Did you view the tutorial video?  Yes  No
Seat Number _____

NAME__________________________  Student ID__________________

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 on each page now!!

You may need the following section of the Chi-square table for p=0.05.

<table>
<thead>
<tr>
<th>d.f.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>3.84</td>
<td>5.99</td>
<td>7.82</td>
<td>9.49</td>
<td>11.07</td>
<td>12.59</td>
<td>14.07</td>
<td>15.51</td>
<td>16.92</td>
<td>18.31</td>
<td>19.68</td>
</tr>
</tbody>
</table>

You may also need this table:

- Proportion Selected (p) 0.5 0.25 0.1 0.05 0.01
- Selection Intensity (I) 0.8 1.27 1.76 2.06 2.67
- Standardized Selection Point (Z) 0 0.67 1.28 1.65 2.33

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

a) Briefly Describe why the following statement is false concerning heritability.

If a trait has different heritabilities in two separate populations, then the difference must be due to genetic differences between the populations.

Heritability includes both genetic and environmental variation. They could be different due to different V(G) or different V(E), or both.

b) Consider a Reciprocal Translocation. Describe

i) The possible effects on an individual who has that translocation (the genetic origin of those effects)

Two possible effects: The genes at the break points may also be broken. 2) The regulatory context may be wrong for some genes

ii) The possible effects on the offspring of an individual who is a heterozygote for the inversion

Same as the parents; or possibly partial trisomies and partial monosomies.

c) Last Friday, we discussed chromosome mutations and evolution. In a sentence (or two, at most) give the basic principle that allows for Inversions to lead to Reproductive Isolation.

If populations are homozygous for an inversion, then the offspring of hybrids (crosses of that population with the original) will more likely have chromosomal defects.

This reduced fitness brings about reproductive isolation.
2. (15) We are interested in whether or not a certain gene in a population has Hardy-Weinberg Proportions. A survey of the population revealed the following numbers for each genotype:

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Observed Number</th>
<th>Expected Number</th>
<th>Chi-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>FF</td>
<td>389</td>
<td>384.03</td>
<td>X</td>
</tr>
<tr>
<td>FS</td>
<td>126</td>
<td>135.94</td>
<td>X</td>
</tr>
<tr>
<td>SS</td>
<td>17</td>
<td>12.03</td>
<td>X</td>
</tr>
<tr>
<td>Total</td>
<td>532</td>
<td>532</td>
<td>2.84</td>
</tr>
</tbody>
</table>

a) What are the observed allele frequencies: \[ \begin{align*} &0.969\text{F} &0.031\text{S} \end{align*} \]

b) Complete the Chi-Square table except for the X’s.

c) How many degrees of freedom for this experiment? \[ 1 \]

d) State your conclusion from this experiment (the genetic conclusion).

The data are consistent with this population having Hardy-Weinberg proportions for this gene.

3. (12) An individual is heterozygous for an inversion as diagrammed below:

Normal Chromosome

| A | B | C | D | E | F | G |

Inverted Chromosome

| A | D | C | B | E | F | G |

a) This inversion is Pericentric Paracentric

b) Give the four chromatids that result when there is crossing over between C and D.

\[ \begin{align*} &ABC\text{EFG} &ABC\text{OCA} \\
&\text{ADCGEFG} &\text{OFCDEBG} \end{align*} \]
6. (8) Match the population genetics/evolutionary term or phrase with the description or example. Each number is used at most once.

1) Assortative Mating
2) Random Drift
3) Stabilizing Selection
4) Gene Duplication
5) Founder Effect
6) Directional Selection
7) Inbreeding

Possible origin of new genes

Caused by individuals mating others with similar phenotypes

Sickle Cell Anemia, for example

Causes the increase in appearance of deleterious recessive genes without increasing allele frequencies.

7. (10) Match the chromosomal structure with the description that best fits. Chromosomal structures can be used more than one time.

1) aneuploidy
2) centromere
3) duplication
4) euploidy
5) inversion
6) transposition
7) fusion
8) synaptonemal complex
9) telomere
10) translocation

The result of DNA moving to another part of the same chromosome.

Recombination among nonhomologous chromosomes.

Directs the separation of chromatids during meiosis or mitosis.

Trisomy, for example.

Result of unequal crossing over.

8. (4) Each of the following statements concerning heritability are true EXCEPT ONE. Circle the statement that is not true. Carefully read each statement before choosing.

a) Heritability measures the degree that variation in phenotypes can be attributed to variation in genotypes.

b) If a trait has a high heritability, then a selective breeding program may be effective.

c) If a trait has a low heritability, then there is large environmental variation in that population compared to genetic variation.

d) If a trait has a high heritability and two populations with a common environment have vastly different phenotypes, then the difference between those populations will be largely genetic.

d) The difference between two populations with vastly different environments will never be genetic.
4. We are interested in increasing the feed efficiency of Guinea Pigs. We know that feed efficiency for our variety of Guinea Pigs is normally distributed with a mean of 0.31 and a standard deviation of 0.03. From similar experiments on our pig ranch, we have found that the heritability in the broad sense for feed efficiency is 0.75, and heritability in the narrow sense is 0.30. We hope to increase feed efficiency by a mass selection scheme. We will select the top 1% of the population.

a) What is the Selection Differential?
   \[ S_D = \frac{I}{\sigma} \]
   \[ \sigma = 0.03 \]
   \[ I = 2.67 \]

b) What is the Selection Response?
   \[ S_R = h^2 I \sigma \]
   \[ h^2 = 0.75 \]
   \[ \sigma = 0.03 \]
   \[ M = 0.30 \]

c) What is the expected mean efficiency of the offspring generation (progeny of the selection individuals)?
   \[ M + h^2 I \sigma \]

5. Consider a plant population with the following genotypic frequencies:
   0.1764 AA + 0.4872 Aa + 0.3364 aa

a) Give the allelic frequencies.
   \[ A = 0.42 \]
   \[ a = 0.58 \]

b) This population is undergoing mutation. The mutation rate from A to a is \( 1 \times 10^{-4} \) and from a to A is \( 3.0 \times 10^{-5} \). Calculate the allele frequency for A after one generation.
   \[ A = 0.109759 \]
   \[ (1 - 1 \times 10^{-9}) \cdot 0.42 + 3 \times 10^{-9} \cdot 0.58 \]

c) Consider the original population in a). Assume that AA has a fitness of 1.0, Aa has a fitness of 0.7 and aa is lethal. Compute the allele frequency of A for the next generation.
   \[ A = \frac{AA + Aa}{AA + Aa + aa} \]
   \[ = \frac{1.1764 + 0.4872 + 0.3364}{1.1764 + 0.3364 + 1.68 \times 10^{-2} + 0} \]
   \[ = 0.64909 + 0.64909 \]

You may need to use some of these equations:
\[ p^2W_{AA} + 2pqW_{Aa} + q^2W_{aa} \]
\[ p^2 + Fpq \]
\[ (1-m)p + mP \]
\[ (1-\mu)p + v(1-p) \]
\[ 2(1-F)pq \]
\[ q^2 + Fpq \]
9. For the Valle Grande Lava Viper, we have determined that the following traits are located on the same chromosome, and have the given map:

<table>
<thead>
<tr>
<th>Body Length</th>
<th>Skin</th>
<th>Coloring</th>
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</thead>
<tbody>
<tr>
<td>Long</td>
<td>Smooth</td>
<td>Tan</td>
</tr>
<tr>
<td>Short</td>
<td>Scaly</td>
<td>Black</td>
</tr>
</tbody>
</table>

<p>| | |</p>
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<tr>
<td>5</td>
<td>7</td>
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</table>

Dominant
Recessive

C = 0.8

A homozygous individual with a Long Body, Scaly Skin, and Tan Coloring is mated with a homozygous individual with a Short Body, Smooth Skin, and Black Coloring to form the F1 generation, which are then test crossed. Give the expected frequencies among the test cross offspring.

\[DCO = (0.5 \times 0.7)^2\]
\[= 0.24025\]

\[= 0.028\]

\[\frac{1}{2} \times (0.05 - 0.028)\]

\[\frac{1}{2} \times (1 - 0.05)\]

\[\frac{1}{2} \times (0.07)\]

10. (EXTRA CREDIT) **Black & White** Give the color of the puppy in the video.