Name: _____ Lab TA _____

HOW EVOLUTION WORKS – Adaptation by Natural Selection, Genetics & Speciation

Multiple Choice: Select the **best** answer (2 pts each)

____C__1. Which of the following is **not** one of Darwin's three postulates?

A. more organisms are born than can possibly survive
B. there is a struggle for existence
C. individuals must compete with each other physically
D. populations tend to grow faster than the resources needed to sustain them

____D__2. In the AE article "Was Darwin Wrong?" Darwin is described as employing evidence for evolution from all of the following disciplines **except**:

A. morphology
B. paleontology
C. embryology
D. genetics

____A__3. Fitness (in an evolutionary sense) refers to an individual's:

A. lifetime reproductive success
B. size and strength
C. aggressiveness
D. age at death

____B__4. Evidence for "*fast*" rates of evolution come from studies on:

A. the fossil record
B. artificial selection
C. geologic processes
D. primate behavior

____C__5. The only evolutionary mechanism that introduces new genetic variation is:

A. genetic drift
B. gene flow
C. mutation
D. natural selection

____A___6. The "watchmaker" analogy described in the AE article "The Facts of Evolution" is sometimes used to explain which concept?

A. intelligent design
B. macroevolution
C. punctuated equilibrium
D. stabilizing selection

____C___7. The correct sequence for the transfer of "information" during **protein synthesis** is:

A. mRNA [transcription] ---> DNA [translation] ---> tRNA
B. tRNA [transcription] ---> mRNA [translation] ---> DNA
C. DNA [transcription] ---> mRNA [translation] ---> tRNA
D. DNA [transcription] ---> tRNA [translation] ---> mRNA

____B___8. The evolution of phenotypically distinct baboons living in diverse but contiguous habitats, where different adaptations are favored, is most likely due to:

A. allopatric speciation
B. parapatric speciation
C. sympatric speciation
D. domestication

____B___9. In a group of hunter-gatherers, there were no individuals with blood type B, but a few generations after this group began exchanging mating partners with another group, there were several members with blood type B. Which of the following best explains this phenomenon?

A. mutation
B. gene flow
C. natural selection
D. founder effect

____D___10. The inhabitants of Tristan da Cunha are descended from one family and a few sailors. The incidence of a rare eye disorder is much higher in these islanders than in other human populations. The disorder has an abnormally high frequency in this small population because many or most can trace descent from a colonist carrying the allele for this trait. Which of the following explains this phenomenon?

A. mutation
B. gene flow
C. natural selection
D. founder effect

Fill-in. For each blank, write in the **best** answer (each blank is worth 2 pts).

11. _____**Uniformatarianism/Lyell**_____ describes the idea that the cause of past events must be found in natural forces that operate today.

12. A ____**Genotype/gene**_____ refers to the particular combination of alleles

that an individual carries at specific loci.

13. The process of cell division that produces gametes is called

_____**Meiosis**_____.

14. The three-letter "words" that specify particular amino acids during protein

synthesis are called _____**Codons/anti-codon (RNA or DNA = -1pt)**_____.

15. Individuals who have two copies of the same allele are referred to as

Homozygous____ for that allele (or at that locus).

16. The __**Hardy-Weinberg**_____ model is used to calculate expected

genotypic frequencies that remain constant in the absence of evolutionary forces.

17. In RNA, the base uracil replaces _____**Thymine**_____.

18. Before DNA goes into the translation process, its "message" is first transcribed

into a specific type of RNA known as **Messenger RNA (mRNA)**_____.

19. Natural selection acts on
__**Individuals/traits/phenotype/fitness/variantion**__, but __**Populations /Species/genotype/genes**__are the units of evolution.

20. _____**Microevolution/anagenesis (evolution/adaptation/natural selection/genetic drift = -1pt)**___ is the process by which populations change over time whereas _____**Macroevolution/speciation/cladogenesis (evolution = -1pt)**_____ results in the origin of new taxa.

21. For the following descriptions, specify whether they apply generally to *Discontinuous* **(D)** or *Continuous* **(C)** traits (1 pt each).

       __**C**__ Are often influenced by the environment

       __**D**__ Result in discrete phenotypes

       __**D**__ Describe pea plant features experimented on by Mendel

       __**C**__ Are normally distributed (i.e. in the form of a bell-shaped curve)

       __**C**__ Are controlled by multiple genes

       __**D**__Are **not** important for the evolution of *complex* adaptations

22. TRUE/FALSE:

Indicate whether the following statements are true (**T**) or false (**F**) – (1 pt each)

__**F**__ a) Evolution is goal-oriented and always produces the ideal adaptation

__**F**__ b) Mutations cannot be neutral, but must confer either a positive or negative effect on an organism

__**T**__ c) A homologous feature is one that is due to common descent

__**T**__ d) An derived feature has evolved since the last common ancestor

__**T**__ e) A phylogeny reflects the evolutionary relationships between species, also taking into account the estimated age of divergence since the last common ancestor

__**F**__ f) The domestication of livestock for specific traits is an example of natural selection

Short Answers

23. Colorblindness is a *sex-linked, recessive* trait in humans. Matings between a phenotypically normal woman who is a carrier (**X^BX^b)** and a normal color-vision man (**X^BY**) will produce, *on average*, children in what proportions (6 pts)? *Use the Punnett Square.*   Each box and external label in the Punnett square is worth +0.5 pt. You must have included sex chromosomes and sex-linked alleles to get full credit. Each blank is also worth +0.5 pt. You must have listed values as % to get full credit.

	X^B	**Y**
X^B	**X^BX^B**	**X^BY**
X^b	**X^BX^b**	**X^bY**

_**25**__ % **X^BY** [normal son]

_**25**__ % **X^bY** [colorblind son]

_**25**__ % **X^BX^B** [normal daughter]

_**25**__ % **X^BX^b** [carrier daughter]

__**0**__ % **X^bX^b** [colorblind daughter]

For questions 24-25, please refer to the following phenotypic distribution: In a study population of 10,000 people, there are **7,000** individuals with blood group *M* and **3,000** individuals with blood group *N*; there are *no* individuals with blood group MN in *this* generation. The alleles *M* and *N* are **co-dominant**.

24. Calculate the **allele frequencies** for *M* and *N* in this population; be sure to show your work (4 pts):

Must show correct work to receive full credit (+2pts).

MM = 7,000   M allele = 7,000 x 2 = 14,000/20,000 = 0.7
NN = 3,000   N allele = 3,000 x 2 = 6,000/20,000 = 0.3
MN = 0

M = __**0.7**____ (+1pt, must be as a frequency)
N = __**0.3**____ (+1pt, must be as a frequency)

25. Using the allele frequencies calculated in question #24, and assuming Hardy-Weinberg conditions are met, what are the **expected genotypic frequencies** in the next/second generation, F_1? Show your work (4 pts).

Must show correct work to receive full credit (+1pt).
$p^2 + 2pq + q^2 = 1$
$(0.7)^2 + 2(0.7)(0.3) + (0.3)^2 = 1$
$0.49 + 0.42 + 0.09 = 1$
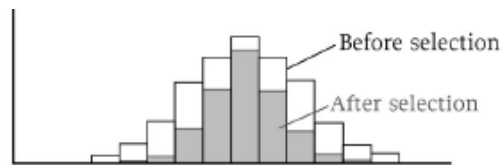
MM = __**0.49**___(+1pt, must be as a frequency)

MN = __**0.42**___(+1pt, must be as a frequency)

NN = __**0.09**___(+1pt, must be as a frequency)

26. **Diagram** and **describe** briefly (1-2 sentences) the following types of selection

example: <u>stabilizing selection</u>:

Before selection

After selection

"intermediate traits are favored"

a) <u>bi-modal / disruptive selection (2 pts)</u>:

Extreme variants are favored by selection, have higher relative fitness, etc. (+ 1pt)

Diagram = + 1pt

b) <u>directional selection (2 pts)</u>:

One extreme variant is favored by selection, has higher relative fitness, etc. (+ 1 pt)

Diagram = + 1pt

27. **Define** and then **describe** briefly how *bottleneck* AND *founder* effects may alter gene frequencies across generations (4 pts)

Bottleneck: sudden, drastic (often catastrophic?) reduction in population size(+ 1 pt)

Founder effect: small subset of parent population migrates to new location (+ 1 pt)

In BOTH, the survivors and colonists do not reflect the extent of genetic diversity in the parent populations. Hence, following population expansion, genetic variation will be quite different when compared to ancestral/parent populations. Genetic variation is reduced relative to original population. (+ 2 pts)

28. **Name** and **describe** the two major species concepts and, for each, be sure to include the mechanism by which individuals remain similar (4 pts):

BIOLOGICAL (+ 1 pt)**: individuals that can interbreed to produce viable offspring**(+ 0.5 pt)**; gene flow maintains similarities**(+ 0.5 pt)

ECOLOGICAL (+ 1 pt)**: identifies species as shaped by similar selection pressures**; **may (finches) or may not (ground squirrels) include gene flow. the finches would be two distinct species despite gene flow because distinct phenotypes remain and hybrids are less fit (hybrid depression); and the squirrels would be the same species even without interbreeding** (+ 1 pt)

29. **Distinguish** between *allopatric* speciation and *sympatric* speciation (2pts).

ALLO: reproductive isolation and genetic differentiation with geographic barriers; i.e. in isolation (+ 1 pt)

SYMP: when selection favors different phenotypes in the same environment (+ 1 pt)

30. In the AE article "**How the dog got its curly tail**" researchers bred for tameness in the silver fox. However, other "non-selected" traits also became predominant in the tame foxes. List three of these traits and explain how these "non-selected" features arose when *tameness* was the only trait under direct selection (4 pts).

LIST THREE CHARACTERS (+ 3 pts)
From among curly tails, floppy ears, shorter legs, broader skulls, spotted fur.

EXPLANATION (+ 1 pt)
Correlated evolution… probably due to linkage?

All characteristics, including tameness, are by-products of retention of juvenile characteristics. Tameness is a juvenile characteristic. By selecting for tameness, researchers were also inadvertently selecting for all other juvenile characteristics. It's a packaged deal.

31. **List** and **describe** briefly three constraints on the evolution of adaptation(s) [3 pts]
LIST ANY OF THE FOLLOWING THREE FOR FULL CREDIT

-correlated characters(+ 0.5 pt)*: when two or more traits evolve in relation to one another, can be negative or positive correlation (beak depth AND width)* (+ 0.5 pt)

-disequilibrium(+ 0.5 pt)*: "lag-time" or mismatch between adaptation(s) and current environmental conditions* (+ 0.5 pt)

-genetic drift(+ 0.5 pt)*: "sampling bias," where randomly "selected" variants survive and pass on genes (e.g. bottleneck and founder effects)* (+ 0.5 pt)

-local vs. optimal adaptation(+ 0.5 pt): natural selection = myopic = small improvements to existing phenotype does ont account for future best possible phenotype(+ 0.5 pt)

-laws of physics and chemistry(+ 0.5 pt): traits have to be possible physically (+ 0.5 pt)

For questions 32-33, please refer to the following figure:

8
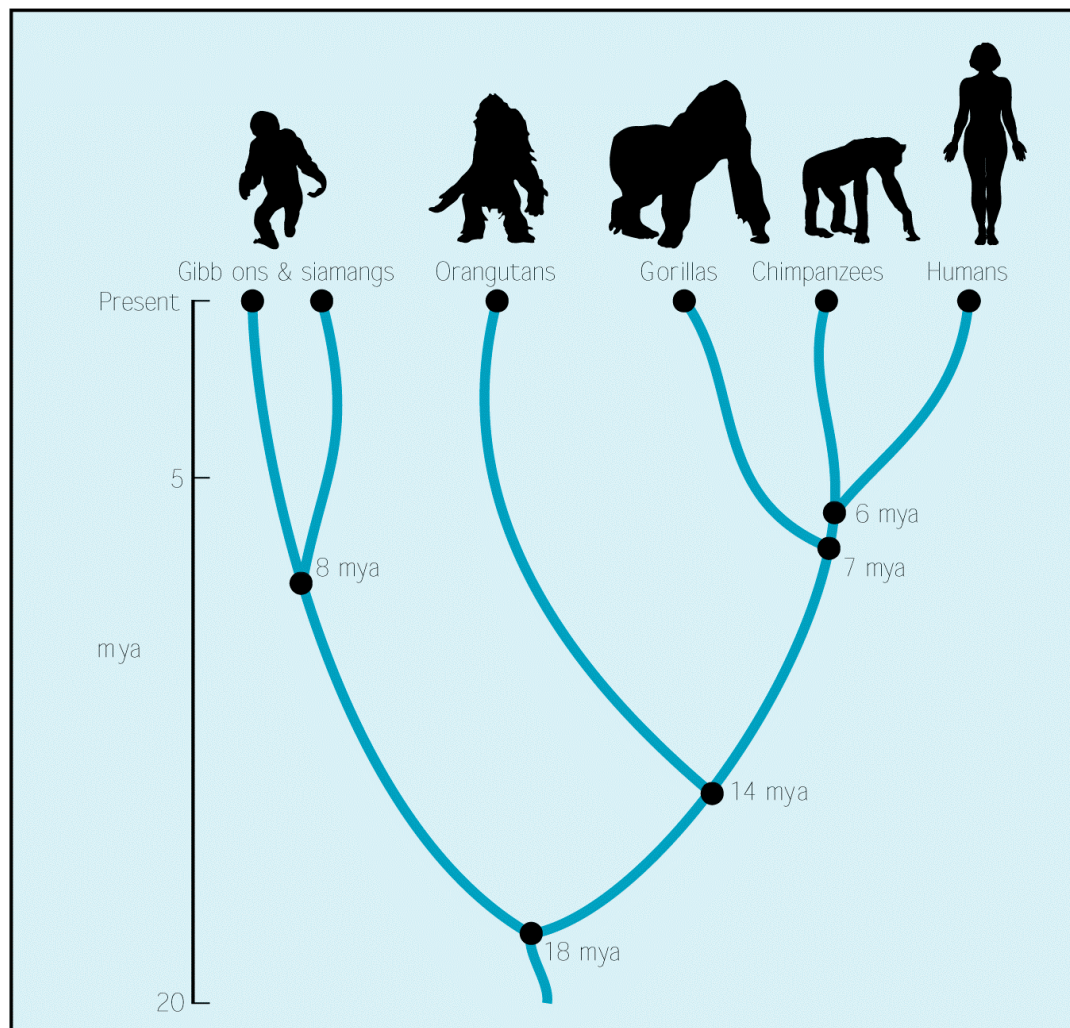
32. Among chimpanzees, gorillas, humans, and orangutans, which two species share the most recent common ancestor? (2 pts)

Chimpanzees & Humans Must list both to get full credit.

33. The last common ancestor of *gibbons* and *siamangs* lived approximately

8 MYA (1 pt) whereas the last common ancestor of *orangutans* and the *African*

apes is estimated to have lived approximately **14 MYA** (1 pt)

34. We reconstruct phylogenies on the assumption that species with many phenotypic similarities are more closely related than species with fewer phenotypic similarities. However, similarities can also arise through other means. Briefly describe the problems associated with **convergence** and **ancestral characters** when reconstructing phylogenies, and be sure to *define* each concept (3 pts).

Convergent traits, those due to similar selection pressures(+ 0.5 pt)*, do not accurately represent evolutionary relationships among those species that share the features.* (+ 0.5 pt)

Ancestral traits, those due to a shared common ancestry(+ 0.5 pt), *will not lead to accurate phylogenies if rates of evolution differ among species. Only derived traits, those evolved since the last common ancestor can be used.* (+ 0.5 pt)

35. **Distinguish** between *evolutionary* and *cladistic* systems of classification (2 pts).

CLADISTICS: patterns of descent are the only criteria (humans in Pongidae) (+ 1 pt)

EVOLUTIONARY: both patterns of descent and overall similarity are the criteria (humans in Hominidae) (+ 1 pt)