____________________________
   ii. _____________________________
   iii. _____________________________
   iv. _____________________________
   DNA extract, the four dNTPs, primers, DNA/Taq polymerase

10. Describe the three steps in the PCR cycle:
    a. DNA denaturation: heat to split the DNA double strand
    ____________________________________________________________
    b. anneal primers/primer binding to the single DNA strands
    ____________________________________________________________
    c. extend primers/DNA synthesis by Taq polymerase, which adds dNTPs to the primers
    ____________________________________________________________
11. What does *Taq polymerase* do?

   adds dNTPs to the primers, extends the new DNA strand

12. What is a *thermal cycler*?

   used in PCR, manipulates the temperature of the solution

13. *EcoRI* is a type of *restriction enzyme* and recognizes/cuts the DNA sequence: GAATTC.

14. What is gel electrophoresis?

   a process that uses the negative charge of DNA and a fibrous gel to separate restriction fragments/DNA based on size

15. Gels are made of *agrose* which is a polysaccharide derived from *algae/seaweed*

16. DNA is *negatively* charged, because of its *phosphate* backbone, which means that DNA will migrate towards the *positive* electrode.

17. smaller fragments travel farther than larger fragments.

18. Which stain can be visualized under white light? *Fast Blast™*. Which stain can only be visualized under UV light? *ethidium bromide*

19. What is the purpose of the “ladder” in gel electrophoresis?

   Contains DNA fragments of known size and allows us to estimate the size of our unknown DNA fragments
20. Use the following gel to put the sample numbers in order from smallest fragment to largest.
   1, 3, 2, 4

   Ladder          1     2     3     4

   21. According to the gel below, who is the father of the child based on this stained gel? How do you know?
   2, expresses the bands that the child has, that the mother does not

   Ladder   Mother   Child   1    2

   [Image of gel with bands]