NAME: _____STUDENT NUMBER:_____

Biology 2C03
Term Test #2

Instructor: Dr. Kimberley Dej
Date: Tuesday March 13, 2012
Time: 9:30 am to 10:20 am

Instructions:

1) This midterm test consists of 13 pages. Please ensure that all pages are present.

2) Print your name and student number at the top of each page. Also, print your name and student number on the scantron card.

3) There are 35 multiple-choice questions (1 mark each). Please use the computer card to record your multiple-choice answers. Any answers not indicated on the scantron card will not be graded. **(35 marks total)**

4) There are 3 short-answer questions. Please answer these questions in the allotted space on this quiz. **(15 marks total).**

5) **The final grade is out of 50 marks.**

6) The test is 50 minutes long.

7) Please hand in the test package and the scantron card at the end of the test. Removal of tests is considered academic dishonesty.

Good luck!!

Grade:	
MCQ :	/35
SA:	/15
Final:	/50

Part A. 35 Multiple-choice questions: 1 mark each.
Please indicate your answers on the scantron card.

Question 1 through 4. You are studying two strains from a certain species of tomato plants. In a wild strain of tomato plants you measure the weight of fruits and find that the phenotypic variance, $V_P = 6\ g^2$. In another strain of highly inbred tomato plants, $V_P = 4\ g^2$. Both strains are raised under a constant environment.

1. What are V_G and V_E in the wild strain?

a) $V_G = 0\ g^2; V_E = 4\ g^2$
b) $V_G = 0\ g^2; V_E = 6\ g^2$
c) $V_G = 2\ g^2; V_E = 4\ g^2$
d) $V_G = 2\ g^2; V_E = 6\ g^2$
e) $V_G = 2\ g^2; V_E = 0\ g^2$

2. What are V_G and V_E in the inbred strain?

a) $V_G = 0\ g^2; V_E = 4\ g^2$
b) $V_G = 0\ g^2; V_E = 6\ g^2$
c) $V_G = 2\ g^2; V_E = 4\ g^2$
d) $V_G = 2\ g^2; V_E = 6\ g^2$
e) $V_G = 2\ g^2; V_E = 0\ g^2$

3. What is the calculated broad sense heritability in the wild grown tomatoes?

a) 0.0
b) **0.33**
c) 0.5
d) 0.67
e) 1.0

4. You are trying to predict the number of genes contributing to a polygenic trait in wheat plants. An examination of the F2 progeny from a cross between F1 hybrids reveals a ratio of 1/256 that resemble one of the original true-breeding parents that was homozygous for all non-contributing alleles. What is the predicted number of genes that affect this trait?

a) 1
b) 2
c) 3
d) 4
e) 5

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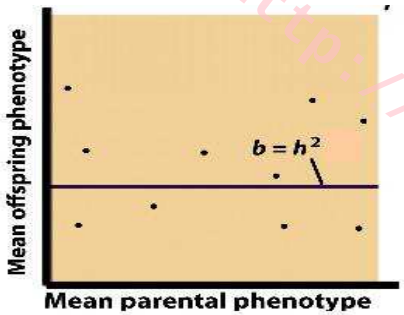
5. You have identified two genes that contribute to the production of hairs on the back of a fly, *A* and *B*. Your true-breeding *A/A B/B* flies have 40 hairs, while your *a/a b/b* flies have no hairs. You cross these lines and then perform an F1 dihybrid cross:

A/a B/b X A/a B/b

You find that the progeny show the following range of phenotypes:
Zero hairs, 10 hairs, 20 hairs, 30 hairs or 40 hairs. What do you suspect is happening?

a) Hair number is a quantitative trait, *A/A b/b* have 20 hairs
b) Hair number is a quantitative trait, *A/A b/b* have 10 hairs
c) Hair number is a quantitative trait, *A/A b/b* have 30 hairs
d) This is an epistatic relationship, A is epistatic to B and *A/A b/b* have 20 hairs
e) This is an epistatic relationship, B is epistatic to A and *A/A b/b* have 0 hairs

6. You are studying narrow-sense heritability of a trait and find the following graph:



What do you conclude about the heritability of this trait?

a) $h^2 = 1$ and all of the phenotypic variation is due to genotypic variation
b) $h^2 = 0$ and all of the phenotypic variation is due to genotypic variation
c) $h^2 = 1$ and all of the phenotypic variation is due to environmental variation
d) $h^2 = 0$ and all of the phenotypic variation is due to environmental variation
e) you need more information to form a conclusion

7. A genetics researcher determines that the broad-sense heritability of height among McMaster University students is 0.90. Which of the following conclusions is reasonable?

a) Sally is a McMaster student so 10% of her height is determined by environment
b) 90% of variation in height among all undergraduate students in Ontario is due to genetic variation
c) 90% of the height of McMaster students is determined by genes
d) 10% of the variation in height among McMaster students is determined by variation in non-genetic factors
e) since the heritability of height is so high, any change in environment would have little effect on the height of students

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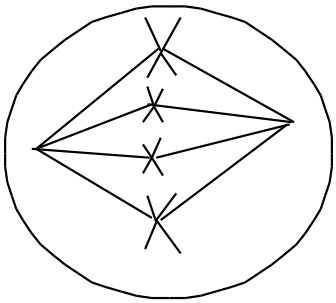
8. The kangeroo has a diploid number of 2n = 16. How many chromosomes would you see in a gamete from a female kangeroo?

a) 1
b) 2
c) 8
d) 16
e) 32

9. What term best describes the structure of the following chromosome?

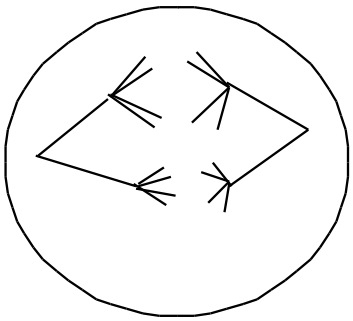
a) Acentric
b) Metacentric
c) Acrocentric
d) Telocentric

10. The following is from a somatic cell with 2n = 4. Which stage of the cell cycle is the following image from?



a) Anaphase of mitosis
b) Metaphase of mitosis
c) Anaphase of meiosis I
d) Metaphase of meiosis I
e) Metaphase of meiosis II

11. The following is from a species with 2n -= 4. Which stage of of the cell cycle is the following image from?



a) Anaphase of mitosis
b) Metaphase of mitosis
c) Anaphase of meiosis I
d) Metaphase of meiosis I
e) Anaphase of meiosis II

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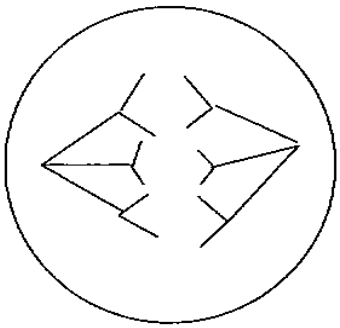
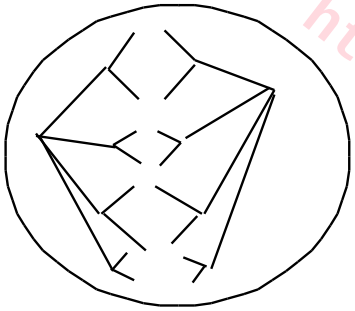
12. Which stage of the cell cycle is the following image from?



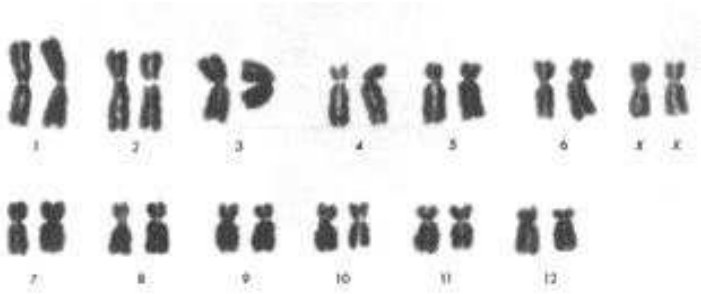
a) anaphase of mitosis
b) metaphase of meiosis I
c) anaphase of meiosis I
d) metaphase of mitosis
e) anaphase of meiosis II

13. What is the chromosome number (haploid number of chromosomes) for the species shown below? This cell is in mitosis.



a) 1
b) 2
c) 4
d) 8
e) 16

14. What is the chromosome number (haploid number of chromosomes) for the species whose karyotype is shown below?



a) 1
b) 2
c) 12
d) 13
e) 26

15. Which of the following divisions can be referred to as a reductional division?
a) Mitosis
b) Meiosis I
c) Meiosis II
d) Both Meiosis I and II

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Questions 16 through 18. A black female cat (X^bX^b) and an orange male cat (X^BY) were mated to each other and produced a male cat that was calico.

16. Which sex chromosomes do you suspect are found in the male calico cat?
    a) $X^bX^BX^B$
    b) X^bY^B
    c) $X^bX^BX^b$
    d) **X^bX^BY**
    e) X^b

17. Which sex chromosomes and genotypes did this male inherit from his father?
    a) X^b
    b) X^bY
    c) **X^BY**
    d) Y^B
    e) X^B

18. Male calico cats are rare. What mistake caused this to occur, when did it occur and in which parent?
    a) Nondisjunction in meiosis I of the father
    b) Nondisjunction in meiosis II of the father
    c) Nondisjunction in meiosis I of the mother
    d) Nondisjunction in meiosis II of the mother
    e) More than one of these above options is possible

19. What would be the genotype of the four gametes produced by nondisjunction of the X chromosomes at the second division in the formation of an oocyte in humans (note: nullo means a gamete with no sex chromosomes).
    a) X, X, X, X
    b) XX, X, nullo,
    c) X, X, nullo nullo
    d) XX, XX, nullo, nullo
    e) X, X, XX, nullo

20. Sturtevant performed the following cross: w/w X w^+/Y
Most offspring: females have red eyes and males have white eyes
But, 1/2000 females were instead white eyed. What explained this?
    a) the white gene is on the X-chromosome
    b) the X-chromosome carrying the white gene underwent nondisjunction
    c) the females were in fact genetically male and had the genotype XXY
    d) the females only had one X-chromosome
    e) Sturtevant had made an error

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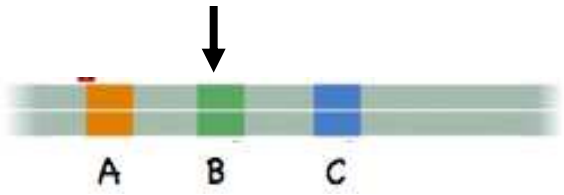
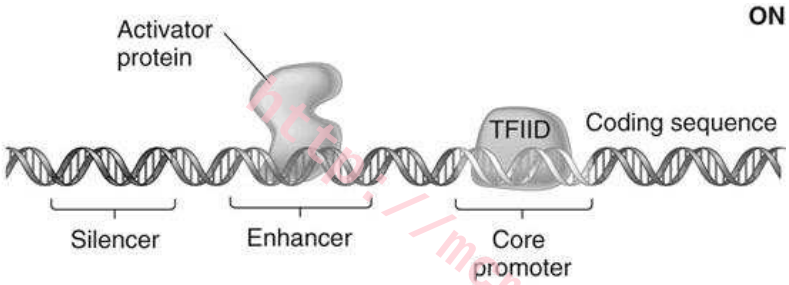
21. The following image represents three neighbouring genes from the human genome. A DNAse sensitivity assay is used to identify active genes. If the arrow represents a DNAse sensitive site, which gene(s) would you predict are being actively transcribed in this cell type?



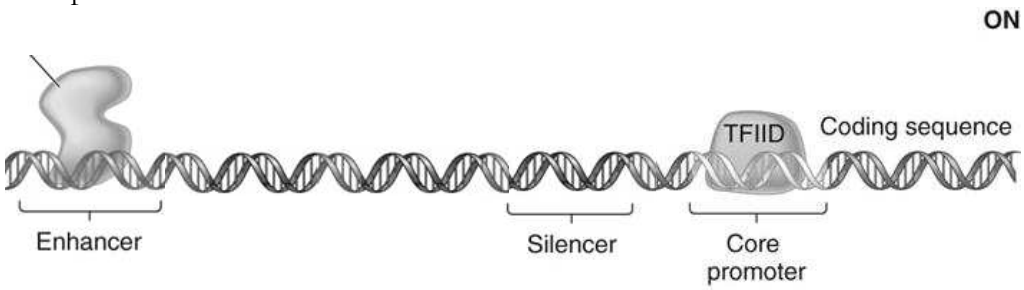
a) genes A and C
b) gene A
c) gene B
d) gene C

22. In the following diagram, which is an example of a *cis*-acting sequence and which is an example of a *trans*-acting factor?



	cis-acting	;	**trans-acting**
a)	enhancer	;	silencer
b)	activator	;	TFIID
c)	TFIID	;	promoter
d)	activator	;	enhancer
e)	**enhancer**	**;**	**TFIID**

23. You rearrange the DNA show in Question 22 to look like the following. What will be the likely effect on transcription?



a) Increase transcription
b) Decrease transcription
c) No change in transcription

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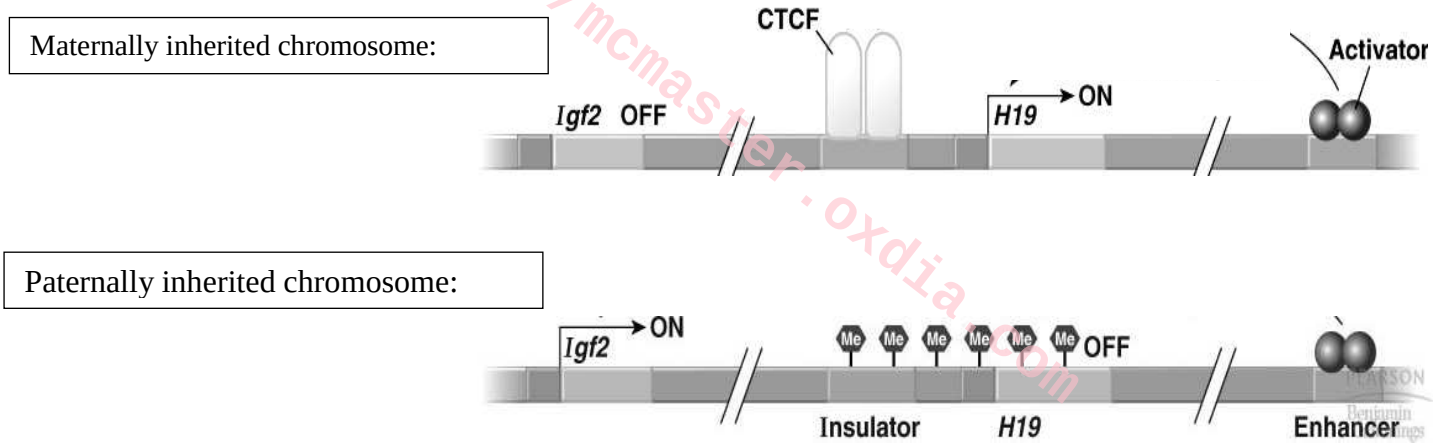
24. What is the product of the *Xist* locus that is required for X-inactivation?
    a) a protein that coats the active X-chromosome
    b) a protein that coats the inactive X-chromosome
    c) an RNA that coats the active X-chromosome
    d) an RNA that coats the inactive X-chromosome
    e) the product has not yet been characterized

25. What is the effect of acetylation of histone tails?
    a) Tightening association of DNA around nucleosomes, silencing transcription
    b) Weakening association of DNA around nucleosomes, silencing transcription
    c) Tightening association of DNA around nucleosomes, permitting transcription
    d) Weakening association of DNA around nucleosomes, permitting transcription

Questions 26 through 31. You are given the following diagram of an imprinted region of the human genome *H19* is transcribed from the maternal chromosome, but *Igf2* is not. In contrast *Igf2* is transcribed from the paternally inherited chromosome, but *H19* is not. DNA methylation occurs on the paternally inherited chromosome immediately upstream from the start of transcription of the *H19 gene*. This phenomenon is known as genomic imprinting.



26. What is the trans-acting factor that prevents activation of the gene *Igf2* on the maternal chromosome?
    a) inhibitor
    b) activator
    c) silence
    d) insulator
    e) CTCF

27. What do you expect to see with respect to expression of Igf2 and H19 alleles located in the maternal chromosome if there was a loss of function mutation in the gene encoding the *CTCF* protein?
    a) Both *Igf2* and *H19* active
    b) Both *Igf2* and *H19* inactive
    c) *Igf2* active and *H19* inactive
    d) *Igf2* inactive and *H19* active

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28. What would be the effect on mouse size if there was no methylation occurring in these animals?
    a) No difference
    b) Decreased size
    c) **Increased size**

Questions 29-31. You rearrange the chromosome region to look like this (both maternal and paternal homologues show the same new organization. There is no change in the pattern of methylation on each homologue.

29. What is the effect on the pattern of expression from the maternal chromosome?
    a) No change, Igf2 OFF, H19 ON
    b) Igf2 ON, H19 OFF
    c) Igf2 ON, H19 ON
    d) Igf 2 OFF, H19 OFF

30. What is the effect on the pattern of expression from the paternal chromosome?
    a) No change Igf2 ON, H19 OFF
    b) Igf2 OFF, H19 ON
    c) Igf2 ON, H19 ON
    d) Igf 2 OFF, H19 OFF

31. What effect would you expect to see in the individual mice?
    a) No difference
    b) Decreased size
    c) Increased size

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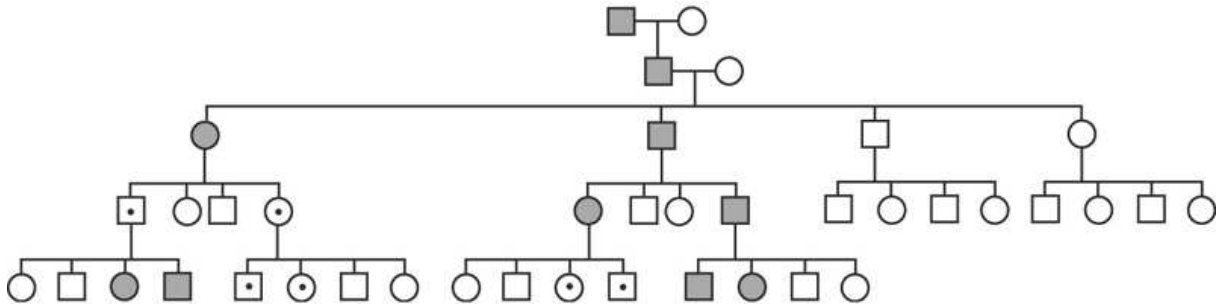
Questions 32 to 35. Recent evidence suggests that Praeder-Willi syndrome is associated with the *SNRPN* gene. The chromosomal region containing the *SNRPN* gene is genomically-imprinted. In the following family, there is evidence that there is the presence of a deletion in the region that includes SNRPN. Below is a pedigree showing the pattern of inheritance of this trait.



32. If a father is affected by the disorder, what is the probability of his children being affected?
    a) 0%
    b) 25%
    c) 50%
    d) 100%

33. If a mother is affected by the disorder, what is the probability of his children being affected?
    a) 0%
    b) 25%
    c) 50%
    d) 100%

34. If a mother is affected by the disorder and passes the mutation on to her son, will her grandchildren be affected ?
    a) Yes, for each there is a 100% chance of being affected
    b) Yes, for each there is a 50% chance of being affected
    c) No, there is no chance of being affected

35. This is likely an example of:
    a) X-inactivation
    b) maternal imprinting to silence the *SNRPN* gene
    c) paternal imprinting to silence the *SNRPN* gene

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Part B. There are THREE short answer questions: 15 marks total.
Please write your answers in the spaces provided.

1. (6 marks) A research student is looking through a population of flies in the lab and finds that some female flies, but no male flies, have large blisters on their wings. When a female with blistered-wings is picked at random and crossed to a male without blisters (wildtype), the student finds the following proportions of phenotypes in the offspring.

1/3 wildtype females
1/3 blistered females
1/3 wildtype males

The experiment is repeated 100 times, always with the same result. Explain these observations by answering the following questions. (Hint: think about Morgan's crosses with the *white* gene).

(a) What are the genotypes of each of the above three categories of flies? *(3 marks)*

wildtype females $X^b X^b$

blistered females $X^B X^b$

wildtype males X^b /Y

(b) Draw out the cross. *(2 marks)*

P: $X^B X^b$ **x** X^b /Y

F1: $X^b X^b$ $X^B X^b$ X^b /Y X^B /Y **(lethal – do not need to include this here)**

(c) Why are there no blistered males? *(1 mark)*

X^B /Y males are lethal

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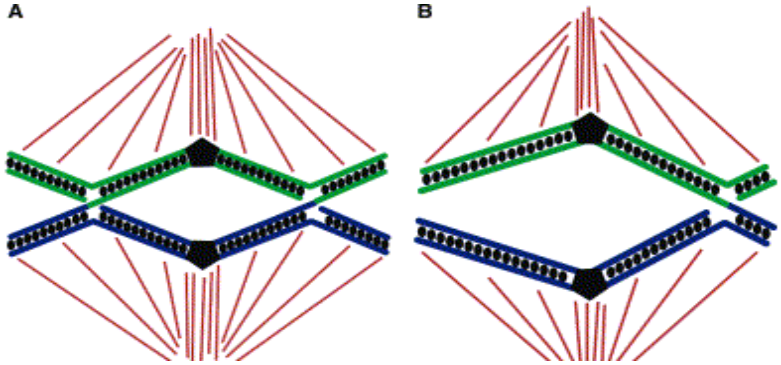
2. *(Total: 6 marks)* The following diagram was used in class to represent bivalents that may tend to lead to nondisjunction in females.



(a) What is holding together the homologues in the above images? *(2 marks)*

Crossovers (1)
And
Sister chromatid cohesion (cohesin proteins) (1/2) beyond the crossovers (1/2).

(b) Which image (A or B) represents the more stable bivalent and suggest a reason why? *(2 marks)*

A (1 mark)
More cohesion (1/2) holding it together at the ends beyond the crossovers (distal to the crossovers) (1/2)
Just "more cohesion" is not sufficient and not true. Just "more crossovers" is not sufficient.

(c) Referring to diagram A, what needs to happen in order to allow anaphase I? *(1 mark)*

Loss of cohesion on arms beyond crossovers.

(d) Referring to diagram A, what needs to happen in order to allow anaphase II? *(1 mark)*

Loss of cohesion at the centromere

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3. *(Total 3 marks)*
(a) Explain the difference between broad-sense and narrow-sense heritability. *(1 mark)*

Narrow-sense: only additive genetic variation

Broad-sense: genetic variation due to additive, dominance, and genetic interactions

(b) Which group would you expect to show a lower value for broad-sense heritability, a group of true-breeding mice or a group of wild mice and why? *(2 marks)*

true-breeding because they are homozygous and show no genetic variation, therefore $V_G/V_P = 0$

This is the end of the test.