Please write the first letter of your last name in the box; 5 points will be deducted if your name is hard to read or the box does not contain the correct letter.
For two extra credit points draw a dinosaur on page 3 of your exam.
Written answers should be concise and precise; answers typically have short correct answers.
Regrade requests cannot be made for exams completed in pencil for any reason.

The exam has 100 points total

(1) MATCH THE NAMES: (1 point each, 13 pts total). Put the letter corresponding to the appropriate name on the blank by each description. Each name can be used only once, but there are more names listed than descriptions so process of elimination is less useful.

F ____ Argued that evolution is best thought of as competition between genes rather than involving organisms.

Q ____ Argued that the geologic record shows a history of gradual change over long periods of time.

P ____ Created binomial nomenclature system to name species of living organisms.

S ____ Discovered the particulate inheritance of genes.

R ____ Invented the most commonly used definition of species as populations of interbreeding individuals.

O ____ Known for an evolutionary theory involving the "use and disuse" of body parts to explain change.

I ____ Proposed an evolutionary model in which slow gradual change is punctuated by short periods of rapid change.

V ____ Proposed the idea of using the constant rate of molecular evolution to create a method of dating evolutionary events.

X ____ United the ideas from population genetics with patterns seen in the fossil record, wrote Tempo and Mode in Evolution.

U ____ Used mathematical models to argue that most genetic changes were due to the fixation of slightly deleterious mutations.

H ____ Used mathematical models to show that genes and evolution were consistent, leading to what is called the "modern synthesis" of evolutionary biology.

M ____ Used mathematics to predict the orbits of the planets.

E ____ Wrote, On the Origin of Species.
(2) GEOLOGIC RECORD. (4 pts)

Carbon dating is often used on old campfire sites to date the age of the fire. The initial ratio of $^{14}C$ to $^{12}C$ in the ash will be the same as the atmospheric ratio (wood formed from trees performing photosynthesis in this atmosphere acquire this ratio). Radioactive decay of $^{14}C$ into $^{14}N$ changes this ratio over time. If the $^{14}C$ in the atmosphere was initially present in amounts of $1:1,000,000,000$ that of $^{12}C$ when the campsite was made, but is now determined to be $1:12,000,000,000$, what is the best estimate for the age of the campsite? (The half-life of $^{14}C$ to $^{14}N$ decay is approximately 5,600 years). (You do not need to show an exact answer, just check the box that best matches, but you must show your work)

- 1,400 yrs
- 9,000 yrs
- 22,400 yrs

Looking at ratios as decay occurs:
- 2,000 yrs
- 11,200 yrs
- 25,600 yrs

- 1/1, 1/2, 1/4, 1/8, 1/16,
- 2,800 yrs
- 13,500 yrs
- 28,000 yrs

- going to 1/12th of starting ratio would
- 3,500 yrs
- 16,800 yrs
- 31,200 yrs

- take between 3 and 4 half-lives.
- 5,600 yrs
- 19,300 yrs
- 33,600 yrs

3 half lives: 3(5600) = 16800, 4 half-lives: 4(5600) = 22400
the only answer fitting that range is 19,300

(3) ARTIFICIAL SELECTION: (3 pts. each).

Consider a population of lizards being bred in captivity in which the number of femoral pores is being selected on. The left hand set of values below shows the initial population of 12 individuals from which the half of the lizards with the most pores were mated. The right hand set of values below shows the next generation produced by the mating of those individuals.

<table>
<thead>
<tr>
<th>Initial</th>
<th>Offspring</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>22</td>
</tr>
<tr>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>20</td>
<td>24</td>
</tr>
</tbody>
</table>

(a) Based on this data what is your estimate of the heritability of femoral pore number in these lizards? $h^2 = \boxed{0.4}$

(b) If we then choose the four largest individuals depicted in bold from the offspring generation and mate them, what do we expect the mean value of the third generation to be? $\boxed{25.2}$
(4) PHYLOGNETIC RELATIONSHIPS OF LIVING ORGANISMS: (2 pts. each).

In the boxes below provide the phylogenies for the following sets of taxa:

Archaea
Dueterostomia
Eubacteria
Plants
Protostomia

Annelida
Arthropoda
Ctenophora
Mollusca
Nematoda

Amphibians
Birds
Fish
Lizards
Mammals

Carnivora
Cetacea
Proboscidea
Rodentia
Sirenia

fish
amphibians
mammals
lizards
birds

Cetacea
Carnivora
Rodentia
Sirenia
Proboscidea
(5) HISTORY OF LIFE ORDERING: (1 point each, 7 pts total).

Using the numbers "1", "2", and "3", clearly indicate the relative order of the events listed on each row ("1" for first or oldest, "2" for second, "3" for last or most recent).

\[
\begin{align*}
&2\text{ Origin of birds} & &3\text{ Origin of flowering plants} & &1\text{ Origin of mammals} \\
&3\text{ 2.5 billion BC} & &1\text{ Hadean eon} & &2\text{ Origin of life} \\
&3\text{ Cenozoic era} & &2\text{ Mesozoic era} & &1\text{ Paleozoic era} \\
&3\text{ Cretaceous period} & &2\text{ Jurassic period} & &1\text{ Triassic period} \\
&1\text{ Eocene epoch} & &3\text{ Holocene epoch} & &2\text{ Pleistocene epoch} \\
&3\text{ 65 million BC} & &2\text{ First placental mammals} & &1\text{ First dinosaurs} \\
&2\text{ Dinosaurs go extinct} & &1\text{ Ediacaran fauna thrive} & &3\text{ Humans evolve} \\
\end{align*}
\]

(6) HISTORY OF LIFE FREE RESPONSE: (4 pts).

When was the Cambrian explosion and what was so interesting about it?

This was the sudden radiation of fossils of life that appeared 453 million years ago. This is interesting because it was so sudden and it was when the major extant phyla that we can recognize appeared (in contrast to the ediacaran fauna which were weird).

(7) HOMOLOGY/ANALOGY: (4 pts). Describe the logic of the homology and analogy line of evidence for evolution. Don't just define the terms, describe the logic and argument.

Some similarities between organisms can be explained by similar functions while others are not easily explainable in this way. Evolution explains there similarities as inherited resemblances due to common ancestors.
FOR THE REMAINING QUESTIONS USE YOUR SCANTRON FORM,

► MULTIPLE CHOICE: (3 pts each).

(1) Which of the following is the most accurate statement?
(A) Synapomorphies generally correspond to traits best explained by analogy.
(B) Synapomorphies generally correspond to traits best explained by convergence.
(C) Synapomorphies generally correspond to traits best explained by homology.
(D) Synapomorphies generally correspond to traits best explained by homoplasy.
(E) Synapomorphies generally correspond to traits best explained by sympleisiomophy.

(2) Which of the following best describes the concept and procedure for radioactive dating?
(A) As samples age they become more radioactive, this can be used to estimate their dates.
(B) Since the rate of decay of radioactive substances changes with the age of a radioactive sample, the relative amount of certain radioactive and non-radioactive isotopes remaining in a sample can be used to estimate the time since the sample was created.
(C) Since the rate of decay of radioactive substances changes with the age of a radioactive sample, the total amount of radiation from a sample can be used to estimate the time since the sample was created.
(D) Since the rate of decay of radioactive substances is constant, the relative amount of certain radioactive and non-radioactive isotopes remaining in a sample can be used to estimate the time since the sample was created.
(E) Since the rate of decay of radioactive substances is constant, the total amount of radiation from a sample can be used to estimate the time since the sample was created.

(3) The phrase "fluidity of the species barrier" in class was used to describe which of the following phenomenon?
(A) Apparently distinct species are often populations capable of interbreeding to generate fertile hybrids.
(B) Many populations within the same species can interbreed and generate fertile hybrids.
(C) Matings between different species often create infertile hybrids.
(D) Ring species are apparently slightly different populations that can mate with one another, but produce infertile hybrids so are different species.
(E) The marine environment contains more different species than the terrestrial environment.

(4) Which of the following is not one of the four major subphyla within Arthropoda?
(A) Chelicerata
(B) Crustacea
(C) Hexapoda
(D) Myriapoda
(E) Onycophora

(5) Which of the following is not one of the major geographic regions observed in terms of organism biodiversity?
(A) Antartic
(B) Neartic
(C) Neotropical
(D) Oriental
(E) Palearctic
Use the 5 phylogenetic trees shown here for the next two questions.

(6) Phylogenies can be drawn using either angled lines or with perpendicular lines. The time axis is usually depicted as either left to right or lower to higher. Which of the 5 perpendicular style phylogenies shown above depict the same relationship as the angled phylogeny to the right?

A

(7) Phylogenies can also be drawn using a radial representation with the time axis leading outward from the center. Which of the 5 perpendicular style phylogenies shown above depict the same relationship as the circular phylogeny?

B

(8) Which of the following is FALSE regarding the phylogeny shown to the right?
(A) A and B are sister taxa.
(B) G, H, and I can define a monophyletic clade.
(C) C is more closely related to D than to A.
(D) E is more closely related to F than to D.
(E) I is more closely related to J than to G.

(9) Which of the 5 phylogenetic trees shown below illustrates the same evolutionary history as the one to the right?  B

(A) Convergence.  (C) Phylogeny.  (E) Synapomorphy.
(B) Homoplasy.  (D) Symplesiomorphy.
Use the 5 phylogenetic trees shown here for the next two questions. The shade of the circles for each extant taxon indicates the morphology of the trait in question.

(11) Which of the 5 phylogenetic trees shown above is the MOST parsimonious? D

(12) Which of the 5 phylogenetic trees shown above is the LEAST parsimonious? C

► TRUE/FALSE questions: (1 point each, 15 pts total).
For these questions, mark "A" for TRUE, "B" for FALSE

(13) The annelids include earthworms, leeches, and onychophorans. F B
(14) The arthropods include praying mantis, mantis shrimp, and manta rays. F B
(15) The echinoderms include starfish, jellyfish, and hagfish. F B
(16) The marsupials include opossums, wombats, and kangaroos. T B
(17) The molluscs include snails, earthworms, and leeches. F B
(18) The molluscs include octopus, cuttlefish, and clams. T A
(19) The monotremes include platypus, echidnas and kangaroos. F B
(20) The order Artiodactyla includes hippos, elephants, and rhinos. F B
(21) The order Carnivora includes skunks, cats, and seals. T A
(22) The order Cetacea includes dolphins, beluga whales, and manatees. F B
(23) The order Lagomorpha includes rabbits, hares, and pikas. T A
(24) The order Rodentia includes rats, mice, and capybara. T A
(25) The primates include gorillas, spider monkeys, and orangutans. T A
(26) The primates include opossums, howler monkeys, and bonobos. F B
(27) The Actinopterygii include tuna, swordfish, and seahorses. T A