NAME: _____KEY_____ Score: _____

Notes:

1. Make sure you have your name on the test.
2. Make sure you have the correct number of pages — check now!
3. Be sure to show ALL your work on problems — credit is given for correct steps in solving the problem. The correct answer without a clear showing of the derivation of the answer will receive little or no credit. If you run out of room in the space given, continue on the back of the page.
4. Maintain silence throughout the test.
5. For multiple choice questions, put the letter of the correct answer in the blank to the left of the question number. Multiple choice questions are worth 3 points each.
6. DO NOT GET UP — if you have a question, raise your hand and the instructor will come to you.
7. Read the questions carefully — misreading is a primary cause of point loss. Also be sure to answer the question that was asked.

1. (13) A population consists of 300 A_1A_1, 150 A_1A_2 and 75 A_2A_2 individuals.

a. (10)Test this population for Hardy-Weinberg genotype frequencies. Use 3.84 as the critical value for your test.

b. (3) If the population is NOT in Hardy-Weinberg, COULD the reason be the Wahlund effect AND WHY OR WHY NOT?

Part A:

	A1A1	A1A2	A2A2	SUM	p	q
OBS	300	150	75	525	0.714286	0.285714
EXP	267.8571	214.2857	42.85714	525		
OBS-EXP	32.14286	-64.2857	32.14286			
(OBS-EXP)^2	1033.163	4132.653	1033.163			
((O-E)^2)/E	3.857143	19.28571	24.10714	47.25	= ChiSq	

$$\chi^2 = 47.25 >> 3.84, \text{ so NOT in Hardy-Weinberg}$$

Part B: Pop not in H-W, COULD be due to Wahlund effect, since there are more observed homozygotes than expected.

2. (13) Derive and solve the recurrence equation for selection against a recessive (homozygous) lethal. Let q=f(lethal allele), and start with a population of codominant genotypes in the Hardy-Weinberg proportions, as done in class. Then assign fitnesses, get the recurrence equation and then solve it. Use words to explain/define all your terms.

A_1A_1	A_1A_2	A_2A_2	genotypes
p^2	2pq	q^2	H-W proportions
1	1	0	fitnesses

$$q_1 = \frac{(2pq)/2}{p^2+2pq} = \frac{pq}{p(p+2q)} = \frac{q}{p+q+q} = \frac{q}{1+q}$$ derivation of recurrence equation

$$q_2 = \frac{q_1}{1+q_1} = \frac{\frac{q_0}{1+q_0}}{1+\frac{q_0}{1+q_0}} = \frac{\frac{q_0}{1+q_0}}{\frac{1+q_0}{1+q_0}+\frac{q_0}{1+q_0}} = \frac{\frac{q_0}{1+q_0}}{\frac{1+2q_0}{1+q_0}} = \frac{q_0}{1+2q_0}$$ working towards solution

$$q_3 = \frac{q_2}{1+q_2} = \frac{\frac{q_0}{1+2q_0}}{1+\frac{q_0}{1+2q_0}} = \frac{\frac{q_0}{1+2q_0}}{\frac{1+2q_0}{1+2q_0}+\frac{q_0}{1+2q_0}} = \frac{\frac{q_0}{1+2q_0}}{\frac{1+3q_0}{1+2q_0}} = \frac{q_0}{1+3q_0}$$ working towards solution

therefore, by mathematical induction,

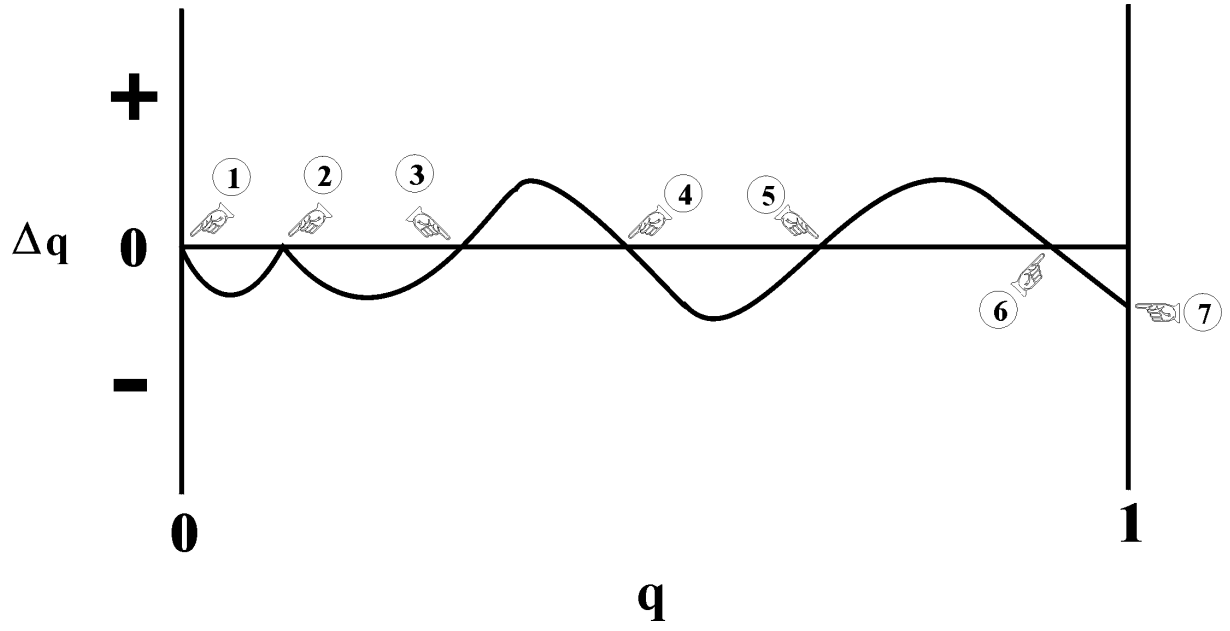
$$q_n = \frac{q_0}{1+nq_0}$$ solution to recurrence equation

$q_1 = \frac{q}{1+q}$ is the recurrence equation

3. (13)Interpret the following Δ q graph, by

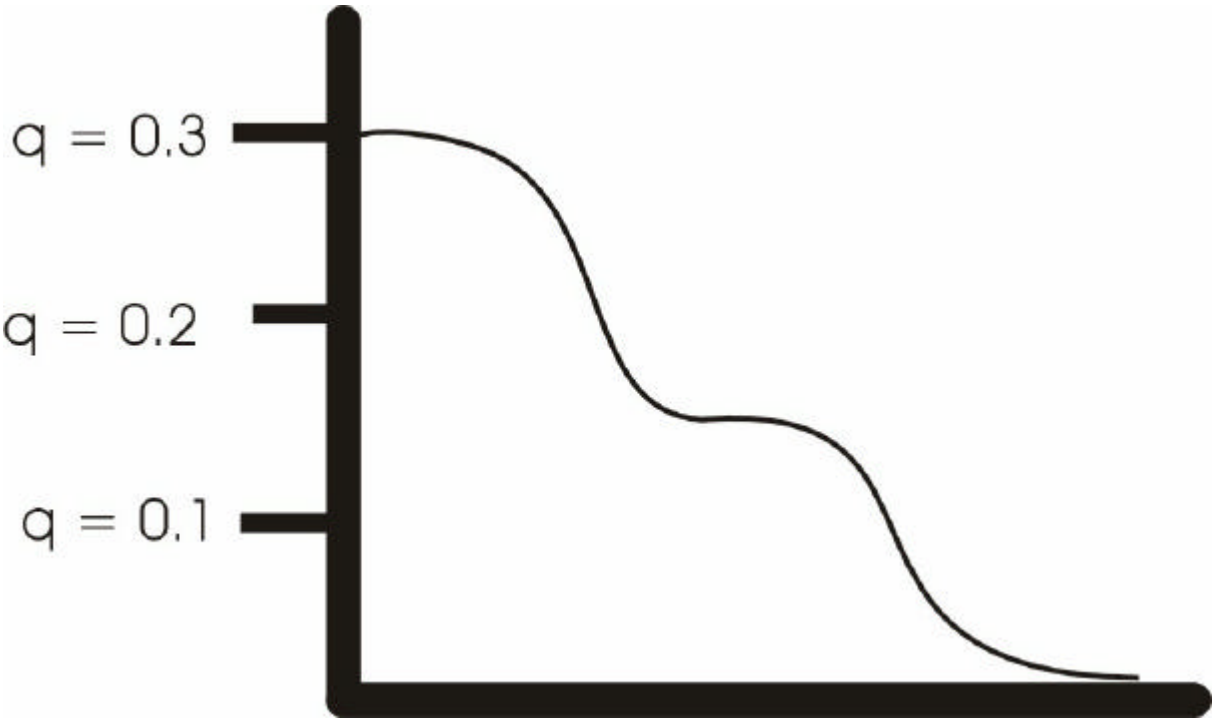
Part A of 2 parts (Part B is below the graph): filling out the chart for each indicated point: (Each indicated point refers to a point where the Δq curve crosses or touches either The Δq=0 line or the q==0 or q=1 axes)

Point #	Equilibrium? Yes (Y) or NO (N)	IF equilibrium, Trivial (T) or Interesting (I)?	IF equilibrium, Stable (S), Metastable (M) or Unstable (U)?	IF stable equilibrium, Globally stable (G) or Locally stable (L)?
1	***Y***	***T***	***S***	***L***
2	***Y***	***I***	***M***	------
3	***Y***	***I***	***U***	------
4	***Y***	***I***	***S***	***L***
5	***Y***	***I***	***U***	------
6	***Y***	***I***	***S***	***L***
7	***N***	------	------	------



Part B of 2 parts: **If the above population starts out in Hardy-Weinberg with $f(A_2A_2) = 0.3$, at which point would you eventually find the population? (Would you find it at point 1, 2, 3, 4, 5, 6, or 7?)** ***Answer is Point 4.***

4. (13) In the Δq graph of problem 3, if the population starts out at point 3, and then q decreases just a bit, plot a q vs. time graph of the population until it reaches its final value of q, assuming the little bit of random fluctuation present in a real population. Be sure to show the proper scale on the q axis, though you don't need a scale on the time axis.



Graph must show 2 reverse logistic curves, one following the other.

___a__ 5. [Ch. 4.2] If any entity has heritable variation in reproduction, and these entities produce more offspring than can survive in the environment, which of the following must occur? **a.** selection **b.** migration **c.** mutation **d.** genetic drift **e.** non-random mating **f.** none of the preceding

__c___ 6. [Ch 4.6] The reproductive success of individuals in a population: **a.** is all the same **b.** is the same among the vast majority of the population **c.** varies among members of the population **d.** is normalized to 1 in recurrence equation calculations **e.** is only used in deriving the solution to a recurrence equation

__a___7. [Ch. 4.8] Which of the following forces is the only one that causes adaptation as a direct consequence of its action? **a.** selection **b.** migration **c.** mutation **d.** genetic drift **e.** non-random mating

__b___8. [Ch. 5.8] Selection-mutation balance occurs when: **a.** selection is equal to but opposite in direction from, the force of mutation **b.** a mutation is selected against, but continues to arise, and thus settles at a low frequency in the population **c.** selection and mutation together balance genetic drift, so there is no net change in gene frequencies **d.** selection and mutation together balance migration, so there is no net change in gene frequencies **e.** selection and mutation together balance any or all of the other forces, so there is no net change in gene frequencies

__d__ 9. [Ch. 5.11] Subdivided populations have a higher proportion of which of the following than an equivalent large, fused population? **a.** heterozygotes **b.** alleles **c.** gametes **d.** homozygotes **e.** translocations **f.** mutations

__d__ 10. [Ch. 6.2] Which of the forces has a greater effect in a small population than a large population, simply due to the population size? **a.** selection **b.** migration **c.** mutation **d.** genetic drift **e.** non-random mating

__c__ 11. [Ch. 6.5] The fate of any given allele in a small population is to: **a.** become fixed **b.** become lost **c.** either become fixed or become lost **d.** rise or fall to an allele frequency of 0.50 **e.** none of the preceding

__b___12. [Ch. 7.9] The higher evolutionary rate of less important (your book says "functionally less constrained") regions of proteins can be explained by: **a.** selection **b.** the neutral theory **c.** the Hardy-Weinberg Law **d.** Wright's shifting balance theory **e.** Fisher's model of adaptive evolution

__e___13. [Ch. 9.5] A character's evolutionary response to selection is determined by its: **a.** level of genetic variation **b.** mutation rate **c.** two-locus combinatorial diffusion model frequency **d.** quantitative epistatic interactions **e.** heritability

__a___ 14. [Ch. 9.8] The amount of genetic variability in a population is reduced by which of the following: **a.** stabilizing selection **b.** dispersive selection **c.** normalizing selection **d.** heritabilizing selection **e.** none of the preceding

__c___15. [Ch. 10.1] A lot of the non-coding DNA in our genome is composed of: **a.** enzyme genes **b.** structural protein genes **c.** repetitive DNA **d.** transcribed DNA **e.** translated DNA

__a___16. [Ch 11.4] Provided that the rate of (favorable) mutation is high enough, which of the following will happen? **a.** sexual populations will evolve faster than asexual populations **b.** sexual populations will evolve at the same rate as asexual populations **c.** sexual populations will evolve more slowly than asexual populations **d.** one cannot tell anything about the comparative rate of evolution in sexual and asexual populations **e.** none of the preceding

__b___17. [Ch. 11.5] The taxonomic distribution of asexual reproduction suggests which of the following: **a.** sexual populations have a higher rate of speciation than asexual populations **b.** sexual populations have a lower rate of extinction than asexual populations **c.** sexual populations are found primarily in animals, rather than plants **d.** sexual populations have a lower rate of speciation than asexual populations **e.** sexual populations have a higher rate of extinction than asexual populations

__b__18. [Ch. 12.8] Group selection is thought to be a generally: **a.** strong force in evolution **b.** weak force in evolution **c.** strong force in plants, but a weak force in animals **d.** strong force in animals, but weak force in plants **e.** none of the preceding

__d__19. [Ch. 12.11] Why do adaptations evolve? **a.** because they increase the fitness of organisms **b.** because they increase the fitness of the species or population **c.** because the increase the reproduction of kin groups **d**. because they increase the reproduction of genes **e.** none of the preceding

__d___ 20. [Ch. 13.7] Natural selection takes time to operate. Thus, organisms may be adapted to past, rather than present, environments. This phenomenon is called: **a.** vestigal adaptation **b**. imperfect selective advantage **c.** coadaptive constraint **d.** time lag **e.** non-random imperfection