MIDTERM EXAM I
VERSION A

Biology 201
University of British Columbia Okanagan
30 January 2019

Name_____

Student Number _____

READ CAREFULLY.
Some questions have multiple parts.

YOU HAVE
VERSION A

There are a total of 40 points

This exam is in two parts.

Part I. Multiple Choice. Circle the phrase that best answers the posed question (1 mark each, 12 marks total).

1. Darwin is identified with the entire concept of Evolution, even though Darwin was by no means the first person to suggest that evolution is responsible for the diversity of organisms now present. Why is Charles Darwin so indelibly associated with the concept of evolution?

a. he was famous
b. he discovered Darwin's finches and used them to show that evolution was happening
c. he argued a lot with Anglican bishops
d. he came up with a testable explanation for how evolution could occur.
e. he took a long trip to the Galapagos Islands

2. For natural selection to occur, a population must have (in no particular order) 1. Heritable (genetic) variation, 2. Survival or reproductive success that is non-random with respect to variation, 3. Variation in expressed phenotypes and

a. no immigration can be going on
b. males and females must be present
c. no inbreeding can be happening
d. there has to be some variation in success
e. all of the above

3. The CCR5- Delta 32 allele (which confers resistance to homozygotes to HIV infection is not predicted to spread particularly fast under natural selection in sub-Saharan Africa This is because:

a. not many people have HIV in Africa
b. the allele only helps people of Scandinavian descent
c. the allele is very rare in sub-Saharan Africa
d. HIV is not a concern anymore
e. all of the above

4. Angus Bateman provided us with an evolutionary explanation for sexual selection. The experiment that Bateman performed involved...

a. comparing the mating success of males with different tail lengths
b. counting the number of offspring produced by both males and females exposed to increasing numbers of mates
c. looking at the effect of skin colour on mating success
d. demonstrating the value of having a good territory
e. all of the above

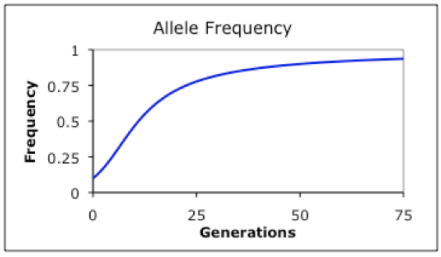
5. In the early days of the AIDS epidemic, AZT was considered to be a promising treatment for individuals infected with HIV. However, this treatment quickly became ineffective. Why?

a. the virus' reverse transcriptase generated a lot of heritable errors which allowed natural selection for resistance to proceed quickly
b. AZT only disrupted one stage of the life cycle, the attachment of the virion to the host cell
c. drug companies charged too much for cash-strapped HIV sufferers to afford treatment
d. HIV sufferers adapted to the drug and started to quickly metabolize the AZT, reducing its therapeutic value
e. all of the above

6. The distinction between migration and dispersal is

a. migration occurs only in the spring and fall
b. dispersal is done by plants and fungi, migration is done by animals
c. migration is to move away from a point with no intent to return
d. in migration the complete process involves an eventual return to the point of departure

7. Examine the plot below showing change in an allele's frequency under natural selection. What can you say about how this allele is expressed? How can you tell?



a. Dominant, because it does not go to fixation
b. Recessive, because it does not go to fixation
c. Quantitative, because its frequency increases quickly and it does not go to fixation.
d. Highest fitness is for homozygotes, because the contrasting allele does not go extinct
e. Recessive, because it is weakly favoured

8. In terms of dispersal, many invasive species like the zebra mussel show the following pattern

a. jump dispersal using humans
b. jump dispersal using humans and then secular dispersal across new terrain
c. secular dispersion using humans and then diffusion across new terrain
d. jump dispersal using humans and then diffusion across new terrain

9. A critical feature that allows plants to be 'shade adapted' is:

a. lower saturation point
b. lower rate of respiration
c. lower compensation point
d. lower rate of photosynthesis

10. Octopus eyes and Human eyes are structurally quite similar but are 'wired' very differently. In Octopi, the sensory neurons attach at the back of the retina, while in Humans the sensory neurons attach to retina cells at the front and consequently partially degrade the image. Evolutionary biologists hypothesize that this is because eyes with lenses evolved separately in octopods and humans from ancestors that did not possess camera eyes. Which of the following statements best applies to this scenario?

a. natural selection can 'plan ahead'
b. natural selection does not operate for the 'good of the species'
c. natural selection does not 'lead to perfection'
d. natural selection will often have a predetermined goal, but can achieve that goal using any of a variety of routes
e. a,c,&d

11. Sexually-selected traits (traits which increase access to mates)

a. are always found expressed by males only
b. are always indicative of a father that will help raise the kids
c. are generally not expressed in the resource-limited sex
d. never impose a survival cost on the male expressing the trait
e. a, b, & d

12. C4 plants have a competitive advantage over C3 plants under environmental conditions which are:

a. wet and warm
b. dry and cold
c. wet and cold
d. dry and warm

Part II. Short answer or calculations (28 marks total) Write your answers on the space below the question. If you require more room, write on the reverse side of the page.

13. (6 points) The tutorial paper by Franks, Sim and Weiss looked at natural selection on flowering time in *Brassica rapa*. What material did they have available that made this study possible? What (in general) did they find? Why is this study noteworthy?

(2 marks) They had seeds that were saved in storage from several years in the past and seeds that were recently harvested.
In between the two samples the population was subjected to several years of drought.

(2 marks) They found that the later sample of seeds (post drought) had an earlier flowering time than the early sample, which had no history of drought.

(2 marks) This study shows rapid evolutionary change in life history as a response to changing conditions, or directly compares populations that have undergone different selection regimes under standardized conditions or anything else that seems reasonable (e.g., measuring both selection and heritability, etc.)

14. (4 points) You observe the following distribution of genotypes in a population of 150 individuals

AA:	96
Aa:	48
aa:	6

What are the population frequencies of the two alleles?
F(A)= (2x96+48)/(2x150)=0.8

F(a) = 1-0.8 = 0.2

right approach, wrong answer due to one mistake -1, two mistakes -3, wrong approach -4

15. (10 points) You study the distribution of genotypes for flower colour in beach peas *(Lathyrus sp.)* over two years, 2016 and 2017. Flowers in this species can be either white (W_1W_1) pink (W_1W_2) or red (W_2W_2), which makes genotyping particularly easy.
You observe the following:

2016	white:	10	2017	white:	15
	pink:	46		pink:	33
	red:	64		red:	72

a. (4 marks) What are the expected numbers of individuals in each genotype under Hardy-Weinberg for each year?

	2016		2017	
F(W1)=	0.275		0.2625	
F(W2)=	0.725		0.7375	
	HW	**expected**	HW	**expected**
W1W1	0.075625	**9.075**	0.06890625	**8.26875**
W1W2	0.39875	**47.85**	0.3871875	**46.4625**
W2W2	0.525625	**63.075**	0.54390625	**65.26875**

One mark if just the allele frequencies are calculated, two marks if just the HW genotype frequencies are calculated, full marks if expected are calculated. -1 mark for calculation error, but valid approach.

b. (4 marks) Are either genotype distribution significantly different from HW? (show your calculations supporting your conclusion)

Squared deviations (i.e., $(o-e)^2/e$) for each genotype are:

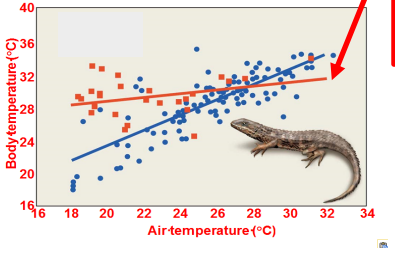
	2016	2017
W1W1	0.094283747	5.479634354
W1W2	0.071525601	3.900756659
W2W2	0.0135652	0.694202456
sum	**0.179374548**	**10.07459347**

The critical value for Chi2 p<0.05 is 3.841, so the distribution in 2017 deviated from HW, but not in 2016

-1 mark for calculation error (in this section), but otherwise valid approach. No marks if the Chi square calculation is done incorrectly (i.e., doing something other than summing the standardized squared deviations for all genotypes in each year as I did above)

c. (2 marks) What may be going on? Give one hypothesis.
We are observing <u>more homozygotes than expected</u> in 2017,: <u>any</u> reasonable hypothesis for this will fly (e.g., selection against heterozygotes in 2017 etc.) For full marks <u>correctly</u> <u>i.d. the pattern</u> and <u>hypothesize why</u>.

16. (4 marks) Label the line that indicates regulation of body temperature. What was your reasoning for choosing this line? How would the ectotherm lizard portrayed on the graph achieve body temperature regulation?



This line (1 mark)

- (2 marks) Line shows body temperature values nearly independent of air temperature values or is a nearly horizontal flat line
- (1 mark)Through behavioural mechanisms or muscle activity

17. (4 marks) A common mistake is to state that an organism was "pre-adapted" for a particular strategy. Why is this a mistake? What process is often referred to as "pre-adaptation"?

- (2 marks) natural selection does not look into the future: there can be no selection for a trait that will be useful in the future
- (2 marks) exaptation is used to denote a trait that is already present and serving some other function that is then co-opted by selection for a new function.

Some useful equations:

$$p^2 + 2pq + q^2 = 1$$

$$f(A_1) = \frac{2(\#(A_1A_1)) + \#(A_1A_2)}{2(All)}$$

or

$$f(A_1) = \frac{(\#(A_1A_1)) + 0.5 * \#(A_1A_2)}{(All)}$$

$$P_{t+1} = \frac{P_t^2(1+S) + P_tQ_t(1+hS)}{1+S(P_t^2 + 2PQh)} \qquad p + q = 1$$

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

$$\chi^2_{crit,0.05} = 3.841$$

$$p_n = p_0 e^{-\mu n}$$

$$\hat{q} = \frac{\mu}{S}$$

$$\hat{q} = \sqrt{\frac{\mu}{S}}$$