111

WESTERN UNIVERSITY
BIOLOGY 1001A

Term Test Oct. 26, 2013 Time: 2 Hours

Student No. _____ Test Room _____ Row _____

INSTRUCTIONS - FOLLOW THE CHECK LIST!

(√)	On your Scantron sheet	
	Print name	Print clearly
	Signature	Do your best
	Instructor	Haffie/MacDougall-Shakleton
	Course	Bio 1001A
	Student number	Print clearly/ Bubble neatly
	Exam Code	**111 – Very important**
	Section	Leave it blank
	Answer Sheet	Leave it blank

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

(√)	On this Test Book	
	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.	

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 OWL for study purposes.

1) Please place your ID prominently on your desk and sign the attendance sheet when it comes to you.
2) There are **46** questions in this test. Check your paper carefully.
3) There is only **one** fully correct option for each question. Part marks may be awarded. **Answer all questions**.
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 hour test period.**
6) When finished, **please stay seated** and raise your hand. We will collect both your test book and your Scantron sheet.

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.

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

Q #	Ans	Clarification	Alt Ans
50	*D*	*However, if you mean Watson the DOG, then my answer changes to . . .*	*B*

Circle the best single letter choice for each of the following questions before transferring your answers to your computer sheet. Note, for "multiple-multiple" style questions, more than one option may be correct (e.g. 1, 2 & 3 only). Part marks may be available for choosing some of the correct answers but choosing any incorrect answer earns a grade of "0".

1. Tests of a new antibacterial drug show that when the drug is present, resistant (mutant) forms of bacteria soon appear and become more common than susceptible forms. However, when drug treatment is stopped, susceptible forms of bacteria soon appear and become more common than resistant forms.

   What does this suggest about the mutation associated with drug-resistance?

   1. When the drug is present, drug-resistant mutant bacteria have an advantage over susceptible bacteria.
   2. Mutation rates overall are higher when the drug is present than after drug treatment.
   3. When the drug is absent, susceptible bacteria have an advantage over drug-resistant mutant bacteria.
   4. The mutation is more likely to occur when it would be useful, that is, during drug treatment.

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

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2. The use of antiviral drugs suffers from a paradox: the more we use them, the less effective they become in controlling viral infections. Why?

   A. Antiviral drugs increase the viral mutation rate, making it more likely overall that a mutation improving resistance will occur.
   B. Antiviral drugs make it more likely that the next mutation to occur will be one that improves resistance.
   C. Once a mutation that improves resistance has occurred, antiviral drugs provide a selective environment in which the mutation is likely to spread.
   D. All of A, B and C are correct.

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3. Which of the following steps are required for a retrovirus to replicate itself?

   1. Reverse transcription of RNA to DNA.
   2. Transcription of DNA to RNA.
   3. Translation of RNA to proteins.
   4. Reverse translation of proteins to RNA.

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

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4. Why has it been so difficult to design safe and effective drug treatments for HIV?

   1. HIV is a complex organism with a large genome.
   2. HIV is a virus, meaning that drugs that disrupt its replication may harm the host as well.
   3. HIV has been infecting humans for many thousands of years, giving it plenty of time to evolve in response to our immune defenses.
   4. HIV has a very high mutation rate, allowing it to quickly evolve resistance to antiviral drugs.

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

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5. RNA molecules that can catalyze reactions, called ribozymes, are rather common. Why are there no catalytic DNA's?

A. The 2' hydroxyl group makes DNA too unstable.
B. DNA molecules are unable to fold into predictable shapes.
C. The presence of thymine in DNA inhibits substrate binding.
D. Being confined to the nucleus, DNA is not readily accessible compared to RNA.

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6. There is no physical evidence that LUCA (Last Universal Common Ancestor) ever existed – it's just one hypothesis to explain the relatedness of modern life forms. So let's imagine for the moment that there was no LUCA.

   Which of the following consequences for the evolution of life would arise if there was no LUCA?

A. Life would have had to evolve multiple times, not just once.
B. The nucleus would have had to develop in many forms of early life, not just one.
C. The basic mechanism of protein synthesis would have had to evolve more than once.
D. Life would have evolved the ability to use another molecule besides H_2O as its solvent.

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7. Reductive Evolution is now seen as a widespread phenomenon in many groups of Bacteria and Archaea.

   What is thought to be the advantage to populations after they undergo reductive evolution?

A. Decrease in cell size.
B. Lower mutation rates.
C. Increased growth rates.
D. Increased cell complexity.

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8. Some people point to the homochirality of life in their arguments against the scientific theory of evolution.

   Which of the following points about homochirality is true?

A. How homochirality evolved remains unknown.
B. Homochirality has been shown to exist only in higher eukaryotes (apes, humans, Tom).
C. Although the Miller-Urey experiment generated homochiral molecules, none of them were biologically important.
D. Scientists have yet to come up with a reasonable hypothesis for why homochirality would have evolved.

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9. Lesulas are a recently-discovered species of monkey living in the African rain forest. They last shared a common ancestor with killer whales about 85 million years ago, and last shared a common ancestor with wallabies about 140 million years ago.

   What can you infer about the evolutionary relationships among these species?

   1. Lesulas are more closely related to killer whales than to wallabies.
   2. Killer whales are more closely related to wallabies than to lesulas.
   3. Wallabies are equally closely related to lesulas and to killer whales.
   4. Wallabies and killer whales are more closely related to each other than either is to lesulas.

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

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10. The most recent common ancestor (MRCA) of humans and salmon lived about 440 million years ago, and the MRCA of humans and sharks lived about 460 million years ago.

    Based on these dates, approximately when did salmon and sharks last share a common ancestor?

    A. Less than 440 million years ago
    B. About 440 million years ago
    C. About 460 million years ago
    D. More than 460 million years ago

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11. Snakes last shared a common ancestor with birds about 280 million years ago. Snakes last shared a common ancestor with turtles about 300 million years ago.

    What can you conclude about the relationships among these groups?

    1. Any traits shared by snakes and birds, but not turtles, are probably due to convergent evolution, not to homology.
    2. Snakes are more closely related to turtles than they are to birds.
    3. Both birds and snakes are descended from turtles.
    4. Birds are more closely related to snakes than they are to turtles.

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

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12. Animals, plants, and fungi are distinct evolutionary groups that each contain some unicellular and some multicellular species. What does this suggest about the evolutionary history of multicellularity?

    A. Multicellularity has probably evolved more than once.
    B. The last universal common ancestor (LUCA) was probably multicellular.
    C. Multicellular animals are more closely related to multicellular plants and fungi than to unicellular animals.
    D. Multicellular species are probably less likely to go extinct than unicellular species.

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13. Photolyase, which efficiently repairs UV damage to DNA using energy from visible light, is an evolutionarily ancient enzyme. Bacteria, Archaea, and almost all Eukarya have photolyase genes and activity, with the apparent exception of placental mammals (i.e. mammals that are not monotremes or marsupials).

    Which aspect of evolutionary theory is supported by the lack of photolyase in any placental mammals?

A. Natural selection is an important evolutionary force.
B. Evolution occurs within populations, not within individuals.
C. Within a population, individuals vary.
D. Organisms descend from a common ancestor.

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14. The statement that "there is an invisible ghost in this exam room, that cannot be detected by human senses or instruments" is not considered scientific. Why not?

A. It cannot be proven to be true, even if it **is** true.
B. It cannot be proven to be false, even if it **is** false.
C. It is almost certainly false.
D. It is such a creepy idea.

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15. Male Australian Jack Jumper ants are haploid. They have only one chromosome and make gametes by mitosis. Female Australian Jack Jumper ants are diploid and make gametes by meiosis as usual.

    How much DNA would be in the nucleus of female Jack Jumper ant zygotes immediately following fertilization?

A. 0.5 x C
B. 1 x C
C. 2 x C
D. 4 x C

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16. A recent genome project reported that a particular species of bladderwort plant has very little junk DNA in its genome. Related species, like snapdragons, have typically high proportions of genomic junk DNA.

    Which of the following sequences would you expect to be much less common in the bladderwort genome compared to the genomes of related species?

A. genes
B. viruses
C. centromeres
D. gene families

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17. The "C-value enigma" arises out of the observation that, for instance, some species of frog have 100 times more DNA than other species of frog.

    In which of the following ways is this observation consistent with evolutionary theory?

A. Some species of frogs have been selected to be dramatically more complex than others.
B. Some species of frogs would, by chance, have many more chromosomes than others.
C. Some species of frogs would have accumulated more active mobile elements.
D. Some species of frogs would live in environments that required fewer genes.

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18. Data presented in class showed that the genomes of representative people of African descent had a great many more novel single nucleotide polymorphisms (SNPs) than representative people of Asian or Caucasian descent.

    Which of the following explanations for the lower frequency of novel SNPs in non-African populations is most likely?

A. Non-African populations have less active mobile elements.
B. Non-African populations have less recombination during meiosis.
C. Non-African populations have less exposure to mutagens such as UV light.
D. Non-African populations have less opportunity to accumulate SNPs over time.

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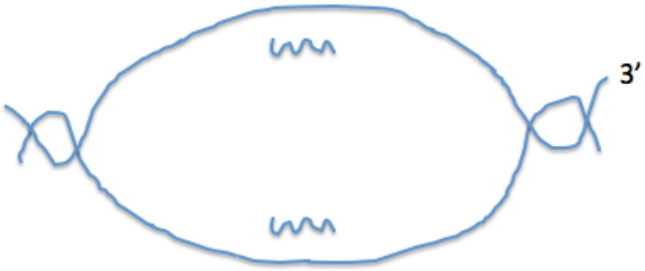
19. In this sketch of a newly formed replication bubble, the two wavy lines show RNA polymers.

    In which direction will each of these two RNA polymers be extended by DNA polymerase III?



	Top RNA	Bottom RNA
A	Extend to the left	Extend to the right
B	Extend to the right	Extend to the left
C	Extend to right and left	Extend to right and left
D	No extension will occur since DNA polymerase III does not extend RNA polymers.	

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20. Nucleic acid biochemistry makes use of several enzymes whose substrate is the "sugar-phosphate backbone" of nucleic acid chains.

    Which of the following enzymes can **break** the covalent bonds linking the sugar-phosphate backbone of nucleic acid chains?

    1. DNA polymerase I
    2. photolyase
    3. DNA polymerase III
    4. primase

A. 1,2 & 3 only
B. 1 & 3 only
C. 2 & 4 only
D. 4 only
E. All of 1,2,3 & 4 are correct.

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21. Although both nuclear and mitochondrial genomes must be replicated during the cell cycle, some aspects of DNA replication in the nucleus are not found in the mitochondrion.

    Which of the following characteristics of DNA replication could apply in the nucleus but NOT in the mitochondrion?

    1. semi-conservative replication
    2. telomerase activity
    3. attachment of spindles to kinetochores
    4. multiple origins of replication

A. 1,2 & 3 only
B. 1 & 3 only
C. 2 & 4 only
D. 4 only
E. All of 1,2,3 & 4 are correct.

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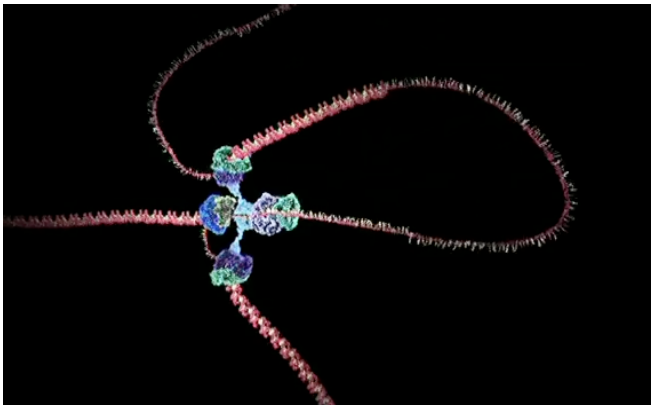
22. In this screenshot of an animation of a replisome, the template DNA to be replicated is approaching from the left; the leading strand is leaving toward the bottom and the lagging strand is looping out to the right.



    In which of the following ways is this replisome participating in **bi-directional** DNA synthesis?

A. There is another, similar, replisome working to replicate the same double-stranded DNA molecule at the other end of the replication "bubble" off to the right of this picture.
B. This one replisome is using 2 DNA polymerase III complexes at the same time; one to replicate the leading strand and one to replicate the lagging strand Okazaki fragment.
C. This one replisome is replicating both the leading and lagging strand at the same time – reading template 3' to 5' on one strand and 5' to 3' on the other.
D. This one replisome is creating both sister chromatids at the same time; one from the leading strand, one from the lagging strand.

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23. Imagine a cell that is stalled at the mitosis checkpoint and cannot proceed through the cell cycle. What might be wrong?

A. The cell has the wrong number of chromosomes (e.g. 2n + 1).
B. The homologous pairs have not all arrived at the metaphase plate following recombination.
C. A kinetochore protein has malfunctioned and the microtubule cannot attach.
D. DNA repair mechanisms have not finished removing mismatched base pairs.

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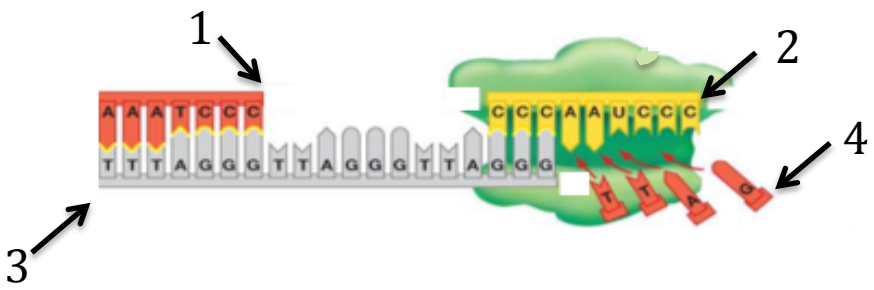
24. In this image depicting the action of telomerase, which arrow points to a 5' phosphate on a DNA nucleotide?



A. 1,2 & 3 only
B. 1 & 3 only
C. 2 & 4 only
D. 4 only
E. All of 1,2,3 & 4 are correct.

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25. Imagine a GC base pair in DNA as a replisome approaches. As the double strands are separated, the guanine on the template strand undergoes a tautomeric shift, resulting in polymerase adding an incorrect base to the growing strand.

Following another round of replication, which of the following SNP mutations will have been caused as a result of adding the incorrect base?

A. GC → CG
B. GC → AT
C. GC → TA

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26. Collections of mutations occurring in a given gene reveal that all base pairs are not mutated with equal frequency.

Which of the following explanations is the most likely to contribute to this unequal distribution of mutation?

A. Some base pairs can never be changed.
B. Many mutagens affect only specific DNA sequences.
C. Proofreading is more effective in certain areas of the gene.
D. Cells have a mechanism to allow beneficial mutations and prevent detrimental mutations.

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27. How does mutagenesis associated with physical agents (e.g. UV, ionizing radiation) compare and contrast with mutagenesis associated with chemical agents or processes (e.g. 5 bromouracil, tautomeric shifting)?

A. Damage from chemical agents can be repaired but damage from physical agents cannot.
B. Physical mutagens (e.g. radioactive iodine) affect somatic cells while chemical mutagens (e.g. cigarette smoke) affect germ line cells.
C. Physical agents (e.g. white light) can be used to repair the damage caused by chemical mutagens (e.g. 5BU).
D. Tautomeric shifts result in unusual hydrogen bonds while UV results in unusual covalent bonds.

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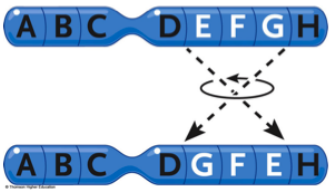
28. Most fish have external fertilization whereby gametes are released into the water and fertilized zygotes develop outside of the parent's body. Imagine that ionizing radiation strikes a zygote, resulting in several double-stranded breaks along one chromosome 4. Repair of these breaks results in a large section of chromosome 4 being inverted as shown.



Which of the following consequences is a likely result of this mutation?

1. Gene duplication.
2. Reduced recombination in this region if the inverted chromosome 4 pairs with its normal homologue in prophase of meiosis.
3. Failure of chromosomes to segregate properly into daughter cells at anaphase of mitosis.
4. Disruption of normal expression of genes located at the inversion breakpoints.

A. 1,2 & 3 only
B. 1 & 3 only
C. 2 & 4 only
D. 4 only
E. All of 1,2,3 & 4 are correct.

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29. Modern analysis has revealed that one of the traits studied by Mendel was caused by insertion of a mobile element into a gene in the pea plant genome.

Which of the following characteristics of such an insertion is true?

1. By our definition, insertion of this mobile element created damage in the target gene.
2. This mobile element would be replicated by DNA polymerase in meristem.
3. This mobile element would likely be removed by excision repair.
4. This mobile element would be present in DNA of pea gametophytes.

A. 1,2 & 3 only
B. 1 & 3 only
C. 2 & 4 only
D. 4 only
E. All of 1,2,3 & 4 are correct.

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30. Base analogues (e.g. 5-bromouracil) are taken up by cells and incorporated into DNA by polymerases.

Which of the following processes would likely incorporate base analogues into DNA?

1. Movement of a retrotransposon.
2. Recombination during meiosis.
3. Excision repair of mismatched bases.
4. Repair of thymine dimers by photolyase.

A. 1,2 & 3 only
B. 1 & 3 only
C. 2 & 4 only
D. 4 only
E. All of 1,2,3 & 4 are correct.

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31. Areas of repeated sequence in the genome are prone to slippage during replication and unequal recombination during meiosis. Both of these mechanisms can increase the number of copies of specific repeated sequences. This, in turn, makes such sites even *more* prone to more errors in the future. And so on and so on . . .

    So which of the following processes likely stops these repeated sequences from continuously increasing in number?

A. Perhaps nothing; genomes with more repeats are larger and therefore favoured by evolution.
B. Such repeats will be used as telomeres and will shorten at each round of replication.
C. Repeats will eventually get deleted when chromosomes are broken by ROS resulting from natural ionizing radiation.
D. The mechanisms mentioned above can also decrease copy number. Overall, copy number fluctuates within a reasonable range.

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32. Similar gene families involved in the development of a segmented body plan have been discovered in the genomes of animals as diverse as fruit flies and rats.

    Which of the following interpretations is most consistent with such observations?

A. Rats and fruit flies are closely related.
B. Segmentation genes were present in the common ancestor of flies and rats.
C. The same segmentation genes evolved in both rat and fly lineages.
D. Gene duplication was common in the evolution of both rats and flies after they diverged from a common ancestor.

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33. One copy of the entire nuclear genome of the bread wheat plant is distributed over 7 different chromosomes (n =7). However, the sporophyte that you see growing in fields is hexaploid (6n). Meiosis in hexaploid wheat reduces the chromosome number in half at meiosis I and reduces the amount of DNA by half in meiosis II – just as usual in other organisms.

    How many chromatids would be present in a wheat spore during metaphase of mitosis?

A. None. Spores do not divide by mitosis.
B. 7
C. 14
D. 21
E. 42

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34. The main evolutionary innovation required for evolution of meiosis from mitosis was a change from the "inheritance of sameness" (same number of chromosomes in daughter cells) to the "inheritance of difference" (only half the number of chromosomes in meiosis I daughter cells).

    Which of the following changes in the organization or action of the spindle apparatus would have been needed for meiosis to evolve from mitosis?

A. Microtubules attach to only one kinetochore on a given replicated chromosome.
B. Kinetochore motor proteins all pull toward one pole or the other.
C. Microfilaments fail to pinch off the two daughter cells in telophase.
D. Intermediate filaments attach to kinetochores instead of microtubules.

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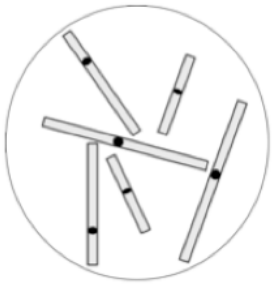
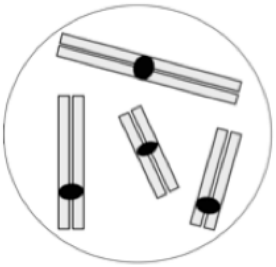
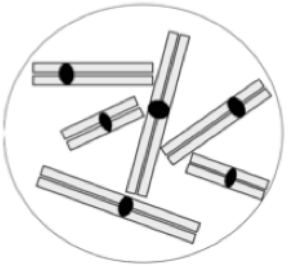
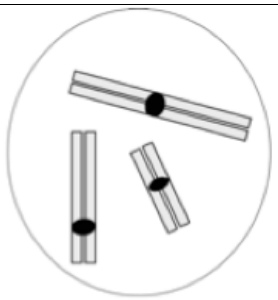
35. Which of the cells shown below is diploid?

1.	2.	3.	4.
			

A. 1,2 & 3 only
B. 1 & 3 only
C. 2 & 4 only
D. 4 only
E. All of 1,2,3 & 4 are correct.

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36. In which of the following ways is one member of a given homologous pair of chromosomes "the same" as the other member of the pair?

1. Both members of the pair are replicated from the same chromosome during S phase.
2. Both members of the pair contribute one chromatid to every gamete produced.
3. Both members of the pair carry their mobile elements in the same locations.
4. Both members of the pair have their centromeres in the same location.

A. 1,2 & 3 only
B. 1 & 3 only
C. 2 & 4 only
D. 4 only
E. All of 1,2,3 & 4 are correct.

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37. Presentations of cell cycling often state that "sister chromatids are identical".

However, in which of the following ways is one chromatid likely *different* from its sister?

1. Following recombination in meiosis, sister chromatids carry different alleles.
2. One chromatid is more susceptible to UV-induced dimers than the other.
3. Replication errors result in each sister chromatid carrying a different collection of SNPs.
4. In a replication bubble, sister chromatids are replicated by different replisomes.

A. 1,2 & 3 only
B. 1 & 3 only
C. 2 & 4 only
D. 4 only
E. All of 1,2,3 & 4 are correct.

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38. Imagine that you have a friend, Kalim, who comes to you after having done personal DNA testing with his family. He is very upset and hopes that you, as a biology student, can help him.

"They say I am heterozygous for a single base pair deletion in a gene that, if homozygous, can make me smell like a fish. And what is worse, neither of my parents have this deletion. I must be adopted."

Which of the following responses regarding Kalim's situation would be accurate?

1. This deletion mutation might have happened as a result of a failure to proof-read your newly replicated DNA when you were dividing as a zygote inside your mother.
2. Relax, if your body is heterozygous it can never be homozygous; you won't ever smell like a fish.
3. Don't worry, only ¼ of your gametes will have the mutation.
4. This mutation might be in your cells, but not your Dad's cells, because of slippage that happened when your Dad was replicating DNA to make the gamete that gave rise to you.

A. 1,2 & 3 only
B. 1 & 3 only
C. 2 & 4 only
D. 4 only
E. All of 1,2,3 & 4 are correct.

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39. A "zonkey" is a hybrid between a zebra and a donkey (I am not making this up.) While Zebras are 2n = 46, donkeys are 2n = 62. Zonkeys are usually infertile.

Which of the following explanations for Zonkey infertility is most likely?

A. In the hybrid zygote, mobile elements in the donkey genome will move into the zebra chromosomes causing widespread mutations.
B. Zonkey gametes will all have an odd number of chromosomes (27) causing them to be nonfunctional.
C. When zebra and donkey chromosomes recombine at meiosis, the resulting chromosomes will be partly zebra and partly donkey. Therefore the resulting zygotes do not survive.
D. The zebra and donkey chromosomes will fail to form proper homologous pairs during meiosis I, creating unbalanced gametes following cell division.

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40. Consider a woman who is heterozygous for two traits: M^+/M^- for Maple Syrup Urine Disease on chromosome 19 and H^+/H^- for hemophilia on the X chromosome.

Which of the following gamete genotypes should this woman expect to produce?

1. M^- H^+
2. M^+ M^-
3. M^+ H^+
4. H^+ H^+

A. 1,2 & 3 only
B. 1 & 3 only
C. 2 & 4 only
D. 4 only
E. All of 1,2,3 & 4 are correct.

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41. Humans with one X chromosome, and two Y chromosomes, develop as males with 47 chromosomes rather than the usual 46. Consider one such man, Munir, who is red/green colour blind due to a recessive allele on his X chromosome.

    If Munir's father and mother were both phenotypically and karyotypically normal, identify which stage of meiosis, in which parent, was a likely site of the error in chromosome movement that resulted in Munir's unusual chromosome number.

    1. Meiosis I in mother.
    2. Meiosis I in father.
    3. Meiosis II in mother.
    4. Meiosis II in father.

A. 1,2 & 3 only
B. 1 & 3 only
C. 2 & 4 only
D. 4 only
E. All of 1,2,3 & 4 are correct.

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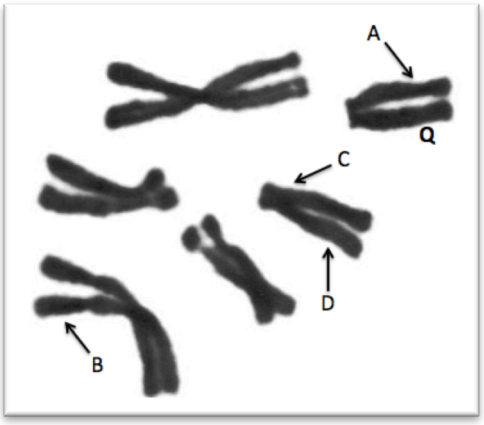
42. This particular animal is heterozygous for the "quick step" alleles, **Q** and **q**.

    The location of the **Q** allele is labeled on the diagram with a "Q"; which arrow indicates the location of the **q** allele?



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43. Cinnabar eyes is a recessive and sex-linked trait in fruit flies. Normal flies have red eyes.

    Which of the following crosses would give rise to progeny in which all sons have an eye colour that was different than that of all daughters?

	Mother	Father
A	Heterozygous Red	Cinnabar
B	Cinnabar	Red
C	Cinnabar	Cinnabar
D	Heterozygous Red	Red

---

44. Anwar and Jane hypothesize that women have a faster reaction time than men when country music is being played. What would be the best null hypothesis for this group?

A. Women prefer country music more than men.
B. Women have a faster reaction time than men.
C. There is no reaction time difference between men and women.
D. Women have a slower reaction time than men because they are easily distracted by country music.

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45. Farida samples 5 different populations of a single fish species and wants to use the chi-square test to determine if there is a difference in predation behaviour among the 5 populations.

Using a 5% rejection level, which critical chi-square value should she use from the table below?

Critical values of Chi-square			
Degrees of freedom	p=0.50	p=0.05	p=0.01
1	0.46	3.84	6.64
2	1.39	5.99	9.21
3	2.37	7.82	11.35
4	3.37	9.49	13.28
5	4.35	11.07	15.09
6	5.35	12.59	16.81
7	6.35	6.35	18.48

A. 0.46
B. 3.37
C. 3.84
D. 5.99
E. 9.49

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46. Given the information below, which of the following magnifications would be achieved by the light microscope?

Ocular lens = 20x
Objective lens = 100x (oil immersion)
1 stage division = 10μm
diameter of the field = 3.5mm

A. 10x
B. 20x
C. 200x
D. 2000x
