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Notes:

1. Use Scantron form to mark your answers for questions 1-50.
2. This is a closed-book, closed-note test.
3. Make sure you write your name on the Scantron form.
4. Turn in the Scantron form and your test.
5. Grades will be posted outside Dr. Bryant's office by 8 AM Friday, 15 March 1996. Grades will be posted by the last 4 SS digits, unless you say different when you turn in your test.
6. The blanks in front of each multiple-choice question are for you to mark your answers before transferring them to the scantron sheet, if you wish. If you use these blanks, you may then compare your answers to the key after the exam is over.
7. Mark the **one best** answer to each multiple-choice question on your Scantron.

- ___e___ 1. [lecture] The unification of Mendelism and Darwinism which occurred in the 1930s and 1940s is called: a. natural selection b. adaptation c. Lamarckism d. evolution **e. none of the preceding (answer is: modern synthesis)**
- ___c___ 2. [Ch. 3] Which of the following is **NOT** a line of evidence for organic evolution: a. direct observation of microevolutionary changes b. the order of groups in the fossil record **c. the fact that genes are on chromosomes in higher organisms** d. homologous similarities among species e. imperfect adaptations
- ___e___ 3. [lecture] Which of the following periods is earliest in time: a. Carboniferous b. Tertiary c. Triassic d. Permian **e. Ordovician**
- ___b___ 4. [lecture] Trilobites lived in which era? a. Archaic **b. Paleozoic** c. Mesozoic d. Cenozoic
- ___a___ 5. [appendix] A fossil is: **a. any trace of past life** b. bones that have turned into rocks c. rocks containing bones, shell or other parts of ancient organisms d. mineralized parts of past life e. none of the preceding
- ___b___ 6. (Ch. 1) Darwin's main contribution was: a. the origination of the idea that evolution has occurred **b. the proposal of and supporting evidence for a mechanism for evolution** c. journals of his trip around the world d. the proposal of and supporting evidence for the idea that fossils represented ancient creatures long since extinct e. the origination of the idea that the earth was very old
- ___c___ 7. (lecture.) *Australopithecus afarensis* lived about how many years ago? a. 15 million b. 5 million **c. 3.5 million** d. 1.2 million e. 50,000
- ___e___ 8. (lecture) The evidence indicates that which of the following was the first to use fire regularly? a. *Australopithecus africanus* b. *Australopithecus afarensis* c. *Homo habilis* d. *Homo sapiens* **e. none of the preceding (answer is: Homo erectus)**
- ___c___ 9. (lecture) Of the following human traits, which apparently evolved first: a. use of fire b. modern-sized brain **c. walking upright** d. use of chipped stone tools e. active hunting of animals for meat

[end of material covered by Test 1]

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- __b__10. [Ch. 2] For a simple Mendelian trait, if a homozygote mates to a heterozygote, and half of their offspring look like each parent, the homozygote was: a. a dominant homozygote **b. a recessive homozygote** c. a codominant homozygote d. a pleiotropic plesiomorphic homozygote e. can't tell from information given
- __b__11. [Ch. 4] If, for many generations, individuals who are taller than average in a population survive and reproduce better than individuals at or below average, and height is heritable, we would have: a. stabilizing selection for height in this population **b. directional selection for height in this population** c. disruptive selection for height in this population d. selection for a trivial stable equilibrium in this population e. heterosis
- __c__12. [Ch. 5] Which of the following is **NOT** one of the forces which can cause evolutionary genetic change: a. natural selection b. mutation **c. crossing over** d. genetic drift e. migration
- __a__13. [Ch. 6] Which of the following would be an example of genetic drift? **a. loss of an allele due to small population size** b. change in allele frequency caused by excess predation on slower individuals c. an excess of homozygotes due to sampling two populations d. increase in homozygosity due to close relatives mating with each other e. increase in an allele due to individuals carrying that allele coming into the population from outside
- __b__14. [Ch 7] Which of the following is **NOT** one of the arguments used by Kimura to support the neutral theory? a. high rate of molecular evolution **b. recombination occurs at a higher rate than neo-Darwinism predicts** c. molecular evolution is more rapid in functionally less constrained parts of molecules d. natural populations are highly polymorphic e. clock-like constancy of rate of molecular evolution
- __b__15. [Ch. 10] Gene families may originate by gene duplication by: a. normal crossing over **b. unequal crossing over** c. plesiosynapsis d. mitosis e. translocational concerted mutation
- __a__16 [Ch. 11] An adaptation is: **a. a feature of an organism enabling it to survive and reproduce in its natural environment better than if it lacked the feature** b. the average number of offspring produced by individuals with a certain genotype, relative to the average number of offspring produced by individuals with other genotypes c. a set of species containing an ancestral species and all of its descendants d. a classification of species by phylogenetics, that is, the branching relationships among the species e. none of the preceding
- __b__17. [Ch. 12] Selection acting for the benefit of the group and against the benefit of an individual and its relatives is: a. species selection **b. group selection** c. individual selection (regular natural selection) d. kin selection e. none of the preceding

[end of material covered by Test 2]

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- __d__ 18. [Ch. 14.1] Cladistics is: a. a feature of an organism enabling it to survive and reproduce in its natural environment better than if it lacked the feature b. the average number of offspring produced by individuals with a certain genotype, relative to the average number of offspring produced by individuals with other genotypes c. a set of species containing an ancestral species and all of its descendants **d. a classification of species by phylogenetics, that is, the branching relationships among the species** e. none of the preceding
- __a__ 19. [Ch. 14.2] The classification of organisms by similarity of appearance constitutes: **a. phenetics**
b. cladistics c. evolutionary taxonomy d. divergence e. phenetic phylogenetics
- __a__ 20. [Ch. 14.6] Evolutionary taxonomy suffers from the ambiguity of: **a. phenetic taxonomy**
b. cladistic taxonomy c. ecological divergence d. punctuated equilibrium e. none of the preceding
- __d__ 21. [Ch. 15.2] "A set of organisms which look sufficiently similar" is the species definition of which of the following: a. cladistic species concept b. ecological species concept
c. evolutionary species concept **d. phenetic species concept** e. none of the preceding
- __e__ 22. [Ch. 15.4] "a set of organisms who recognize one another as potential mates" is the species definition of which of the following: a. cladistic species concept b. ecological species concept
c. evolutionary species concept d. phenetic species concept **e. none of the preceding (answer is recognition species concept)**
- __b__ 23. [Ch. 15.6] In the biological species concept, which of the following is responsible for maintaining the integrity of the species? a. mutation **b. gene flow** c. genetic drift
d. pangenesis e. sufficiently shared phenotypes
- __d__ 24. [Ch. 16.1] When one population of interbreeding organisms splits into two populations of separately breeding populations, what has happened? a. convergence b. macroevolution
c. hybrid breakdown **d. speciation** e. none of the preceding
- __b__ 25. [Ch 16.2] If a new species evolves in a subpopulation on the edge of a species range (that is, contiguous with the main species range), it is called: a. allopatric speciation **b. parapatric speciation** c. sympatric speciation d. phenopatric speciation e. cladopatric speciation
- __a__ 26. [Ch. 16.4] If a new species evolves in a subpopulation geographically isolated from the main species range, it is called: **a. allopatric speciation** b. parapatric speciation c. sympatric speciation d. phenopatric speciation e. cladopatric speciation
- __e__ 27. [Ch. 16.6] Sympatric speciation is most likely if: a. it follows a macromutational event
b. there was a preceding allopatric speciation event c. the amount of prezygotic isolation is very low d. assortative mating never occurs **e. a stable polymorphism is followed by assortative mating**

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- __e__ 28. [Ch. 17.2] Phylogenetic reconstruction is easy when: a. there are a great number of evolutionary character changes b. there are a very average number of evolutionary character changes c. there are a very small number of evolutionary character changes d. there are no evolutionary character changes **e. different characters imply the same phylogeny**
- __e__ 29. [Ch 17.3] On which of the following should phylogenetic inference be based? a. analogies b. ancestral homologies c. symplesiomorphies d. plesiomorphies **e. shared derived homologies**
- __c__ 30. [Ch. 17.7] From which of the following can character polarities be inferred? a. symplesiomorphies b. synapomorphies **c. outgroup comparisons** d. homologies e. none of the preceding
- __e__ 31. [18.1] Biogeographers attempt to explain how: a. genetics and ecology interact b. cladistics and biogeography are related c. ice ages and meteorite impacts caused extinctions d. the major faunal regions of the world came about **e. species and higher taxa are geographically distributed**
- __e__ 32. [18.3] The similarity of their animals divides the world into how many biogeographic regions: a. 2 b. 3 c. 4 d. 5 **e. 6**
- __b__ 33. [18.6] The ranges of species in the northern hemisphere moved to the south during: a. the Mesozoic **b. the ice ages** c. the Carboniferous d. the Devonian e. none of the preceding
- __c__ 34. [18.7] The phylogenetic relationships among members of a taxon in different areas is depicted by: a. a phenogram b. a cladogram **c. an area cladogram** d. a vicariance diagram e. none of the preceding
- __c__ 35. [19.1] A "darwin" is an evolutionary rate change of: a. 10% per million years b. 100% per million years **c. a factor of 2.718 per million years** d. a factor of 3.1415 per million years e. none of the preceding
- __e__ 36. [19.3] Evolutionary rates: a. do not vary b. vary among taxa, but not geological times c. vary among geological times, but not among taxa d. vary among both taxa and geological times **e. vary among geological times, taxa, and types of taxa.**
- __b__ 37. [19.9] Darwin was obviously a phyletic gradualist. a. true **b. false**
- __b__ 38 [19.10] It is clear that evolution has the same set of rates and processes at all taxonomic levels. a. true **b. false**
- __c__ 39. [20.3] Changes in the rate and timing of developmental processes often result in: a. homeotic mutations b. vicariance events **c. morphologic transitions** d. mass extinctions e. none of the preceding

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- __c__ 40. [20.4] Recapitulation is the idea that: a. new evolutionary developments always happen at only the earliest life stages b. new evolutionary developments are added at any life stage **c. the embryological development of an individual organism is a direct reflection of its evolutionary history** d. higher taxa evolve by truncation e. none of the preceding
- __c__ 41. [20.7] Changes in the timing of developmental events are called what type of evolutionary events? a. homeotic b. homochronic **c. heterochronic** d. heterotic e. none of the preceding
- __e__ 42. [20.9] The argument that new higher taxa arise by paedomorphosis from the larval stages of ancestors seems to imply that: a. terminal addition is a common mode of macroevolution b. non-terminal addition is a common mode of macroevolution c. larval stages are evolutionarily inflexible d. allometric changes are common in macroevolution **e. none of the preceding (answer is: larval stages are evolutionarily flexible)**
- __d__ 43. [21.1] A lineage undergoing directional evolution for a long period is said to be: a. an example of macroevolution b. a coevolutionary event c. an example of coadaptation **d. an evolutionary trend** e. none of the preceding
- __c__ 44. [21.3] Evolutionary trends may be driven by: a. macromutation b. a shortage of mutations **c. a change in the physical environment** d. paedomorphosis e. truncation
- __b__ 45. [21.5] Coadaptation, such as mutualism, is probably usually the result of: a. macromutation **b. coevolution** c. a change in the physical environment d. paedomorphosis e. truncation
- __d__ 46. [21.7] If speciation in parasites and hosts is simultaneous, the phylogenies of the hosts and parasites would be: a. inverted b. cladograms c. phenograms **d. mirror images** e. escalatory
- __a__ 47. [22.1] Ecological causes of species extinctions are best studied in: **a. modern forms** b. fossil forms c. either modern or fossil forms, it makes no difference (no d or e choices)
- __c__ 48. [22.3] How are extinction rates related to the age of a species? a. the older a species is, the more likely it is to become extinct b. the younger a species is, the more likely it is to become extinct **c. extinction rates are not correlated with the age of a species** (no d or e choices)
- __e__ 49. [22.7] The best studied mass extinction is which of the following: a. end-Ordovician b. end-Devonian c. end-Permian d. end-Triassic **e. end-Cretaceous**
- __b__ 50. [22.12] The evidence suggests that: a. mass extinctions are generally caused by asteroid impacts **b. mass extinctions are not generally caused by asteroid impacts** (no c, d, or e choices)

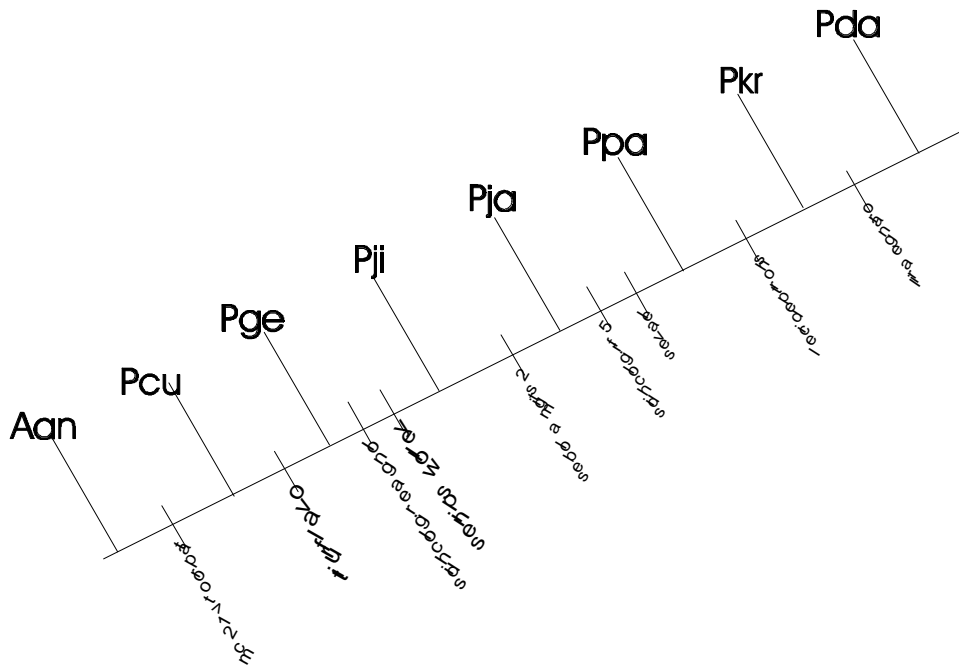
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51. (10 points) Construct a fully resolved cladogram for the 7 members of the *Pseudocactus* genus shown below, using *Acactus anonymous* as the outgroup. Between each branch of your cladogram, write in the new trait (such as oval fruit, orange aril or whatever) that evolved.

Species	Leaves present?	Spine color?	Fruit Shape?	Pedicle Length?	Taproot length?	Aureole glochids?	Stigma lobes?	Fruit glochids?	Fruit aril?	# apomorphies
<i>Acactus anonymous</i>	no	brown	round	long	<10 cm	short	3	20	red	0
<i>Pseudocactus curtii</i>	no	brown	round	long	<u>>12 cm</u>	short	3	20	red	1
<i>Pseudocactus pamii</i>	<u>yes</u>	<u>yellow</u>	<u>oval</u>	long	<u>>12 cm</u>	<u>long</u>	<u>2</u>	<u>5</u>	red	7
<i>Pseudocactus jamesii</i>	no	<u>yellow</u>	<u>oval</u>	long	<u>>12 cm</u>	<u>long</u>	<u>2</u>	20	red	5
<i>Pseudocactus jilii</i>	no	<u>yellow</u>	<u>oval</u>	long	<u>>12 cm</u>	<u>long</u>	3	20	red	4
<i>Pseudocactus georgii</i>	no	brown	<u>oval</u>	long	<u>>12 cm</u>	short	3	20	red	2
<i>Pseudocactus kristii</i>	<u>yes</u>	<u>yellow</u>	<u>oval</u>	<u>short</u>	<u>>12 cm</u>	<u>long</u>	<u>2</u>	<u>5</u>	red	8
<i>Pseudocactus davidii</i>	<u>yes</u>	<u>yellow</u>	<u>oval</u>	<u>short</u>	<u>>12 cm</u>	<u>long</u>	<u>2</u>	<u>5</u>	<u>orange</u>	9



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52. (10 points) List three definitions of a species, by the names used in your book, give the definition of each, choose the one you think is best, and defend your answer. (tell why the definition you chose is better than each of the other two you listed)

The phenetic species concept defines species on the basis of similar appearance. The cladistic species concept defines species as organisms between branching points of a cladogram, and the biological species concept defines species as groups of interbreeding organisms which do not breed with other such groups. Although evolutionary relationships are best defined using the cladistic species concept, and although the phenetic species concept is used widely as a practical matter for field identification, I believe the biological species concept is the best overall definition. The reason I think so is because I view a species as a shared gene pool; that is, a collection of organisms who evolve together due to their shared genes. The only way this can happen is if those organisms interbreed, thus sharing genes. The biological species concept best captures this sense of common evolution through a shared gene pool.

53. (10 points) Compare and contrast phyletic gradualism and punctuated equilibrium as theories of evolutionary rates. (define the terms, tell their similarities, tell their differences, give whatever evidence is available to support each theory).

Phyletic gradualism is the theory that evolution proceeds by slow, gradual, transformation of one species into another, so that a complete fossil record would show insensible gradations between species. Punctuated equilibrium is the theory that evolution proceeds by long periods of morphological stasis and short periods of rapid transformation between species. In punctuated equilibrium "long" and "short" periods of time are meant to refer to geological time, not generational time; in phyletic gradualism, transformations occur slowly and continuously over both geological and generational time. The two theories are similar in that they are both models of neo-Darwinian speciation; they are different in their predictions of the fossil record. Of the three relatively well-studied cases, two appear to be punctuated equilibrium (humans and the Lake Turkana snails), and one appears to be phyletic gradualism (the Ordovician trilobites). Many more studies will be necessary to determine whether either theory really explains the majority of evolutionary transformations.

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54. What is Evolution?. Write between 300 and 500 words, as legibly as possible.
(The following is 497 words)

Evolution is genetic change in a lineage, which is a group of organisms and their ancestors and/or descendants through time. The study of evolution includes the study of evidence for evolution, population genetics, adaptation and natural selection, classification, and the rates and modes of evolutionary change. The evidence for evolution includes the fossil record, which shows ever more dissimilar fossils as rocks get older; laboratory experiments which can produce new species; artificial selection experiments which produce new kinds (dogs, cats, pigeons, and flowers, for instance); evolution on a small scale in nature (such as the peppered moth and insects evolving resistance to insecticides); the imperfectness of adaptation; and homologous similarities among organisms.

Population genetics is the branch of genetics which studies the ways in which genetic changes may occur in lineages. Such changes have been seen in extensive laboratory experiments, and the mathematical theory is well-developed. Five major forces can cause evolutionary genetic change: selection, migration, mutation, non-random mating and genetic drift. Of these, selection, which is a difference in reproduction among individuals, is the most generally important. Selection is also the only force that can produce an adaptation, which is a feature of an organism that allows it to reproduce better than if it lacked the feature.

Organisms may be classified in many ways, but the cladistic method is the most generally used today. This method involves classification by shared derived traits, and defines a species as the organisms in a lineage between branching points of that lineage. Other methods of classification define species differently.

Fossils are traces of past life. Single-celled organisms arose at least 3.8 billion years ago, and large multi-cellular organisms arose in quantity 600 million years ago. Since then, there has been a general increase in the size and complexity of organisms on the planet. Evolution may proceed gradually with unnoticeable gradations from species to species (phyletic gradualism), or species may remain practically unchanged until a new species arises in a geologically short period of time (punctuated equilibrium). It is currently unresolved whether either phyletic gradualism or punctuated equilibrium is the case for most of evolutionary change. As far as the evidence goes, changes which result in new kingdoms, phyla or other large groupings are no different in kind than those which result in new species — macroevolution is brought about by the same processes as microevolution.

Species may go extinct due to competition, shifts in climate or other factors, and the majority of species that have lived on the planet are extinct. However, species do not "age"; that is, they appear to have a constant probability of extinction which does not increase with the length of time the species has existed. On occasion, many species go extinct simultaneously, which is called a mass extinction. The best studied of these, between the Mesozoic and Cenozoic, was caused by a meteorite that fell on the Yucatan Peninsula in Mexico, 65 million years ago. Probably not all mass extinctions were caused by meteorites.