

PLSC 431/631

**Intermediate Genetics
Final Exam - 2002**

"Upon my honor, I have neither given nor received aid in writing this exam."

Name _____

1. For full credit, circle all of the correct answers. (2 pt each)

Mendel introduced which of the following innovations to the field of genetics?

- a. developed pure lines prior to genetic analysis
- b. analyzed the inheritance of plants
- c. counted phenotypes and kept detailed statistical results
- d. observed unique phenotypes

The most common type of interaction between alleles at a gene is:

- a. codominance
- b. epistasis
- c. dominance
- d. lethal

Applications of Mendel's first law allow us to predict

- a. the nature of mutations in specific genes
- b. the effect of promoter mutations
- c. dominant, recessive and codominant allelic interactions
- d. the distribution of alleles among gametes

Applications of Mendel's second law allows us to explain

- a. PCR and RFLP patterns
- b. epistatic interactions
- c. genetic linkage maps
- d. the inheritance of two genes in an individual

In a segregating population, a DNA marker cosegregates with a gene 98% of the time? What is the distance between the marker and the gene?

- a. 0.2 cM
- b. 2 cM
- c. 20 cM
- d. 200 cM

If the F_1 s from corresponding reciprocal crosses do not have the same phenotypic expression, what type of genetic effects may be controlling the phenotype?

- a. dominant inheritance
- b. pleiotropy
- c. maternal inheritance
- d. maternal effect

Your F₂ generation from a cross of two homozygous individuals segregates in a 15:1 ratio. This indicates:

- a. recessive repression
- b. duplicate genes
- c. complementary gene action
- d. epistasis

Speciation within a population is minimized by what factor(s)?

- a. genetic drift
- b. migration
- c. mutation
- d. selection

For globular trichomes in soybean, $V_p=200$ and $h=0.2$. From this data, what quantitative genetic parameter can you estimate?

- a. V_G
- b. V_A
- c. V_E
- d. V_{GE}

Transposons in humans:

- a. are ancient
- b. are a minor component of the genome
- c. exhibit clustering
- d. are primarily related to retrotransposon elements

The ____ gene distinguishes retrotransposons from cancer-causing retroviruses.

- a. *gag*
- b. *onc*
- c. *env*
- d. *pol*

What distinguishes McClintock's *Ac/Ds* transposable elements and yeast *Ty* elements?

- a. mode of replication
- b. mode of transposition
- c. mode of transcription
- d. mode of translation

Of the following statements, which is (are) not a tenet of Darwin's theory of evolution by natural selection?

- a. Heritable phenotypic variation must exist within the population.
- b. Over evolutionary time, evolution occurs by small cumulative changes
- c. Within a population, the number of offspring produced each generation exceeds the carrying capacity of the environment.
- d. For speciation to occur, individuals within a population must become reproductively isolated.

A new mutation can be:

- a. dominant
- b. recessive
- c. neutral
- d. lethal

Generally, a gain-of-function mutation is:

- a. incompletely dominant
- b. dominant
- c. recessive
- d. non-existent

A loss-of-function mutation can be:

- a. incompletely dominant
- b. dominant
- c. recessive
- d. spontaneous

Two new recessive mutations are discovered. The F_1 from the cross of these two mutants exhibits the wild type phenotype. The two mutations:

- a. are alleles of same gene
- b. are found in two different genes
- c. may exhibit complementary gene action in the F_2
- d. may exhibit duplicate gene action in the F_2

What term best describes cloning a gene by first developing molecular markers tightly linked to the gene?

- a. detailed genetic analysis
- b. cDNA cloning
- c. positional cloning
- d. genomic DNA cloning

A gene is only expressed during the seedling stage of a plant in its root tissue. This gene is expressed in what manner(s)?

- a. constitutive
- b. spatial
- c. repressed
- d. temporal

Of the following molecular events, which is the most critical for phenotypic expression?

- a. the development of a replication apparatus
- b. the availability of a DNA template and a 5'-OH group
- c. the binding of the RNA polymerase complex to the promoter
- d. the excision of introns from the primary transcript

The molecule that binds to a repressor to activate a bacterial operon is called a(n):

- a. ligand
- b. effector molecule
- c. trans-acting factor
- d. operator

In the lac operon, catabolite repression operates through the interaction of what molecules?

- a. lactose and the repressor
- b. RNA polymerase and the promoter
- c. CAP and cAMP
- d. permease and beta-galactosidase

A repressible systems

- a. involves the interaction of the repressor and the effector molecule to shut down gene expression
- b. involves the interaction of the repressor and the effector molecule to turn on gene expression
- c. is exemplified by the *trp* operon of *E. coli*
- d. is exemplified by the *lac* operon of *E. coli*

Which of the following is(are) not required for transcription?

- a. phenotype
- b. dominant gene
- c. cis-acting sequences
- d. trans acting factors

What conserved sequence is first bound when the RNA polymerase complex is being built?

- a. GC box
- b. poly-A tail
- c. CAAT box
- d. TATA box

Cis-acting elements are bound by:

- a. steroids
- b. RNA polymerase complex
- c. the TATA box
- d. trans-acting factors

Which type of molecule(s) can act as a component of a signal transduction pathway.

- a. kinase
- b. steroid
- c. hormone receptor protein
- d. G-protein

Cancer tumor suppressor genes are generally:

- a. dominant
- b. co-dominant
- c. recessive
- d. lethal

What pair of molecules are primary factors in the transition between the different stages of the cell cycle?

- a. glucocorticoid and the glucocorticoid receptor
- b. cyclin and cyclin dependent kinase
- c. GTP and the Ras protein
- d. epidermal growth factor (EGF) and EGF receptor

Phosphorylation is a key event involved in:

- a. activating membrane receptor kinases
- b. nuclear breakdown during mitosis
- c. activating the *lac* operon
- d. activating transcription factors

2. Draw the Central Dogma of Molecular Genetics. Include in your drawing: 1) the molecules involved; 2) the names of the different steps; and 3) arrows showing the flow of information from DNA to phenotype. (10 pt)

3. Partial diploids for the *lac* operon genes were constructed in *E. coli*. Are the following **constitutive**, **repressed**, or **inducible**. (3 pts each)

a. $\frac{I^- P^+ O^+ Z^+ Y^+ A^+}{I^+ P^+ O^+ Z^+ Y^+ A^+}$ _____

b. $\frac{I^- P^+ O^+ Z^+ Y^+ A^+}{I^s P^+ O^+ Z^+ Y^+ A^+}$ _____

c. $\frac{I^s P^- O^+ Z^+ Y^+ A^+}{I^+ P^+ O^c Z^+ Y^+ A^+}$ _____

d. $\frac{I^- P^+ O^+ Z^+ Y^+ A^+}{I^- P^+ O^+ Z^+ Y^+ A^+}$ _____

e. $\frac{I^- P^+ O^+ Z^+ Y^+ A^+}{I^- P^+ O^+ Z^+ Y^+ A^+}$ _____

The following essays require complete sentences. If you present a drawing, you must refer to it in your narrative. The length of the essay should correspond to the point value of the question.

4. As you are aware, photosynthesis occurs in the chloroplast organelle. You discover a mutant in the photosynthesis process. Describe experiments you would perform to determine if the mutant is controlled by genes found on the chloroplast or nuclear DNA? Design an experiment that would allow you to distinguish between the two possibilities? Which results would lead you to conclude that the gene is inherited as an organelle gene? As a nuclear gene? (10 pts)

5. You wrote a paper that describes a gene that was cloned by positional cloning. Describe the disease, the gene and its protein product. What is the nature of the mutation that causes the disease. (10 points)

6. What are the differences between gene expression pathways where a steroid or a protein is the primary ligand necessary to activate gene expression. A portion of your discussion should specifically address why and how one of these control mechanisms utilizes a signal transduction pathway (15 pts).

6. Parkinson's disease is second only to Alzheimer's disease as a neurodegenerative disease. Scientists used molecular markers to place the gene within a YAC contig and found the gene for alpha-synuclein within this region. They noticed a sequence difference in a mutant allele that, in comparison to the normal allele, was diagnostic by digestion of a PCR product with the *Tsp45I* restriction enzyme. They screened a population segregating for the disease by digesting the PCR fragment with the enzyme. The results of the analysis for a portion of two populations are shown in the figure below. Filled symbols represent affected individuals. Numerical identifiers denote the individual of the pedigree immediately above. Why did the researchers using PCR/RFLP approach rather than a simple RFLP analysis? What molecular allele is associated with the disease? How did you make this decision? Is Parkinson's disease a dominant or recessive trait? How did you come to that conclusion? Is there evidence of recombination in this pedigree? How did you come to this conclusion. Provide a possible explanation for any lack of total linkage between the disease and the marker. (30 points)

