111

UNIVERSITY OF WESTERN ONTARIO

BIOLOGY 1002

March 18, 2012 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, Maxwell	
	Course	Bio 1002	
	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 34 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 4 or 5 choices.*

1. Which of the following statements about the process of cellular respiration is correct?

   1. Most of the ATP is generated by substrate-level phosphorylation.
   2. The efficiency with which the energy of glucose is converted into ATP is close to 90%.
   3. While the citric acid cycle releases CO_2, electron transport releases O_2.
   4. Overall it is catabolic, but it consists of both exergonic and endergonic reactions.

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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2. The total free energy present in glucose is 686 kcal/mol, and the free energy needed to reduce NAD^+ to NADH is 53 kcal/mol.

   Why are only two molecules of NADH formed during glycolysis when many more could be formed?

A. Most of the free energy in glucose is used to synthesize ATP in glycolysis.
B. Most of the 686 kcal/mol is released as heat because glycolysis is very inefficient.
C. Most of the free energy in glucose remains in pyruvate.
D. Most of the free energy in glucose is released as CO_2.

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3. A key enzyme of the Krebs cycle is isocitrate dehydrogenase which catalyzes the conversion of isocitrate to alpha ketoglutarate.

   Given your understanding of the Krebs cycle, how is the activity of isocitrate dehydrogenase regulated?

A. It is activated by lactate.
B. It is inhibited by glucose.
C. It is activated by a low ADP/ATP.
D. It is activated by a high NAD^+/NADH.

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4. Someone on a ketogenic diet relies heavily on the consumption of fats for energy. A fatty acid is broken down into 5 molecules of acetyl-CoA.

What is the total yield of ATP generated from the complete oxidation of this acetyl-CoA? (Assume that all components of the respiratory pathway are operational.)

A. 45
B. 50
C. 60
D. 70

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5. A bodybuilder named Jimmy McBuff arrives at the emergency room barely alive. His work-out partner tells the physician that Jimmy had recently taken ten times the recommended dose of RippedFreak supplement. After some tests, the physician suspects that RippedFreak probably contains an uncoupler.

   Which of the following clinical findings is consistent with the hypothesis that Jimmy consumed an uncoupler?

A. Jimmy had an unusually low rate of breathing.
B. Jimmy had an unusually high body temperature.
C. The NAD^+/NADH ratio in Jimmy's blood was unusually low.
D. The levels of glucose in Jimmy's blood were unusually high.

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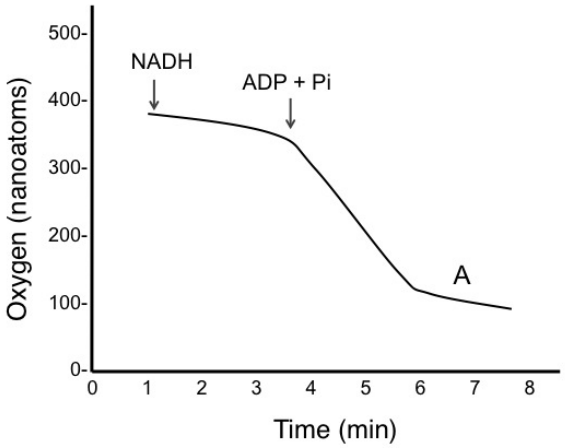
6. The graph at right shows the rate of respiration in isolated mitochondria. (The arrows indicate addition of NADH, ADP etc.)

   Which of the following metabolic conditions is the best explanation for the rate of respiration denoted by region A?



A. Inhibition of glycolysis.
B. Addition of an uncoupler.
C. A very high ATP/ADP ratio.
D. Decrease in the proton motive force across the inner mitochondrial membrane.

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7. Under conditions of low oxygen, the activation of fermentation results in the generation of lactate from pyruvate. However, lactate contains more free energy than pyruvate.

   Therefore, why does fermentative metabolism exist at all?

A. It generates NAD^+, which is required for ATP synthesis in the cytosol.
B. Unlike pyruvate, lactate can be directly oxidized by the electron transport chain.
C. Maintenance of a high lactate/pyruvate ratio is essential for normal respiratory metabolism.
D. The conversion of pyruvate to lactate generates additional ATP that partially offsets the loss of oxidative phosphorylation.

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8. One industrial application of fermentation is the production of fuel ethanol from corn. Based on your experience in the lab, which of the following components is not likely necessary for high-yielding production of ethanol from corn starch in industrial fermenters?

A. amylase; an enzyme to convert starch to simple sugars
B. anaerobic environment
C. optimal pH and temperature
D. continuous removal of lactic acid

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9. Which of the following statements about yeast fermentation is not correct?

A. Sodium dodecyl sulfate (SDS) is commonly used to increase the rate of yeast fermentation.
B. Yeast can break down glucose in the absence of oxygen.
C. CO_2 is one of the end products of yeast fermentation.
D. Yeast has a relatively high tolerance for the end products of fermentation.

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10. The hypoxia inducible factor (HIF-1α) is a key regulator of the cellular respiratory pathway. It is possible to create a form of HIF-1α that cannot be degraded.

What would be the metabolic consequence of expressing such an altered protein in yeast?

A. Increased rate of fermentation.
B. Increased rate of the citric acid cycle.
C. Build-up of acetyl-CoA in the mitochondrion.
D. Constitutive activation of pyruvate decarboxylase complex activity.

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11. One hypothesis concerning lateral gene transfer is that proteins that are rapidly degraded tend to remain coded by the organelle genomes.

Which of the following proteins is most likely to remain coded in the organelle genome?

A. Isocitrate dehydrogenase
B. Pyruvate decarboxylase kinase
C. Reaction centre protein of photosystem II
D. ATP synthase component that forms the H^+ channel

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12. Eukaryotic cells tend to be more complex than prokaryotic cells, and this complexity is linked to having more usable energy.

What specific trait was the result of this additional energy supply?

A. Development of the nucleus.
B. The ability to synthesize more proteins.
C. The ability to maintain a higher cell surface area to volume ratio.
D. Development of a respiratory electron transport chain that uses O_2.

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13. How many different genomes are found in one cell of the algae *Vaucheria*?

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

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14. Which of the following statements about lateral gene transfer is correct?

    1. Molecular evidence suggests that endosymbiosis did not occur in *Giardia.*
    2. Lateral gene transfer results in a change in the location of a gene - but the coding sequence of the gene remains unchanged.
    3. A typical mitochondrial genome contains approximately the same number of genes as a bacterial genome.
    4. The rate of DNA mutation is likely higher in the mitochondrion than in the nucleus.

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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15. Recall that the "SD box" is a sequence in DNA that, following transcription, is understood as a region on messenger RNA that base pairs with a complementary region of RNA in the small subunit of ribosomes (rRNA).

    If the sequence of this region of rRNA is 5' UCCGAUA 3', what would be the corresponding sequence of the SD box as it appears <u>in the template strand of DNA</u>?

A. 3' AUAGCCU 5'
B. 3' ATAGCCT 5'
C. 3' AGGCTAT 5'
D. 3' AGGCUAU 5'

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16. Each of the following DNA sequences binds a protein. Which one binds a protein that is an enzyme?

A. promoter
B. enhancer
C. lac operator
D. CAP binding site

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17. In *Vaucheria*, both subunits of rubisco are coded in the chloroplast. When these genes are transcribed, where would their mRNA be translated?

A. On ribosomes in the nucleus.
B. On ribosomes in the cytoplasm.
C. On ribosomes in the chloroplast.
D. On ribosomes on the rough endoplasmic reticulum.

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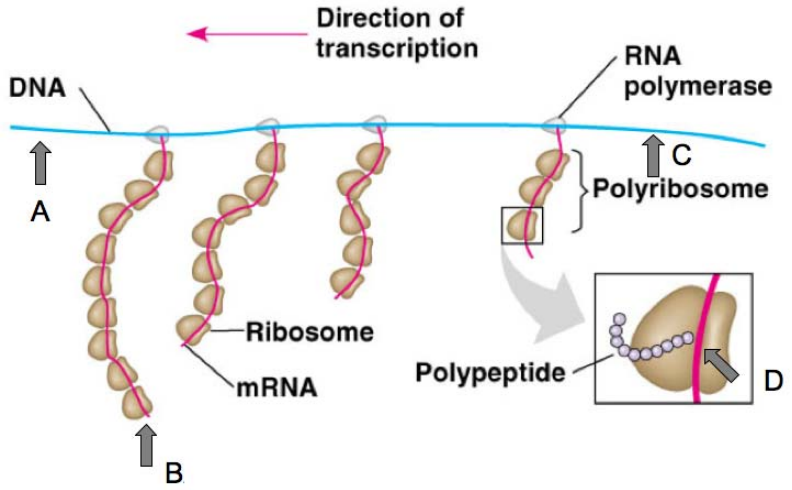
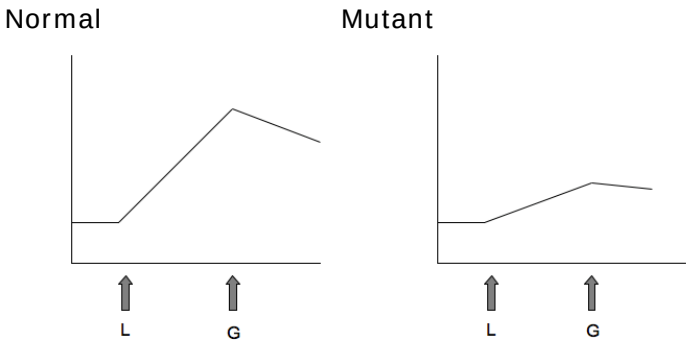
18. In this diagram from class, one gene is being transcribed by several RNA polymerase molecules. At the same time, several ribosomes are translating each mRNA.

    Which arrow points closest to the location of the codon "AUG"?



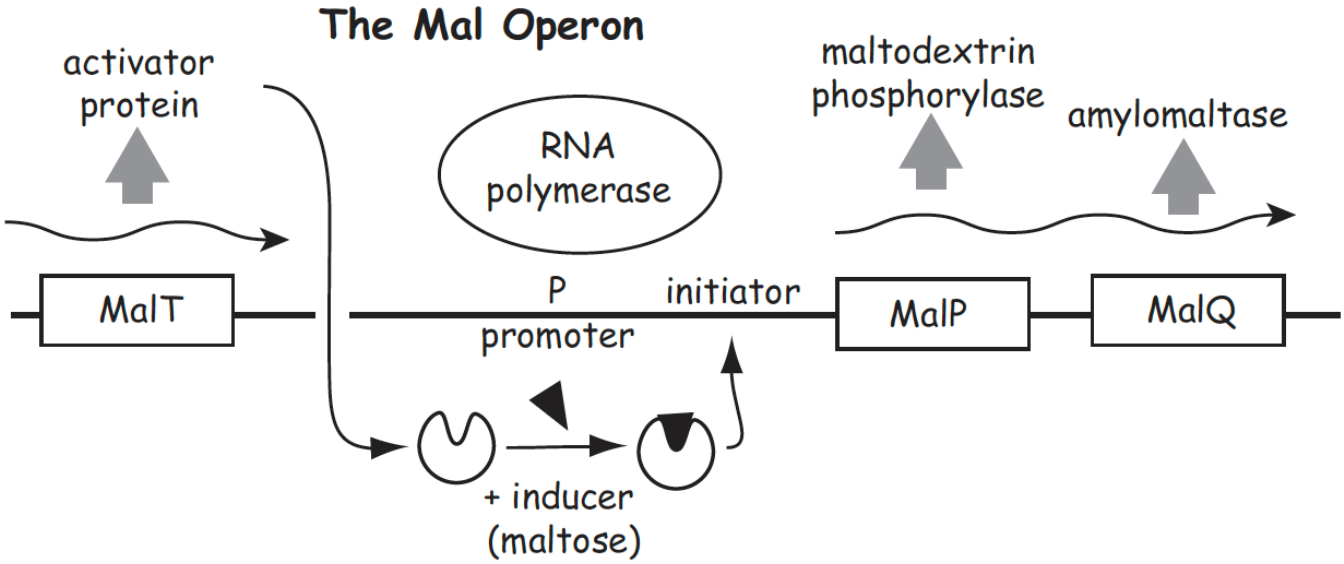
19. At left below, a graph shows the normal expression of galactosidase over time in *E. coli* cells with added lactose (L) as well as glucose (G).

    At right below, a graph shows the expression of galactosidase over time in *E. coli* cells carrying a mutation. What is a likely location of this mutation?



A. A mutation in lac operator, reducing binding to lac repressor.
B. A mutation in lac promoter, reducing "attractiveness" for polymerase.
C. A mutation in the coding region of CAP gene such that no CAP is made.
D. A mutation that increases the activity of adenylate cyclase, the enzyme that makes cAMP.

The following two questions refer to the Maltose Operon as described below. Although we only studied the lac operon, lactose is just one of the sugars that can be broken down by *E. coli* to obtain energy. Maltose is another. Maltose metabolism genes are also organized into an operon. However, regulation of these genes is different than that for the Lac operon. The Mal operon is under the regulation of an activator protein, MalT. Once bound to maltose, MalT then binds to the "initiator" DNA sequence shown below to promote transcription of the two enzyme genes MalP and MalQ.



20. What would be the expression of the Mal operon in MalT$^-$ mutants that could not produce any activator protein?

	Absence of Maltose	**Presence of Maltose**
A.	Operon "off"	Operon "off"
B.	Operon "off"	Operon "on"
C.	Operon "on"	Operon "off"
D.	Operon "on"	Operon "on"

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21. Just like the Lac operon, the Mal operon is sensitive to the availability of glucose through the binding of CAP/cAMP. However, in the Mal operon, the CAP/cAMP binding site is near the promoter of MalT.

Would you predict the binding of CAP/cAMP near MalT to be an example of positive, or negative, regulation in the Mal operon? Why?

A. positive, because MalT is an activator that increases transcription.
B. positive, because binding CAP/cAMP should increase transcription or MalT.
C. negative, because increasing glucose availability should decrease CAP/cAMP binding.
D. negative, because high glucose availability should decrease production of Mal operon genes.

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22. Which of the following signals in the lac operon is understood by the cell in the form of DNA?

    1. CAP binding site
    2. lacI promoter
    3. operator
    4. lacZ start codon

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. Insulin is a protein hormone that has been industrially produced by transferring the gene from human cells to *E. coli*.

    Which of the following insulin gene sequences is likely to be recognized by *E. coli*?

    1. mRNA clipping sequence
    2. intron
    3. promoter
    4. start codon

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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24. Which of the following processes involves complementary base-pairing between one type of RNA and another?

    1. translation termination
    2. transcription of *Xist* gene
    3. chromatin remodeling
    4. intron splicing

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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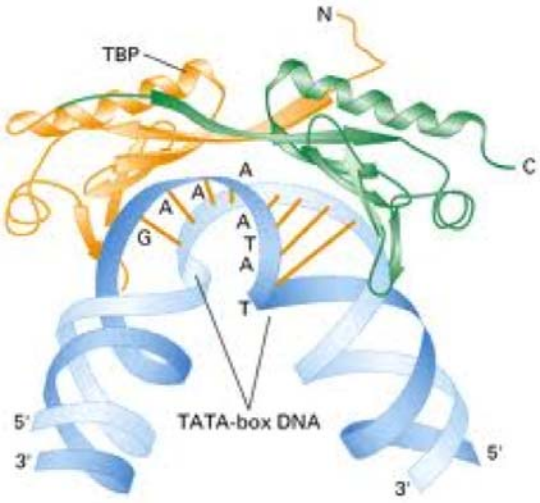
25. This image shows the binding of TATA binding protein (TBP) with DNA. Compare this to the binding of catabolite activator protein (CAP) by choosing the correct statement(s) below.



1. Both TBP and CAP bind to promoters.
2. Both TBP and CAP are found in *E. coli.*
3. Both TBP and CAP base pair with DNA.
4. Both TBP and CAP are translated on cytosolic ribosomes.

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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26. Which of the following must cross the nuclear membrane to get from where it is synthesized (i.e. transcribed for RNA, translated for protein) to where it functions?

1. epidermal growth factor receptor (EGFR)
2. microRNA
3. Lac repressor protein
4. cytosine methylase enzyme

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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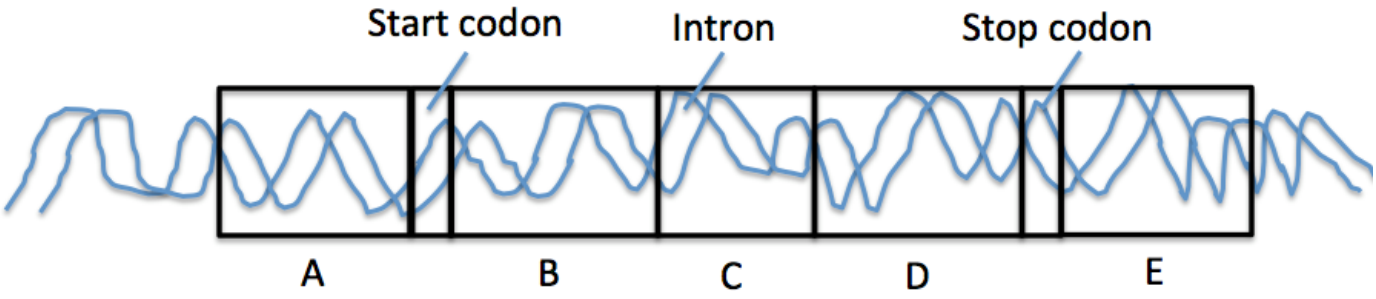
27. Peroxisomes are membrane bound organelles in *Vaucheria* cells that consume large amounts of oxygen as they break down fatty acids into acetyl CoA. Since peroxisomes have no genome, all enzymes must be imported from the cytoplasm. Many proteins that function inside peroxisomes are unusual in that their import signal peptide is <u>at the opposite end of the protein</u> compared to the import signal peptides of proteins that function inside nuclei, mitochondria or chloroplasts.

The various regions of a hypothetical peroxisomal protein gene are blocked in the diagram below. In which of these regions would you expect to find the import signal sequence?



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28. Although it is most efficient to regulate expression of genes at the level of transcription, the activity of some gene products is regulated after they are made by translation (i.e. Post-translational control).

    Which of the following protein molecules is non-functional in the form that is produced by translation? (Don't worry about issues of protein folding.)

    1. CAP
    2. cytochrome oxidase
    3. cyclin-dependent kinase
    4. HIF-1α

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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29. Imagine that you hear that cancer researchers have discovered a connection between a particular type of tumor and ubiquitin metabolism.

    In which of the following ways is ubiquitin most likely to be related to the rapid cycling characteristic of tumor cells?

A. Ubiquitin could bind to the wrong mRNA, resulting in the wrong alternative splicing of a tumor suppressor gene.
B. Ubiquitin might fail to bind to a cyclin protein, resulting in a higher than normal level of this protein.
C. Ubiquitin might not be translated due to binding of a cancer causing microRNA (oncomir) to ubiquitin mRNA.
D. Ubiquitin might remodel the nucleosomes in the promoter of an oncogene, increasing expression.

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30. Sometimes, identical twins are separated at birth and raised by different adoptive families. Although identical twins inherit exactly the same DNA from their biological parents, in what ways would you predict separated twin girls to be different from each other?

    1. They likely have different epigenetic "marks" resulting from parental care.
    2. They likely inactivate different X chromosomes in any given patch of skin.
    3. They likely have a different risk of developing cancer as a result of exposure to environmental mutagens (e.g. second hand cigarette smoke).
    4. They likely received different "imprints" on chromosomes from their parents.

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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31. Which of the following types of cancer is not among the top four most common in Canada?

A. breast cancer
B. lung cancer
C. colon cancer
D. skin cancer

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32. Some members of certain families inherit a predisposition to cancer.

Which of the following explanations is the most likely?

A. They inherit a mutated oncogene allele that is over-expressed.
B. They inherit a particularly oncogenic combination of microRNAs.
C. They inherit an oncogenic virus inserted into the DNA of their parents.
D. They inherit one defective allele of a gene coding for a tumour suppressor protein.

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33. Which of the following observations is consistent with the idea that the cause/progression of cancer has an important epigenetic component?

1. Some tumor suppressor genes ensure efficient DNA repair.
2. Some carcinogens are not mutagens.
3. All of the cells in a given tumor have the same inactivated X chromosome (in females).
4. Some tumor cell nuclei can drive normal development when transplanted into egg cells.

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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34. In the 1950's, introductory biology students learned that "one gene codes for one enzyme".

Which of the following observations from modern introductory biology show that this simple relationship between genes and enzymes is **not** always true?

1. Some genes code for several different enzymes by alternative splicing.
2. Some enzymatic activity is in RNA ribozymes, that don't have genes.
3. Some enzymes are composed of several proteins, each with their own gene.
4. Some genes are transcribed by several polymerases at the same time.

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

End of test