111

UNIVERSITY OF WESTERN ONTARIO

BIOLOGY 1222

December 16, 2008 Time: 2 ½ Hours

Student No. _____ Test Room _____ Row _____

INSTRUCTIONS - FOLLOW THE CHECK LIST!

(√)	On your Scantron sheet		Fill the bubbles completely • Use **HB pencil only** • No stray marks or doodles • Make all erasures complete **Yes** - Calculators are permitted (non-programmable only) **No** – Borrowing is not allowed
	Print name	Print clearly	
	Signature	Do your best	
	Instructor	Haffie, MacShack	
	Course	Bio 1222	
	Student number	Print clearly/ Bubble neatly	
	Exam Code	**111 – Very important**	
	Section	Leave it blank	
	Answer Sheet	Leave it blank	

(√)	On your Test Book		**Do not write your name on the cover** Your Scantron answers will be emailed to your UWO email account within a week. Review copies of this test will posted on WebCT for study purposes
	Student number	No names please	
	Test Room	The room you're in right now	
	Row number	We will tell you this	
	Indicate your answers in the test book. Leave no questions blank.		

1) Please place your ID prominently on your desk and sign the attendance sheet when it comes to you.
2) There are **50** questions in this test. Check your paper carefully.
3) There is only **one** fully correct answer for each question. Part marks may be awarded. **Answer all questions**. We do not subtract wrong from right.
4) Indicate your answers in **both** the test paper **and** on the Scantron.
5) It is your responsibility to transfer all answers from the test book to the Scantron sheet **within the 2 ½ hour period.**
6) When finished, **please stay seated** and raise your hand. We will collect both your test book and your Scantron sheet. Test books will be returned to you in tutorial.

Warning The Scantron marking program has a cheating analysis feature that compares answer patterns for all papers. It alerts us to similarities. We then check seating arrangements.
Do not sit near your study partners or write the same test codes. Keep your work directly in front of you. Please help us avoid any and all misunderstandings during these tests.

Comments: Please defend your arguments **on this page only**. Comments will not be accepted after the test.

Circle the best single letter choice for each of the following questions before transferring your answers to your Scantron sheet. **Please note that not all questions have 5 choices.**

1. Imagine that you isolate some cells in metaphase of meiosis I from a rat and prepare them on slides for standard light microscopy. Imagine that you do the same for cells in metaphase of mitosis from the same animal.

   You have two sets of slides but you forget to label them and they become mixed up.

   Which of the following observations would allow you to distinguish the mitosis slides from the meiosis slides?

   A. Only cells on the meiosis slides would have sex chromosomes.
   B. Only cells on the meiosis slides would show homologues paired together.
   C. Only cells on the mitosis slides would contain microtubules attached to centromeres.
   D. Cells on the meiosis slides would have half as many chromosomes as those on the mitosis slides.
   E. Cells on the mitosis slides would have replicated chromosomes (composed of two chromatids each); cells on the meiosis slides would have unreplicated chromosomes.

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2. All sexually reproducing organisms, including most algae, fungi, plants and animals, use meiotic cell division at one point or another in their life cycle.

   Which of the following characteristics is shared by all cells resulting from meiosis II, regardless of the organism?

   A. They do not divide by mitosis.
   B. They fuse with other products of meiosis to form a zygote.
   C. They are "repaired" by recombination and free of mutations.
   D. They have half the usual number of chromosomes for the species.
   E. They contain either maternal or paternal chromosomes, not both.

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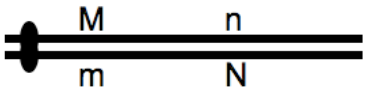
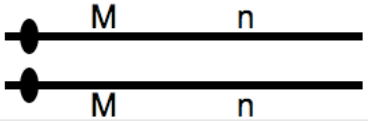
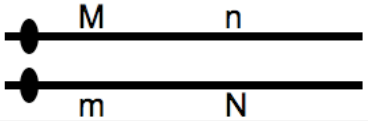
3. Males of the Australian Jack Jumper ant are haploid and therefore make gametes only by mitosis. They have the lowest possible chromosome number - one.

   If a particular male ant carries two genes linked in trans, which of the following diagrams most accurately represents the arrangement of alleles one would expect to find in G2 cells? (Note that each line represents one double helix of DNA and that the dots indicate centromeres.)

A. 

B. 

C. 

D. 

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4. Meiosis in male fruit flies has a very unusual characteristic; the synaptonemal complex, a collection of proteins required for homologous pairing, never forms during prophase.

   If homologues cannot pair intimately during meiosis, which of the following mechanisms for generating diverse gametes would therefore not be available?

A. X-linkage
B. Crossing-over
C. Independent assortment
D. Random alignment of chromatids at metaphase II
E. C and D only are correct.

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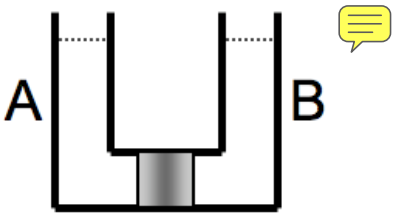
5. The device shown below is a "Davis U-tube". It is composed of two chambers separated by a filter with holes that are just small enough to prevent bacterial cells from the liquid culture in one chamber from coming into any type of contact with those in the other chamber.

   Imagine that mutant $\mathbf{x^+y^-z^+}$ cells are put into Chamber A and mutant $\mathbf{x^-y^+z^-}$ cells are put into Chamber B.

   After one day, several recombinant normal cells ($\mathbf{x^+y^+z^+}$) are recovered from Chamber A but not from Chamber B.

   Which of the following is the most likely explanation of this observation?



A. The $\mathbf{y^+}$ allele was on a transposon that moved directly from the chromosome of $\mathbf{y^+}$ cells to the chromosome of $\mathbf{y^-}$ cells.
B. The $\mathbf{y^+}$ allele was on an F plasmid that moved from cells in Chamber B to those in Chamber A.
C. The $\mathbf{y^+}$ allele was carried from Chamber B to Chamber A inside the head of a virus.
D. The $\mathbf{y^-}$ allele recombined with other $\mathbf{y^-}$ alleles to give a normal, $\mathbf{y^+}$, allele.
E. The $\mathbf{y^-}$ allele suffered a mutation to $\mathbf{y^+}$.

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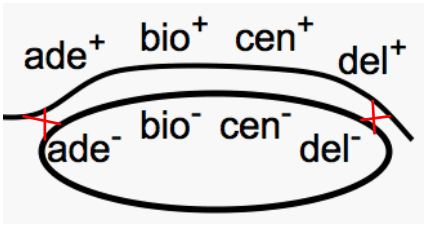
6. The diagram below shows four bacterial genes on a linear fragment of donor chromosome aligned with the homologous region of a recipient chromosome. The donor DNA contains normal alleles while the recipient has only mutant alleles for all four genes.

   Recall that recombination events can result in the normal alleles from the donor fragment being "exchanged" for the mutant alleles on the recipient chromosome. The donor fragment is then degraded while the recombinant recipient chromosome is replicated and passed on to daughter cells as usual.



   Which of the following types of recombinant recipient would be least frequent? (That is, which type of recombinant recipient would require the highest number of recombination events?)

A. *ade*$^+$ *bio*$^+$ *cen*$^+$ *del*$^+$
B. *ade*$^+$ *bio*$^+$ *cen*$^+$ *del*$^-$
C. *ade*$^-$ *bio*$^+$ *cen*$^+$ *del*$^-$
D. *ade*$^+$ *bio*$^+$ *cen*$^-$ *del*$^-$
E. *ade*$^+$ *bio*$^-$ *cen*$^-$ *del*$^+$

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7. Which of the following crosses illustrates the concept of "independent assortment"?

	Cross	Result
A.	Dd x Dd	1 DD: 2 Dd: 1 dd
B.	I^AI^B x I^AI^B	1 I^AI^A: 2: I^AI^B:1 I^BI^B
C.	dd x DY	1 Dd female: 1 dY male
D.	DdEe x DdEe	9 D_E_: 3 D_ee: 3 ddE_: 1 ddee
E.	DdEe x ddee	9 D_E_: 3 D_ee: 3 ddE_: 1 ddee

---

8. How many different gametes would be obtained from an elephant with the genotype **PpQqTT** if none of the genes are linked? *(Read the genotype carefully.)*

A. 2
B. 3
C. 4
D. 6
E. 8

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9. How many different gametes would be obtained from an elephant with the genotype **PpQqTT** if the first two genes are linked in cis at 20 map units? *(Read the genotype carefully.)*

A. 2
B. 3
C. 4
D. 6
E. 8

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10. In a certain type of domestic bird, two alternative alleles at one gene control the colour of feathers. Three colours are observed: blue, black and speckled white. Crosses among these three yield the following results.

Parents	Progeny
black x blue	blue and black (1:1)
black x speckled white	blue
blue x speckled white	blue and speckled white (1:1)
black x black	black
speckled white x speckled white	speckled white

What progeny would result from a blue x blue cross?

A. black, blue, speckled white (1:2:1)
B. blue, speckled white (3:1)
C. blue, black (3:1)
D. speckled white only
E. blue only

---

11. Consider a dihybrid test-cross in finches (HhLl x hhll) giving four classes of progeny as shown below.

    Which of the following hypotheses is supported by these data?

Progeny	Number
HhLl	252
Hhll	246
hhLl	254
hhll	248

A. One gene affects the expression of the other.
B. The alleles of both genes are codominant.
C. The two genes are linked in cis.
D. One parent is linked in cis, the other in trans.
E. The two genes are far apart on the same chromosome.

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12. Recall that *Drosophila* geneticists have agreed on a particular "normal" or "wild-type" fruit fly. Mutations in a gene called "Barbie and Ken" result in an absence of external genitalia. (The gene is named after the famous anatomically incorrect dolls. I am not making this up.)

    The mutation is recessive in that crosses among heterozygotes produce about 1/4 affected offspring.

    What is the proper notation for the wild-type allele of this gene?

A. bk^+
B. bk
C. BK^+
D. BK

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13. Consider a cross between two corn plants. One is homozygous recessive for two genes, striped leaves (**stst**) and red seed coat (**rr**); the other is heterozygous for both genes (**STst Rr**) and shows the alternative phenotypes of green leaves and clear seed coat, respectively.

    One thousand progeny were randomly selected and found to be as follows:

Progeny	Number	Progeny	Number
Striped Leaves Red Seed	104	Striped Leaves Clear Seed	409
Green Leaves Red Seed	391	Green Leaves Clear Seed	96

What is the map distance (cM) separating these two genes?

A. 0.20
B. 20
C. 0.8
D. 80
E. Can not tell without knowing the cis or trans arrangement in the dihybrid parent.

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14. A colour-blind man has a daughter (Beth) with normal vision. This daughter marries a colour-blind man (Denis).

    Who has the higher likelihood of being colour-blind: Denis and Beth's sons or their daughters? (Recall that colour-blindness is a sex-linked recessive trait.)

A. sons
B. daughters
C. Neither of the above is correct; sons and daughters have an equal chance of being colour-blind in this family.

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15. In *Drosophila*, the genes for brown eye and vestigial wing are linked at 30 map units on the X chromosome.

    If a dihybrid female (linked in cis) was crossed to a brown vestigial male, what would be the percentage of wild-type progeny?
    (There are no alleles for either of these particular genes on the Y chromosome.)

A. 15
B. 17.5
C. 35
D. 50
E. 70

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16. The drug AZT was originally highly effective in treating HIV, but over time has become much less effective. Why?

    1. AZT has severe side effects on the host.
    2. AZT treatment increases the risk that a virion will mutate in order to improve its resistance.
    3. The frequency of the human CCR5-Δ32 allele, which provides some protection against HIV, is decreasing.
    4. When AZT is present, AZT-resistant virions are better able to replicate than AZT-susceptible virions, so there are more AZT-resistant strains of HIV now than in the past.

A. 1, 2 and 3
B. 1 and 3
C. 2 and 4
D. 4 only
E. 1, 2, 3 and 4 are correct

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17. Why has it been so difficult to develop a vaccine that protects against HIV infection?

    1. Retroviruses have very high mutation rates.
    2. Vaccines work mainly by blocking reverse transcription, but HIV has already evolved resistance to drugs designed to interfere with reverse transcription.
    3. HIV coat proteins, or epitopes, evolve very quickly.
    4. In humans, mutations that protect against HIV are not completely dominant.

A. 1, 2 and 3
B. 1 and 3
C. 2 and 4
D. 4 only
E. 1, 2, 3 and 4 are all correct

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18. People with one copy of the **CCR5-Δ32** allele are more resistant to HIV than people with no copies of **CCR5-Δ32**, but less resistant than people with two copies of **CCR5-Δ32**.

    What does this tell us about the protective effect of the **CCR5-Δ32** allele?

A. It is recessive.
B. It is underdominant.
C. It is maintained by heterozygote advantage.
D. It is experiencing disruptive selection.
E. It is incompletely dominant.

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19. Why do antiviral drugs often have more severe side effects than antibiotics?

A. Viruses have higher mutation rates than bacteria.
B. Viruses are parasites and cannot easily be targeted without also harming host cells.
C. Viruses have more genes than bacteria.
D. Viruses replicate more quickly than bacteria.
E. Antiviral drugs interfere with reverse transcription, an important process in human cells.

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20. The hypothesis that "life exists on other planets" is

A. falsifiable, but not verifiable.
B. verifiable, but not falsifiable.
C. both falsifiable and verifiable.
D. neither falsifiable nor verifiable.

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21. According to Karl Popper, which of the following is necessary for a hypothesis to be considered "scientific"?

A. It must be correct.
B. It must be falsifiable.
C. It must be verifiable.
D. It must be published in a scientific journal.
E. It must have already been tested at least twice.

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22. Many scientific theories include both a pattern and a process. On which PROCESS was Darwin's theory of evolution based?

A. Orthogenesis
B. Particulate inheritance
C. Descent with modification from a common ancestor
D. Inheritance of acquired traits
E. Natural selection

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23. Why was Darwin's idea of blending inheritance <u>incompatible</u> with the idea of evolution by natural selection?

A. Blending inheritance reduces the amount of phenotypic variation in each generation.
B. Blending inheritance causes harmful alleles to increase in frequency.
C. Blending inheritance produces offspring that are less fit than either parent.
D. Blending inheritance produces offspring that are genetically identical to their parents.
E. Blending inheritance causes populations to remain in Hardy-Weinberg equilibrium.

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24. In an effort to provide a wider pool of professional basketball players, imagine that the NBA begins an ambitious program to increase human height. The program provides all North American children with an excellent, high quality diet.

    How will this program affect the heritability of height in North America?

A. Heritability will increase.
B. Heritability will decrease.
C. Heritability will not change.

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25. Imagine an Intro Bio class in which the height of students ranges from about 4'10" to 6'5". The height of any individual can be predicted quite well if we know the height of the individual's biological parents.

    During a midterm exam, the ceiling of one of the exam rooms caves in and crushes all of the students in the room. Students writing in the other exam rooms are unharmed, however, and in later life produce many children.

    The average height of students that survive the accident is identical to the average height of students that were crushed.

    Which of the four postulates of natural selection is/are illustrated by this example??

    1. Individuals vary with respect to a trait (height).
    2. Some of this variation is heritable.
    3. Some individuals are more successful than others at surviving or reproducing.
    4. Differences in survival or reproduction are related to variation in the trait.

A. 1, 2 and 3
B. 1 and 3
C. 2 and 4
D. 4 only
E. 1, 2, 3 and 4 are all correct

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26. In Darwin's finches, knowing the beak depth of both parents allows us to predict beak depth of their offspring reasonably well, but not perfectly. Why not?

A. Parents and offspring often share similar environments.
B. Beak depth has a heritability of zero.
C. Beak depth has an environmental, as well as a genetic, component.
D. Beak depth is not variable in this population.

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27. How did Darwin's theory of evolution compare to that of Lamarck?

A. Darwin proposed that inheritance is particulate; Lamarck believed in blending inheritance.
B. Darwin's theory included both a pattern and a process; Lamarck's theory also included both a pattern and a process.
C. Darwin proposed that species evolve; Lamarck argued that species do not evolve.
D. Darwin proposed that species evolve over generations as some individuals outcompete others; Lamarck proposed that species evolve due to individuals changing within their lifetime.
E. Both B and D are correct.

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28. Why do trade-offs often limit the effectiveness of natural selection?

A. Improving one trait may come at the cost of worsening another trait.
B. The environment can often change faster than populations can evolve.
C. Natural selection can only act on the available genetic variation.
D. Improving the fitness of one individual tends to harm the relative fitness of other individuals.
E. Trade-offs reduce the amount of genetic variation in the population.

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29. Why are most genetic disorders associated with recessive alleles?

A. Individuals with one copy of a harmful recessive allele do not have low survivorship.
B. Homozygous dominant individuals survive better than heterozygotes.
C. Recessive alleles increase in frequency faster than dominant alleles do.
D. Heterozygotes have higher fitness than either type of homozygote.
E. Recessive mutations are nearly always harmful; dominant mutations are usually helpful.

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30. In a population of parrots, blue individuals (genotype **BB**) produce an average of 2 offspring over the course of their lifetimes. Green parrots (**Bb**) produce 8 offspring on average, and yellow parrots (**bb**) produce 6 offspring on average.

What is the relative fitness (w) of genotype **Bb**?

A. 16
B. 8
C. 1
D. 0.25
E. 0.125

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31. In the previous question, if selection pressures remain the same, and there is no genetic drift, migration or mutation occurring, what can you predict about the fate of alleles **B** and **b**?

A. Allele **b** will eventually reach a frequency of 1, and **B** will be lost.
B. Whichever allele is currently more common will reach a frequency of 1.
C. Whichever allele is currently less common will reach a frequency of 1.
D. Both alleles will be maintained in the population.

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32. How does directional selection affect the amount of genetic variation within a population?

A. The amount of genetic variation increases.
B. The amount of genetic variation decreases.
C. The amount of genetic variation stays the same.

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33. Imagine a population of raccoons in which food-washing behaviour is controlled by one gene locus. **FF** individuals wash their food thoroughly before eating; **Ff** individuals wash their food less thoroughly; and **ff** individuals never wash their food. After observing 1000 raccoons, you count 300 **FF**, 200 **Ff** and 500 **ff** individuals.

What is the frequency of the **f** allele for this population?

A. 0.36
B. 0.5
C. 0.6
D. 0.7
E. Because the population is not in Hardy-Weinberg equilibrium at the food-washing locus, it is impossible to calculate the frequency of the **f** allele.

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34. Western's mascot is a wild horse called a mustang. Imagine that fur colour in mustangs is controlled by one gene locus: **RR** individuals are red, **Rr** individuals are purple, and **rr** individuals are blue. In a population of 100 mustangs, you count 5 red, 90 purple and 5 blue individuals.

    Which of the following is a likely explanation of this distribution?

A. Fitness is not related to fur colour.
B. This locus works by blending inheritance.
C. **R** and **r** are equally frequent, so the population is in Hardy-Weinberg equilibrium.
D. The population is extremely inbred.
E. This locus shows heterozygote advantage (overdominance).

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35. Which of the following processes is most likely to increase the frequency of homozygotes in a population?

A. genetic drift
B. disassortative mating
C. overdominance
D. negative frequency-dependent selection
E. migration

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36. What is/are the major genetic effect(s) of inbreeding on a population?

    1. It increases the frequency of harmful alleles.
    2. It increases the frequency of recessive alleles.
    3. It increases the mutation rate.
    4. It decreases the proportion of individuals that are heterozygous.

A. 1, 2 and 3
B. 1 and 3
C. 2 and 4
D. 4 only
E. 1, 2, 3 and 4 are correct

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37. According to sexual selection theory, when should females compete for mates more intensely than males do?

A. Whenever females have higher average fitness than males.
B. Whenever females invest less in offspring than males do.
C. Whenever females have lower average fitness than males.
D. Whenever females invest more in offspring than males do.
E. Females should never compete for mates more intensely than males do.

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38. According to the "rubies in the rubbish" hypothesis, which of the following is an important advantage of sex?

A. Sex increases the rate of helpful mutations and decreases the rate of harmful mutations.
B. Sex preserves adaptations to a stable environment.
C. Sex increases the chance that at least some offspring will have fewer harmful mutations than their parents.
D. Sex reduces the mutation rate.

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39. Which of the following accurately describes sexual selection in humans?

1. Males and females are both very choosy when selecting short-term mating partners.
2. Males and females are both very choosy when selecting long-term mating partners.
3. Males and females have very similar potential fitness.
4. Males and females have very similar average fitness.

A. 1, 2 and 3
B. 1 and 3
C. 2 and 4
D. 4 only
E. 1, 2, 3 and 4 are correct

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40. Which of the following best describes the "lottery ticket" hypothesis for the evolution of sex?

A. Only a tiny minority of animal species reproduce asexually, so there must be some important benefit to reproducing sexually.
B. Sexually produced offspring contain fewer mutations than asexually produced offspring.
C. Although most mutations are harmful, some can be extremely helpful.
D. Producing a wide variety of offspring genotypes is a good way to ensure that at least some will be well adapted to new environmental conditions.
E. Your odds of finding a high quality mate are about as good as your odds of winning the lottery.

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41. For what type of population is the *Biological Species Concept* most useful?

A. Populations that are extinct.
B. Populations that are allopatric.
C. Populations that are sympatric.
D. Populations that reproduce asexually.
E. Populations that are arranged in a ring.

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42. Which of the following examples represent postzygotic isolating mechanisms?

1. When male donkeys mate with female horses, the offspring are sterile.
2. When two types of rose are crossed, the offspring are more fit than either parental type.
3. When male goats mate with female sheep, the offspring die before being born.
4. One type of flower is visited and pollinated only by bees; another type of flower is visited and pollinated only by hummingbirds.

A. 1, 2 and 3
B. 1 and 3
C. 2 and 4
D. 4 only
E. 1, 2, 3 and 4 are correct

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43. Why does the group of salamanders whose range forms a ring around California's Central Valley represent a problem for the Biological Species Concept?

A. Biologists do not know why the salamanders live all around, but not in, the Central Valley.
B. All the populations freely interbreed with one another, so it is not clear why the populations look so different.
C. All the populations look very similar to one another, so it is hard to tell them apart and to estimate how many species are in the group.
D. At one point in the ring, adjacent populations do not interbreed, but they are connected by a series of populations that do interbreed.
E. The populations are postzygotically, but not prezygotically, isolated from one another.

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44. Many years ago, when Dr. Beth first went birdwatching, myrtle warblers and Audubon's warblers were thought to represent two different species. Based on the Biological Species Concept, myrtle warblers and Audubon's warblers are now considered all part of the same species. What must have been discovered about these birds?

A. Myrtle and Audubon's warblers interbreed in the wild to produce fertile offspring.
B. Myrtle and Audubon's warblers look too similar for us to reliably tell them apart.
C. Myrtle and Audubon's warblers live in the same geographic area.
D. Myrtle and Audubon's warblers are genetically quite similar to one another.

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45. Based on the phylogeny shown in Figure 1, which of the following groupings are monophyletic?

1. **U** and **V**
2. **R**, **S**, **T**, **U** and **V**
3. **T**, **U** and **V**
4. **S**, **T**, **U** and **V**

A. 1, 2 and 3
B. 1 and 3
C. 2 and 4
D. 4 only
E. 1, 2, 3 and 4 are all monophyletic groupings

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46. According to the phylogeny shown in Figure 1, which species is most closely related to **T**?

A. **S**
B. **U**
C. **S** and **U** are equally closely related to **T**
D. **U** and **V** are equally closely related to **T**
E. **R**, **S**, **U** and **V** are equally closely related to **T**

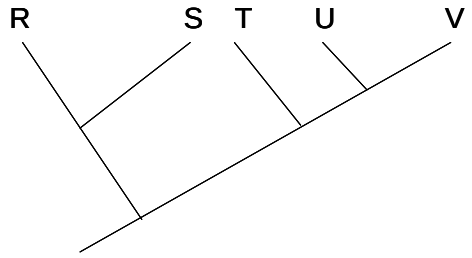

Fig. 1: Evolutionary relationships among species **R**, **S**, **T**, **U** and **V**.

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47. If Figure 1 is correct, what can you conclude about a trait that is present in species **R** and **U**, but absent in species **S**, **T** and **V**?

A. The trait is ancestral.
B. The trait is derived.
C. The trait is an autapomorphy.
D. The trait is shared by **R** and **U** due to homoplasy.
E. None of A, B, C or D is correct. **R** and **U** cannot share traits that are not also present in **S**, **T** and **V**.

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48. Which of the following statements helps to explain why the fossil record is described as 'biased'?

A. Fossilization happens so slowly that only the most ancient species have had a chance to form fossils.
B. Supporters of punctuated equilibrium sometimes hide or destroy transitional forms in an attempt to make evolution seem more rapid than it really is.
C. Transitional forms are less likely to fossilize than either ancestral or descendant forms are.
D. Organisms with shells, bones or teeth are more likely to go extinct than soft-bodied organisms are.
E. Organisms with shells, bones or teeth are more likely to be preserved as fossils than soft-bodied organisms are.

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49. You are excited to find a rock containing 7 parts parent isotope (Thorium-232) to 1 part daughter isotope (Lead-208). If the half-life of Thorium-232 is 14 billion years, approximately how old is the rock?

A. 2 billion years
B. 3.5 billion years
C. 7 billion years
D. 12.25 billion years
E. 14 billion years

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50. Which of the following best describes an "adaptive radiation"?

A. A helpful (adaptive) new trait spreads throughout a population.
B. A helpful (adaptive) new trait jumps from species to species.
C. Two formerly isolated populations come back into secondary contact and produce hybrids that are well adapted to the new environment.
D. A species that is well adapted to its current environment expands its geographic range.
E. A species diverges into many new descendant species, each in its own ecological niche.
