111

UNIVERSITY OF WESTERN ONTARIO

BIOLOGY 1001A

October 29, 2011 Time: 2 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, MacDougall-Shackleton	
	Course	Bio 1001A	
	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 **48** 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 hour test 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.

Challenges: 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 computer sheet. Note: *Questions may have 3, 4 or 5 choices.*

1. Eukaryotic cells are, on average, considerably larger than prokaryotic cells. Why might this be?

A. Eukaryotic cells need to be larger because their membrane-bound nucleus is larger than the nucleoid region of prokaryotes.
B. Eukaryotic cells need to be larger because they are usually part of multi-cellular organisms.
C. Eukaryotic cells can be larger since they can generate energy from several internal mitochondria.
D. Eukaryotic cells can be larger since they have desaturase enzymes that can maintain fluidity in large amounts of membrane.

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2. Mayonnaise can be made at home by adding a stream of olive oil into some vinegar in a blender. The blender creates tiny droplets of oil suspended in the water. If you then blend in an egg, amphiphilic phospholipids in the yolk will stabilize the oil droplets and prevent the oil from separating from the water.

What would you predict this would all look like at the molecular level?

A. The phospholipids would form a double membrane around each oil droplet.
B. The phospholipids would have their hydrophobic tails in the oil droplets and their hydrophilic heads in the surrounding water.
C. The oil droplets would line up in a membrane with the phospholipids holding them together.
D. The phospholipids would form spheres around the water molecules, keeping them away from the oil.

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3. Cells that make large amounts of insulin (a protein hormone) for export have correspondingly large amounts of rough endoplasmic reticulum (ER).

What makes endoplasmic reticulum "rough"?

A. ER is "rough" if it has many associated vesicles to transport proteins to the cell surface.
B. ER is "rough" if it has many associated intermediate filaments that help it to maintain its shape while proteins move through it on their way to the cell surface.
C. ER is "rough" if it has many associated plasmodesmata that provide easy export channels through the cell membrane.
D. ER is "rough" if it has many associated ribosomes to translate proteins destined for export.

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4. Imagine your friend discovers a new unicellular organism that has a DNA genome and ribosomes but no other cytoplasmic organelles.

Which Domain of life would this new organism belong to?

A. Archaea
B. Bacteria
C. Eukarya
D. A or B is possible.

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5. The sporophyte stage of the fern plant, *Ophioglossum pycnostichum* has an amazing 630 pairs of homologous chromosomes in each cell. (Recall that you have only 23 pairs.)

   How many chromosomes would be present in a dividing gametophyte cell at metaphase of mitosis?

A. 315
B. 630
C. 1260
D. 2520
E. 5040

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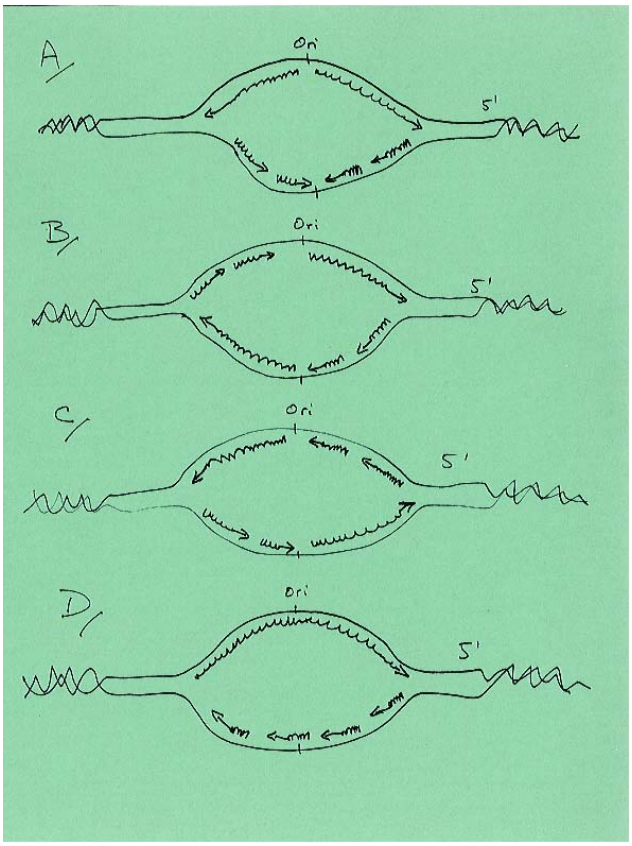
6. Imagine that students from your study group prepared these sketches to illustrate the semi-discontinuous replication of DNA in a replication bubble.

   Which sketch is accurate assuming that the 5' end of the top strand is on the right?



A.
B.
C.
D.

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7. Some cancer tumors increase in size because their cells are rapidly dividing "out of control".

   If you cut a cross section through such a tumor and observed the cells with a microscope, which stage of the cell cycle would most of the cells be in?

A. G_0
B. Interphase
C. Mitosis
D. Cytokinesis

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8. The drug 5-bromouracil (5BU) is used to treat certain forms of cancer. This toxic compound resembles thymine (T) and is incorporated into growing DNA chains across from adenine (A).

   If 5BU is provided to a cancer cell entering S phase, where will this drug be found in the chromosomes of newly formed daughter cells following mitosis?

A. All of the chromosomes inherited by all daughter cells would contain 5BU.
B. Only half of the chromosomes inherited by any given daughter cell would contain 5BU.
C. Only half of the daughter cells would have 5BU in all of their chromosomes; the other half of the daughter cells would have no 5BU in their chromosomes.

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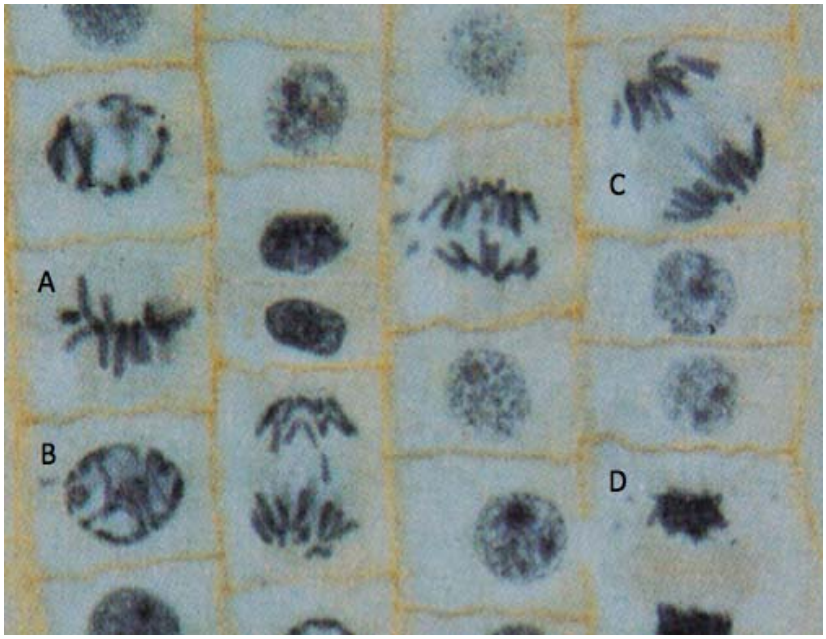
9. This image shows dividing cells with their chromosomes stained similar to the preparations you observed in the lab.



Although the cytoskeleton is not visible in this image, which cell would most likely have had kinetochore motor proteins actively moving along microtubules?

A. A
B. B
C. C
D. D

---

10. What role do cell cycle checkpoints play in the "inheritance of sameness"?

1. Checkpoints ensure that DNA polymerase does not read the wrong template strand.
2. Checkpoints ensure that all kinetochores are attached to spindles before anaphase.
3. Checkpoints ensure that organelles are properly replicated.
4. Checkpoints ensure that damage is repaired before DNA is replicated.

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

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11. The table below summarizes a survey of cells in various stages of mitosis in plant meristem tissue.

Stage of mitosis	Number of cells	% of total cells
Prophase	22	44
Metaphase	5	10
Anaphase	7	14
Telophase	16	32
Total # cells	50	

What can you conclude from these data?

A. Meristem cells divide faster than other plant cells.
B. Telophase follows anaphase.
C. Meristem cells don't go through interphase.
D. Prophase is the longest phase during mitosis.

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12. Imagine that you isolate some cells in metaphase of meiosis I from a rat and prepare them on slides for immunofluorescence light microscopy with staining for chromatin and the cytoskeleton. 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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13. ~~During transduction, progeny viruses are released as the donor cell is ruptured and killed. The recipient cell is then infected by one of the progeny viruses - but this cell is not killed.~~

    ~~Why does the recipient cell survive infection by a virus?~~

~~A. Recipient cells are infected by a progeny virus that is lacking some essential genes in order to carry bacterial DNA.~~
~~B. Recipient cells are infected by a progeny virus that is mutated and incapable of killing its host.~~
~~C. Recipient cells are infected by a progeny virus that carries antibiotic resistance.~~
~~D. Recipient cells are infected by a rare progeny virus that carries bacterial DNA rather than viral DNA.~~

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14. ~~Lederberg's experiment was significant because it demonstrated a kind of sexuality in bacteria.~~

    ~~What is "sexual" about conjugation?~~

~~A. Integration of a plasmid into a bacterial chromosome.~~
~~B. Movement of a plasmid from one host to another.~~
~~C. Creating new combinations of alleles on bacterial chromosomes.~~
~~D. One cell taking up DNA released into the environment by another cell.~~

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15. ~~Recall that, during Lederberg's experiment with *E. coli* cells, each of the two "parent" strains was plated individually onto petri dishes containing minimal medium (lacking amino acids).~~

    ~~What was the purpose of this step in the experiment?~~

~~A. This step confirmed that conjugation was the only likely method of genetic exchange.~~
~~B. This step confirmed that the wild-type strains could grow on minimal medium.~~
~~C. This step confirmed that the two parent strains carried different mutations.~~
~~D. This step confirmed that the mutations carried by the parent strains prevented any of them from growing on minimal medium.~~

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16. When does non-disjunction occur during meiosis?

A. Non-disjunction occurs when homologous pairs fail to undergo recombination.
B. Non-disjunction occurs when homologous pairs fail to separate to opposite poles in meiosis I.
C. Non-disjunction occurs when homologous pairs fail to separate to opposite poles in meiosis II.
D. Non-disjunction occurs when homologous pairs fail to enter the same cell at fertilization.

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17. "Interkinesis" is the name of the period between the end of meiosis I and the beginning of meiosis II.

    Which of the following is true during interkinesis?

    1. Cells are haploid.
    2. Sister chromatids are likely identical.
    3. Chromosomes have two chromatids.
    4. S phase prepares for meiosis II.

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

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18. Consider a spore produced by meiosis in a flowering plant. This amount of DNA in this cell is defined as "1C". The number of chromosomes in this cell is defined as "1n". That is, the value of n and the value of C are equal.

    At which stage of cell cycle/division is the value of C **double** the value of n?

    1. Metaphase of meiosis I.
    2. Metaphase of meiosis II.
    3. G2.
    4. G1.

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

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19. The *Drosophila Bar* gene was introduced in class. Recall that the mutant allele of this gene causes a change in the shape of fruit fly eyes.

    Which of the following cells in a fruit fly would contain this gene?

    1. Cells in brain.
    2. Cells in the eye.
    3. Cells in the wing.
    4. Gametes

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

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20. Consider a male fruit fly that is heterozygous for 3 genes, all linked on Chromosome 3. All dominant alleles are on one homologue, and all recessive alleles are on the other homologue. Although we didn't discuss this in class, you might be surprised to learn that *Drosophila* males do not engage in crossing-over during meiosis.

    How many different gametes would this male make?

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

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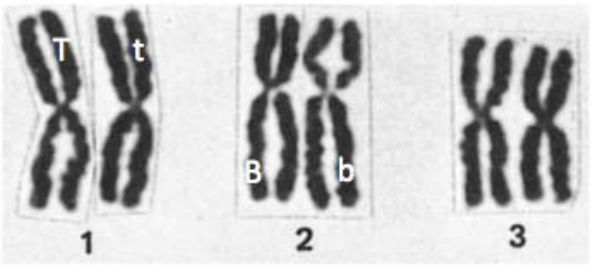
21. The four figures below each show the karyotype of a mosquito (2n = 6 chromosomes) that is heterozygous for two genes, **T** and **B**.

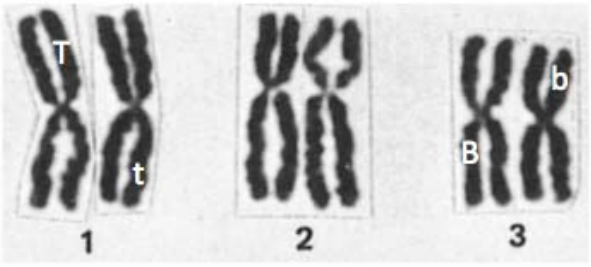
    Which of the figures correctly shows the relative location of the various alleles on the chromosomes?

A.



B.

C.



D.

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22. ~~Wilson's disease leads to liver damage as well as joint inflammation, kidney failure, uncontrolled shaking and psychiatric disturbances in humans. These symptoms all result from an accumulation of copper in the body as a result of the loss of function of a single type of membrane transporter protein that normally exports copper from liver cells.~~

    ~~Given this information, what can you conclude about the Wilson disease mutant allele?~~

    ~~1. This mutant allele is autosomal.~~
    ~~2. This mutant allele is likely recessive.~~
    ~~3. This mutant allele is likely polygenic.~~
    ~~4. This mutant allele is pleiotropic.~~

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

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

Crosses among heterozygotes produce about 1/4 affected offspring.

What is the proper notation for the dominant allele of the Barbie and Ken gene?

A. ***bk***$^{+}$
B. ***bk***
C. ***BK***$^{+}$
D. ***BK***

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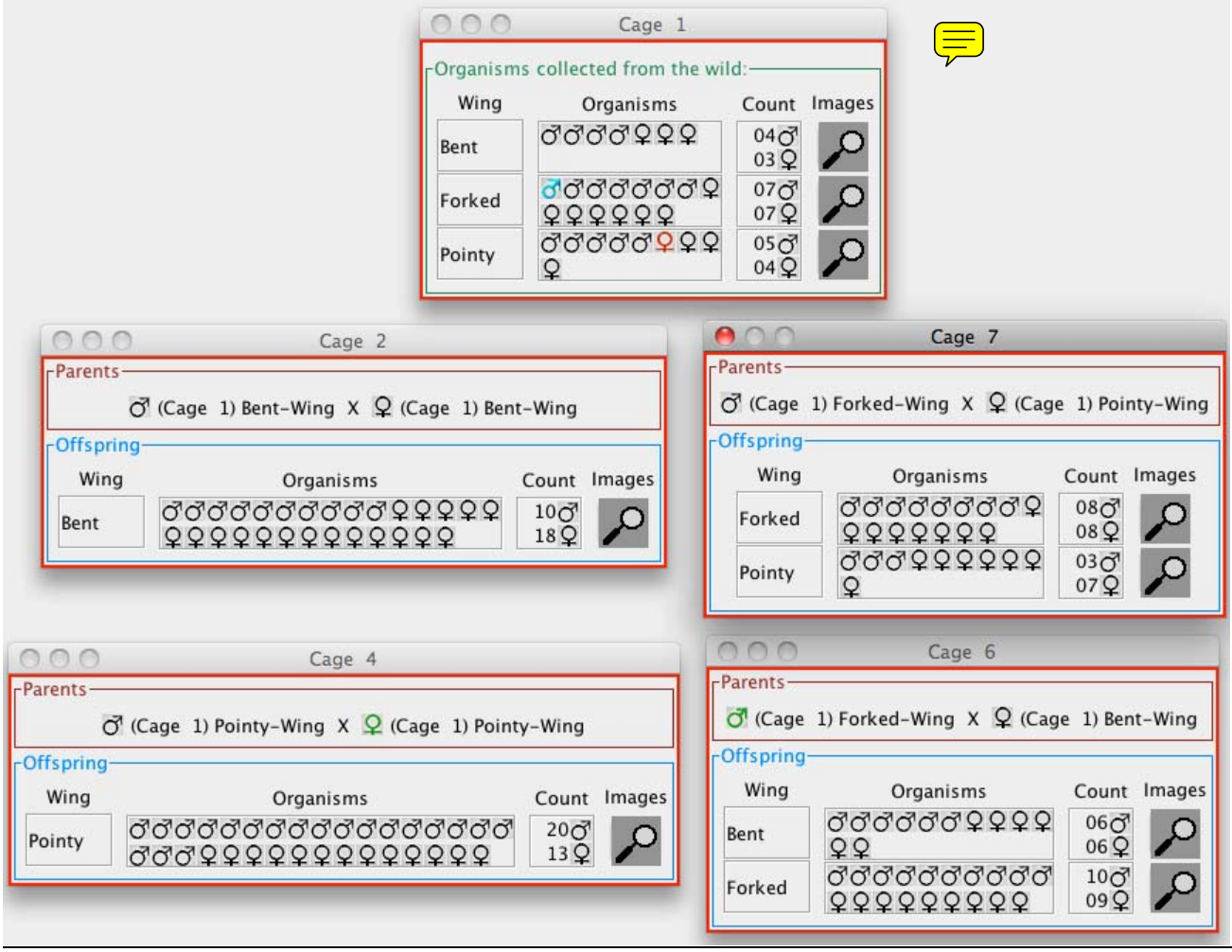
24. The image below shows the results of several simulated crosses of individuals from the original population in Cage 1.

What can you conclude from these data?
(You don't need to have experience with this software to answer the question. Just notice the distribution of progeny from particular crosses and make a model.)

A. Wing shape is controlled by three genes.
B. Wing shape is controlled by three alleles.
C. Wing shape is sex-linked.
D. Wing shape shows codominance (or incomplete dominance).



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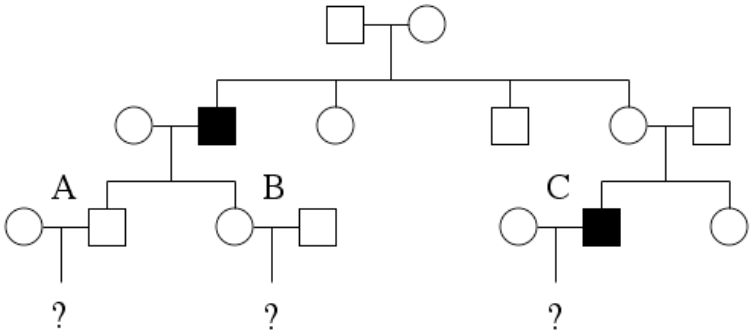
25. Shaded individuals in the following pedigree have a rare **sex-linked recessive** trait.



Which of the three couples (A, B or C) has the **lowest** risk of having an affected child? (Assume that i) circles are female, ii) squares are male, iii) anyone marrying into the family carries only normal alleles.)

A. Couple A
B. Couple B
C. Couple C
D. Couple A and C both have the same low risk.
E. All three couples have the same risk.

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26. The angiotensin converting enzyme (ACE) gene in humans appears to be associated with physical strength and athletic prowess. The two most common alleles of this gene, referred to as "**I**" and "**D**", confer higher than average endurance and power, respectively. For instance, **II** individuals tend to excel at marathon while **DD** individuals may be exceptional sprinters or body-builders.

Two heterozygous parents plan to have three children but don't want any marathoners in the family. What is the likelihood that none of their three children will be ~~**DD**~~? II

A. $1 - (1/4)^3$
B. $3(1/4 \times ½)$
C. ¾ + ¾ + ¾
D. $(¾)^3$

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27. ~~The pathway shown below results in seed colour in a species of tree. Three epistatic genes are involved as shown below. An enzyme coded by the dominant allele of each gene controls each step in the pathway. All recessive alleles code for a defective enzyme that is unable to catalyze its step of the pathway. All genes assort independently of one another and all dominance is complete.~~

~~Gene **A** Gene **B** Gene **C**~~

~~White pigment → Yellow pigment → Orange pigment → Red Pigment~~

~~From the cross **AaBBCc** x **aabbcc**, what fraction of the progeny would be red? (Note that this is a test cross, not a dihybrid cross.)~~

~~A. 1/2~~
~~B. 1/4~~
~~C. 1/8~~
~~D. 1/16~~

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28. The Xolo is the national dog of Mexico. This animal, once considered sacred by the ancient Aztecs, remains a popular pet in modern times. The striking characteristic of this dog is that it has no hair. Xolos carry a mutation in Chromosome 17 that, when homozygous, is lethal.

If two hairless Xolos were mated, what fraction of their surviving offspring would be hairless?

A. 1/4
B. 2/4
C. 2/3
D. All

Case Study: Use the following information to answer **Questions 29, 30 and 31**.

While Xolo dogs are famous in Mexico because they are bald, some people in Mexico are famous because they are very hairy. Victor and Gabrielle Ramos Gomez are brothers who perform as trampoline acrobats. They also have thick dark hair growing over their faces and most of their bodies. This human disorder, called Ambras Syndrome, shows sex-linked dominant inheritance.

The hairy Gomez brothers have a mother (Louisa) who, like them, is affected by Ambras Syndrome. However, Louisa's excessive hair growth occurs in variously scattered patches on her skin rather than in a "full body beard" like her sons.

Karyotype analysis shows that the mutation causing the disorder in affected members of this family is a chromosomal inversion.

29. If Victor has a family with a normal woman, what can you predict about the distribution of hairiness among his children?

A. Sons will be affected; daughters will not.
B. Daughters will be affected; sons will not.
C. Half of sons will be affected; none of daughters will be affected.
D. Half of daughters will be affected; all of sons will be affected.

30. What is the most likely explanation of the patchy expression of hairiness on Louisa's skin?

A. During development, Louisa randomly inactivated one X chromosome in her cells. Therefore, some patches of skin express the normal X; some patches express the mutant X.
B. During development, Louisa formed by fusion of two different embryos. Therefore, some patches of skin express the normal X; some patches express the mutant X.
C. Just after fertilization, the zygote that gave rise to Louisa underwent recombination between her two X chromosomes. Therefore, some patches of skin express the normal X; some patches express the mutant X.
D. Louisa is actually an XXY individual. Therefore, some patches of skin express the hairless female (XX) chromosomes; some patches express the hairy male (XY) chromosomes.

31. What type of chromosomal rearrangement is called an "inversion"?

A. An inversion occurs when one member of a homologous pair of chromosomes is "upside down" relative to the other.
B. An inversion occurs when one sister chromatid is "upside down" relative to the other.
C. An inversion occurs when the genes along one particular section of a chromosome are "upside down" (in the reverse order) relative to a normal chromosome.
D. An inversion occurs when the allele on one sister chromatid is "upside down" relative to the allele on the other sister chromatid.

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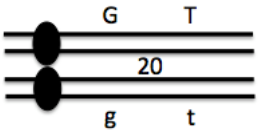
32. This diagram below shows the arrangement of the alleles of two genes on Chromosome 6 entering prophase of meiosis. The map distance separating these genes is also shown.

What will be the expected frequency of the **G t** gamete?



A. 10%
B. 20%
C. 40%
D. 80%

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33. The colour of corn plants is controlled by a gene with two alleles, **Y** & **y**. The dominant allele codes for green colour while homozygous recessive plants are yellowish. Coloured kernels result from a second gene, also with two alleles, **C** & **c**. The dominant allele results in coloured kernels while homozygous recessive plants have colourless kernels.

In a dihybrid testcross, the following progeny were obtained.

Phenotype	Number
Coloured kernel, green plant	12
Coloured kernel, yellow plant	88
Colourless kernel, green plant	92
Colourless kernel, yellow plant	8
Total	200

What can you conclude from these data?

A. One colour gene shows epistasis over the other colour gene.
B. The alleles of these genes assort independently.
C. These genes are separated by 10 map units.
D. These genes were linked in cis in the dihybrid parent.

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34. The genes *dumpy wings* (**dp**), *clot eyes* (**cl**) and *apterous wings* (**ap**) are linked on chromosome II in *Drosophila*. In a series of mapping crosses, the map distances shown below were determined.

Which of these three genes lies between the other two?

Genes involved in cross	Map distance
dp - ap	42
dp - cl	3
ap - cl	39

A. *dumpy wings*
B. *clot eyes*
C. *apterous wings*

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35. Richard samples five different populations of a single fish species and wants to use the chi-square test to determine if there is a difference in predatory behaviour among the five populations.

Using a 5% rejection level, which critical chi-square value should he use from this table?

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	14.07	18.48

A. 3.37
B. 5.99
C. 9.49
D. 11.07
E. None of these values is appropriate in this situation.

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36. While walking in the corridor, you overhear Richard say that he rejected his null hypothesis in the above fish behaviour experiment.

What can you conclude from this information?

A. There was a difference in the behaviour among the populations.
B. His calculated chi-square value was less than the critical value.
C. He should repeat the experiment with fewer populations.
D. The variation in behaviour among populations was just due to chance.

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37. Antiviral drugs generally have more severe side effects than do antibacterial drugs (antibiotics).

Why do antiviral drugs have relatively severe side effects?

A. Viruses have higher mutation rates than bacteria do; they become resistant faster.
B. Eradicating something that is not technically “alive” (such as a virus) requires high doses of harmful chemicals.
C. Viruses replicate using the cellular machinery of their hosts, so drugs capable of stopping viral replication also tend to interfere with host cell physiology.
D. Antiviral drugs expose the patient to viral coat proteins or other viral particles, which increases the risk of secondary infections.

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38. How are retroviruses different from “normal” (non-retro) viruses?

A. Retroviruses are not alive; normal viruses are.
B. Retroviruses can evolve; normal viruses cannot.
C. The flow of information in retroviruses runs from proteins to RNA to DNA; the flow of information in normal viruses runs from DNA to RNA to proteins.
D. Retroviruses have an RNA genome; normal viruses have a DNA genome.

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39. Treating a viral infection with an antiviral drug quickly results in the viral population evolving improved resistance to the drug (that is, "improved" from the virus' point of view).

Why does drug-resistance not evolve in the absence of antiviral treatment?

A. In the absence of antiviral treatment, mutations that improve drug-resistance would not be useful, so they do not occur.
B. In the absence of antiviral treatment, mutations that improve drug-resistance occur but are not passed on to daughter virions.
C. In the absence of antiviral treatment, the rate of mutations that improve drug-resistance is balanced by the rate of mutations that worsen drug-resistance.
D. In the absence of antiviral treatment, mutations that improve drug-resistance are not useful. Although they may occur, they are unlikely to spread.

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40. In humans, the normal CCR5 allele codes for a cell surface receptor that is used by HIV to infect host cells. The mutant CCR5-Δ32 allele codes for an alternative receptor that renders homozygous people highly resistant to HIV infection. People with one mutant allele and one normal allele are somewhat less resistant and homozygous "normal" people are sensitive to infection.

What does this tell us about the CCR5-Δ32 allele?

A. The CCR5-Δ32 allele is codominant.
B. The CCR5-Δ32 allele is not very helpful.
C. The CCR5-Δ32 allele is recessive.
D. The heritability of the CCR5-Δ32 allele is less than one.

~~41. In a galaxy far far away, a Mandalorian bounty hunter is cloned to produce a large army of genetically identical individuals (which we will call the Clone Army). Despite being genetically identical to one another, not all the clones grow to exactly the same height (it depends on how much food they received while growing up).~~

~~What is the heritability of height in the Clone Army?~~

~~A. 0~~
~~B. More than 0, but less than 1~~
~~C. 1~~
~~D. Impossible to tell without more information~~

~~42. Which of the following statements best illustrates evolution?~~

~~A. Shell colour in beetles is governed by the **S** locus; **SS** and **Ss** individuals have colourful shells and **ss** individuals have dull shells.~~
~~B. Beetles with colourful shells are more visible to predators, so they are less able to survive and reproduce than beetles with dull shells.~~
~~C. An unexpected snap of cold weather causes many beetles to freeze to death.~~
~~D. Alleles **S** and **s** have frequencies 0.4 and 0.6 respectively in one generation of beetles (parents), and 0.5 and 0.5 respectively in the next generation (offspring).~~

~~43. Which of the following best describes heritability?~~

~~A. The proportion of an individual's phenotype that is attributable to the individual's genotype.~~
~~B. The proportion of phenotypic variance in a population that is attributable to genetic differences between individuals.~~
~~C. The proportion of genes affecting a trait that are variable (polymorphic) in the population.~~
~~D. The degree to which all members of the population experience the same environment.~~

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44. A population of Wookiees is in Hardy-Weinberg equilibrium at the **W** locus (alleles are **W** and **w**).

What can you conclude about this population?

1. Genotype frequencies must be 25% **WW**, 50% **Ww**, 25% **ww**.
2. Mating must be random with respect to genotype at this locus.
3. All three genotypes must have the same phenotype.
4. All three genotypes must have the same absolute fitness, on average.

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

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45. In a hypothetical population of toucans, beak colour is determined by the **B** locus. Individuals with genotype **BB** have blue beaks, individuals with genotype **Bb** have green beaks, and individuals with genotype **bb** have yellow beaks. Out of 100 toucans, you count 81 blue-beaked, 18 green-beaked, and only one yellow-beaked individual.

What can you reasonably conclude about this trait in this population?

A. All three genotypes have equal relative fitness.
B. Genotype **BB** has the highest absolute fitness.
C. The yellow-beaked individual is probably an immigrant from another population.
D. The yellow-beaked individual is probably a mutant.

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46. Which of the following sets of genotype frequencies describe a population in Hardy-Weinberg equilibrium at the **A** locus?

1. 0.50 **AA**, 0.00 **Aa**, 0.50 **aa**
2. 0.33 **AA**, 0.33 **Aa**, 0.33 **aa**
3. 0.00 **AA**, 1.00 **Aa**, 0.00 **aa**
4. 0.36 **AA**, 0.48 **Aa**, 0.16 **aa**

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

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47. Why is the Hardy-Weinberg principle considered so important?

A. Its assumptions are fairly realistic for natural populations.
B. Deviations from Hardy-Weinberg reveal that at least one evolutionary force is operating.
C. It identifies which evolutionary force(s) is/are operating.
D. It shows how we can use genotype frequencies to calculate allele frequencies.

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48. In a population of salamanders, red individuals (genotype **RR**) produce an average of 15 offspring over their lifetime. Orange individuals (**Rr**) produce a lifetime average of 10 offspring and yellow salamanders (**rr**) produce a lifetime average of 5 offspring.

What is the relative fitness of orange salamanders (genotype **Rr**)?

A. -5
B. 0.333
C. 0.667
D. 10
