FlinnPREP™ for Practice Exam 1
Untimed Free Response

1. Domestic chickens and their ancestral species, the Red Junglefowl, were the subject of an investigation to determine what genes are responsible for egg production. Population III was derived by crossing individuals from population I and population II.

Over time, domestic chickens have been artificially selected to increase the clutch size and size of eggs. This study found that when selecting for the phenotypes of larger egg size and clutch size, many associated traits were selected for as well. These include higher calcium content in the bones and differences in hypothalamus activity.

Clutch Size of Red Junglefowl, Domestic White Leghorns & Hybrids

Population	1	2	3	4	5	6	7	8	9	10	11	12	Mean	SEM
Red Jungle Fowl	4	5	4	6	7	5	5	6	4	5	6	5	5	0.3
Domestic White Leghorns	10	9	11	9	10	9	11	12	11	10	10	11	10	0.3
Hybrids	4	4	7	6	10	8	9	6	9	7	10	6	7	0.6

Table 1. Clutch size of Red Junglefowl, Domestic White Leghorns and Hybrids.

a. Construct an appropriately labeled graph showing the sample mean of each of the three populations to within 95% confidence (±2 SEM). (3 pts)

b. Analyze the data and determine which populations likely have statistically significant differences in clutch size. Justify your response with evidence from the data. (2 pts)

c. Egg shells are made primarily from calcium carbonate with the calcium coming from bones. Predict which population would have the greatest frequency of genotypes associated with high calcium content in their bones. (1 pt)

d. When chickens sit on a clutch of eggs, rather than having the eggs removed each day, they often stop laying eggs and incubate the clutch. This is called brooding. Describe two possible gene regulation mechanisms that may stop egg production and/or induce brooding. (2 pts)

e. Explain one way that non-Mendelian traits like clutch size are inherited. (1 pt)

2. In a water potential investigation, cylinders of crosne (a type of tuber plant) are placed in sucrose solutions of various concentrations in order to determine the water potential of the crosne. Each cylinder of crosne has a 0.3-cm radius and a 2.0-cm height. The lab was conducted at a constant temperature of 20°C in an open beaker.

Concentration	Crosne	
	Initial Mass (g)	Final Mass (g)
0.2 M	2.30	2.41
0.4 M	2.41	2.39
0.6 M	2.38	1.97
0.8 M	2.34	1.84
1.0 M	2.33	1.81

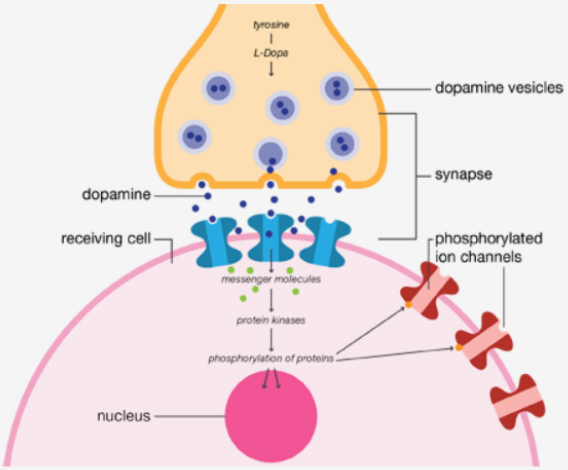
a. Draw a diagram showing the net direction of water and sucrose movement across the membrane of the crosne when placed in a 0.8 M sucrose solution. (1 pt)

b. Based on the data above, calculate the water potential of the crosne. (1 pt)

c. A second experiment using the same conditions as the crosne experiment was conducted using a sweet potato. A literature search shows that a sweet potato has a water potential of –19.5 bars. Calculate the sucrose concentration that would result in the smallest change in mass of the sweet potato. (1 pt)

d. Explain how the structure of the cell membrane affects the movement of sucrose and water to maintain homeostasis. (1 pt)

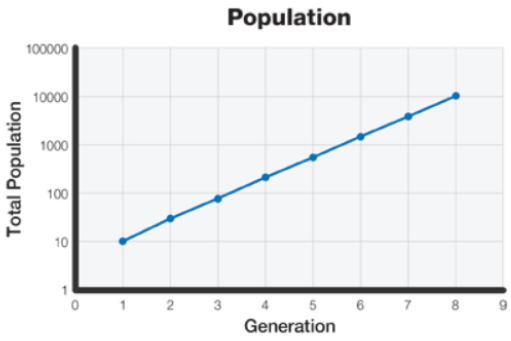
3. The 2000 Nobel Prize in Medicine was shared by three individuals for their research explaining how dopamine works as a neurotransmitter. Dopamine is important in controlling movement and is also responsible for the feeling of euphoria when something pleasurable happens. The figure below shows a neuron acting on a receiving cell by releasing dopamine.



Identify the first step in the signal transduction pathway of the receiving cell.

If dopamine is not broken down after it is released into the synapse, predict the effect dopamine will have on the individual and justify your prediction.

4.



The graph shows the population size starting at the beginning of generation one. Use this information to address the following.

Calculate the average growth rate of this population from generation one to generation three. (1 pt)

Describe the type of growth pattern seen in the graph. (1 pt)

Describe one environmental condition that could lead to this population change. (1 pt)

5. The cheetah is a large predator that is currently listed as Vulnerable on the ICUN Red List of Threatened Species, indicating it is at threat of global extinction. While the total number of wild cheetahs is in the thousands, the genetic diversity of cheetahs is extremely low. Evidence from a study of the genomes of seven cheetahs from two different subspecies-three in Tanzania, representing the East African subspecies and four in Namibia, representing the South African subspecies-supports the claim of low genetic diversity. Some of the specific evidence is outlined below:

I. Compared to domestic cats, tigers, lions and domestic dogs, cheetah DNA contained, on average, 90% fewer instances of single nucleotide variations.

II. 290 genes responsible for the majority histocompatibility complex (MHC) exhibited a 95% reduction in single nucleotide variations compared to cats, humans and dogs. MHC genes are under extreme selective pressure, and this leads to high genetic variation in most mammal species.

III. Cheetahs experience a higher than average rate of juvenile mortality.

IV. Unrelated cheetahs accept each other's skin grafts without reject.

A. Describe two different mechanisms that lead to reduced genetic variation in a gene pool. (2 pts)

B. Predict one way that the genetic variation of cheetahs may be different if populations of cheetahs lived in social groups rather than being solitary and territorial; justify the prediction. (2 pt)

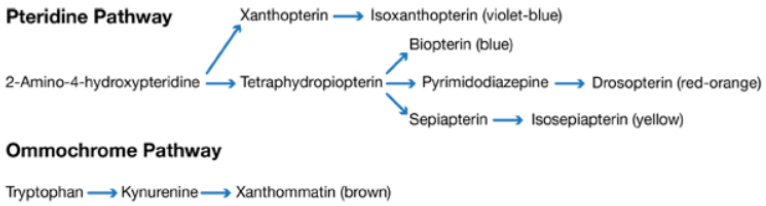
C. Describe one core conserved property of life and explain how it enables scientists to compare the genetic diversity of different species to one another. (2 pts)

D. Explain the role of the MHC (major histocompatibility complex) in mammals and describe how reduced genetic variation in the MHC would impact the immunity of the cheetah population. Explain how this is related to the cheetah's acceptance of skin grafts from unrelated cheetah. (3 pts)

E. About 100,000 years ago, the common ancestor of cheetahs and pumas migrated long distances, from modern-day North America and Europe to Africa and South America.

Predict the change in the environment that instigated this migration. (1 pt)

6. Wild-type *Drosophila melanogaster* have brick-red eyes. The brick-red eye color is the product of two biochemical pathways—the ommochrome pathway and the pteridine pathway. The ommochrome pathway produces brown pigments and the pteridine pathway contributes to red, yellow and blue pigments. Each pathway consists of several steps, which are shown below. The variety of eye colors seen in *D. melanogaster* is the result of genetic mutations that affect proteins involved in either pathway. The following diagrams are simplified versions of the two pigment pathways. Note the intermediary proteins, the enzymes (represented by arrows), and the resulting pigments.



a. Identify which protein would need to be mutated to produce only brown-eyed *D. melanogaster* Justify your choice. (2 pts maximum)

b. Describe what happens at the protein-level when no eye pigments are produced. (1 pt)

c. The genes for pigmentation are highly conserved in animals, including the pteridine pathway. A recent study found that female guppies preferred a shade of orange when choosing a mate. Assuming the pigments and pathways were conserved, identify which pigment(s) are likely present in the preferred male guppies? (1 pt)

Finished