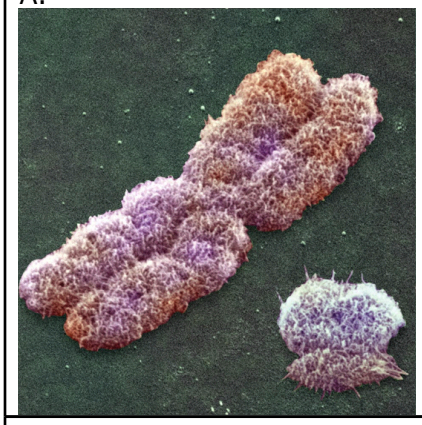
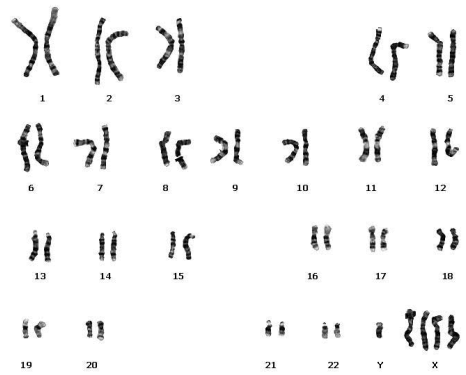
Circle the best single letter choice for each of the following questions before transferring your answers to your computer sheet.

1. Which of the following images of chromosomes was made by fluorescence light microscopy?

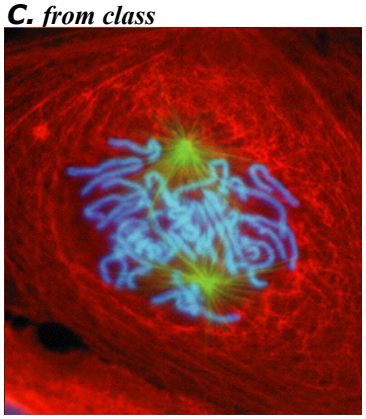
A.



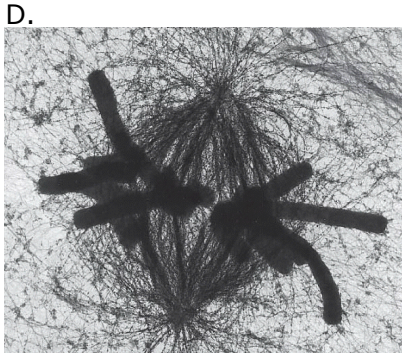
B.



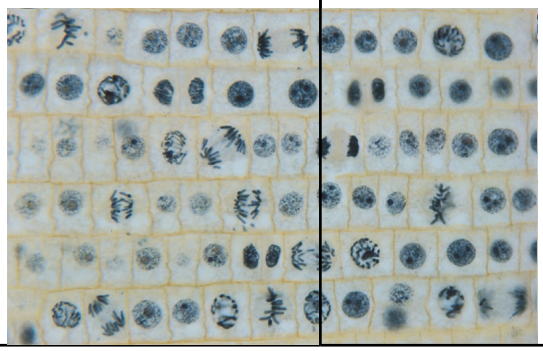
***C.** from class*



D.



E.



2. Typical eukaryotic cells fall into the size range of

A. 1 to 10 µm.
B. 10 to 100 µm.
C. 1 to 10 mm.
D. 10 to 100 mm.
E. 10 to 100 nm.

3. Eukaryotic cells responsible for the synthesis of large quantities of protein for export (e.g. keratin for fingernails) would be expected to have relatively abundant

A. DNA.
B. golgi.
C. ***rough ER***
D. smooth ER
E. mitochondria

4. Cells lining the rumen are firmly secured, one to the next, by

A. gap junctions.
B. ***tight junctions.***
C. plasmodesmata.

D. tonoplasts.
E. cell walls.

Gap junctions are for communication, not anchoring.

5. Typical members of the Domains of Bacteria and Archaea are similar in that they are both prokaryotic. However, they are different in that only the Archaea have a(n)

A. ***association of DNA with histones****.*
B. circular chromosome.
C. nuclear envelope.
D. uni-cellular body.
E. cell wall.

One of the ways that Archaea resemble eukaryotes. From table, Chap 27.

6. The cancer drug Taxol interferes with the separation of sister chromatids during anaphase of mitosis. A potential mechanism of Taxol's action is inhibition of

A. ***kinetochore motor proteins.***
B. signals that prevent apoptosis.
C. formation of cyclin/CDK complexes.
D. actin contraction along the cell plate.
E. tubulin polymerization in intermediate filaments.

7. Recall that Tom dissected a gall on the stem of a goldenrod plant in class. Before being stimulated to divide in response to insect infection, the cells of that mature stem were likely in _____ of the cell cycle.

A. ***G_0***
B. G_1
C. S
D. G_2
E. M

8. Plant cells may divide along any one of three different planes of symmetry. The particular plane to be chosen at any given division is determined by the

A. ***location of bands of microtubules.***
B. position of the central vacuole (tonoplast).
C. formation of new cell wall after cytokinesis.
D. alignment of chromosomes on the metaphase plate.
E. communication with adjacent cells through desmosomes/microfilaments.

See lecture slide.

9. After completing DNA replication, cells will not actually enter mitosis until the

A. telomeres are all sufficiently elongated.
B. homologues have all paired with partners.
C. kinetochores all have microtubules attached.
D. ***cyclin/CDK complex (MPF) is activated.***
E. nuclear lamins have disintegrated.

10. A "nucleosome" is a

A. pore in the nuclear membrane allowing mRNA to pass into the cytoplasm.
B. network of interlaced intermediate filaments supporting the nucleus.
C. structure resulting from the association of DNA with histone proteins.
D. concentrated area of ribosomal RNA within the nucleus.
E. central region of chromatin within prokaryotic cells.

11. The replication of large, linear, chromosomes presents two significant problems:
i) How to replicate fast enough to allow cells to divide rapidly during early development, and
ii) How to deal with the resulting shortening of chromosomes.

The need for speed is achieved primarily by replicating

A. simultaneously from several origins.
B. both DNA strands in the same direction.
C. with two replisomes at each replication fork.
D. with two different polymerases (Pol I and Pol III).
E. semi-conservatively; such that "new" DNA needs to be only half "new".

12. The replication of large, linear chromosomes presents two problems:
i) How to replicate fast enough to allow cells to divide rapidly during early development, and
ii) How to deal with the resulting shortening of chromosomes.

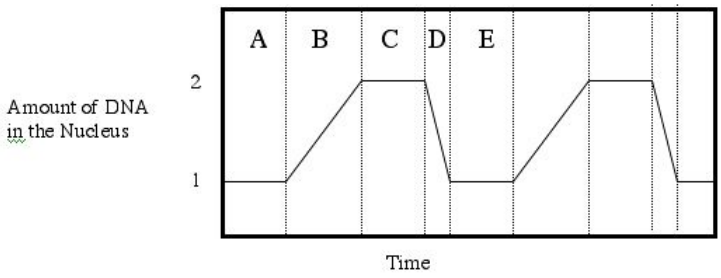
The shortening of chromosomes is counteracted by telomerase adding something to the chromosome ends. What does it add?

A. DNA to replace the missing RNA primer.
B. DNA onto the 5' end of one strand.
C. DNA onto the 3' end of one strand.
D. Extra Okazaki fragments.
E. An RNA template.

Templates are used to determine which complementary base to add next.

13. This figure plots the change in the relative amount of DNA in a nucleus over several "stages" in actively cycling cells.

Which Stage has chromosomes composed of two chromatids each?



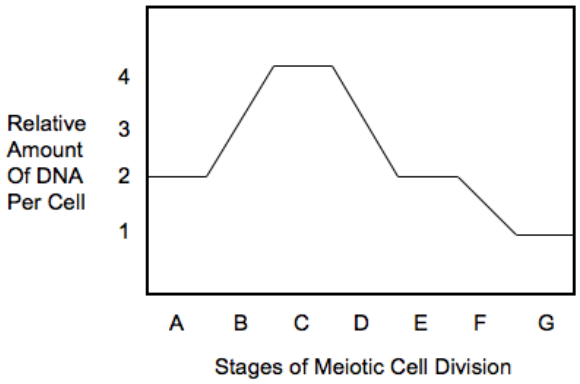
A. Stage A
B. Stage B
C. Stage C
D. Stage D
E. Stage E

14. Meiosis II is sometimes referred to as being "just like mitosis". However, this notion obscures the important differences between these two types of cell division. Meiosis II is not "just like mitosis" in that only cells dividing in Meiosis II

A. divide replicated chromosomes into daughter cells.
B. have half the usual number of chromosomes for a given organism.
C. ensure daughter cells each have the same number of chromosomes.
D. give rise to daughter cells with identical genotypes.
E. will eventually give rise to gametes.

For Questions 15 and 16, refer to the figure below that plots the change in the relative amount of DNA in a nucleus over the course of meiotic cell division.

Stage A is a G1 meiocyte.
Stage G is a gamete.



15. During which Stage would homologues pair and cross-over?

A. Stage A
B. Stage B
C. Stage C
D. Stage D
E. Stage E

16. During which Stage would the sister chromatids of Chromosome 4 each move to opposite poles randomly relative to those of Chromosome 3?

A. Stage C
B. Stage D
C. Stage E
D. Stage F
E. Stage G

Sister chromatids split off in Meiosis II.

17. Before taking this course, many people believe that all chromosomes are shaped like the letter "X"? However, a given chromosome could only appear in the shape of an "X" if its centromere was near the center and if it was also

A. paired with a Y chromosome.
B. highly packaged (e.g. metaphase).
C. "squashed flat" during DNA replication.
D. being pulled to opposite poles by microtubules.
E. crossing over with its homologue during meiosis.

18. Several *in-vitro* fertilization laboratories in the United States now offer a service by which couples can specifically select an embryo that is a close tissue match to a child that they already have. (In the event that one sibling might need a transplant from another in the future.) Such tissue matching would screen for appropriate

A. complementary base sequences.
B. numbers of Barr bodies.
C. sex chromosomes.
D. pairing of homologues.
E. histocompatability (HLA) haplotypes.

For Questions 19 and 20, refer to the data in the Table below.

Hair colour in a species of wild rat has been discovered to be under the influence of a gene, called B, having three alleles: brown (B1), red (B2) and white (B3). Data from experimental crosses is shown below.
Note that the males and females in crosses 1, 2 and 3 are known to be homozygous.

Cross	Male	Female	Offspring
1	Brown	Red	All brown
2	Brown	White	All brown
3	Red	White	All red
4	Brown	Brown	3 brown: 1 red
5	Red	Red	3 red: 1 white
6	Red	Red	All red
7	Brown	Red	1 red: 2 brown: 1 white

19. Based on the experimental data in the Table above, the genotype of the male in Cross 6 is

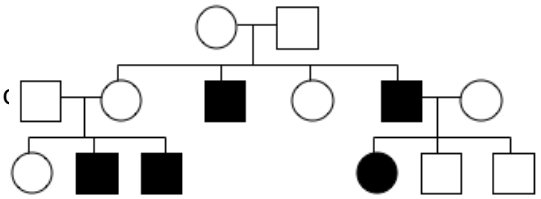
A. B2.
B. B2 B1.
C. B2 B2.
D. B2 B3.
E. either B2 B3 or B2 B2.

20. The 1:2:1 ratio in Cross 7 indicates that

A. the B1 allele is codominant.
B. both parents have the same genotype.
C. the B3 allele is recessive to both B1 and B2.
D. the brown offspring all have the same genotype.
E. there are two genes controlling coat colour in this Cross.

Two different heterozygotes in this cross.

21. Given that this disorder is much less severe in the affected female, what is the most likely mode of inheritance for the trait shown in this pedigree? (Assume people marrying into this family are homozyg



A. autosomal recessive
B. autosomal dominant
C. sex-linked recessive
D. sex-linked dominant
E. None of the above.

X-linked recessive can work if affected female is much less severe due to random X inactivation.

22. Consider your maternal lineage: your mother, her mother, her mother and her mother (back to your great-grandmother). Now consider Creutzfeldt-Jakob disease, a rare but fatal type of human "Mad Cow" disease caused by a mutated gene on Chromosome 20. If your great grandmother was homozygous for the mutation, what is the likelihood that you have inherited this mutation from her?

A. 1/2
B. 1/4
C. 1/8
D. 1/16
E. 1/32

Question was deleted due to confusion around grandmother. Note that having the mutation is not the same as having the disease.

23. Carlos and Wei-Mei are planning to have a baby. They met two years ago at a Research Symposium about a disorder called trimethylaminuria (TMAU). Affected people lack a liver enzyme that normally breaks down trimethylamine (TMA). As a result, gaseous TMA is excreted in sweat and people tend to smell like (rotting) fish. Wei-Mei has an affected son from her first marriage and Carlos has an affected aunt (his mother's sister). No other family members are affected. People marrying into the family (ie. Carlos' father) are assumed to be homozygous normal.
What is the likelihood that Carlos and Wei-Mei will have an affected child?

A. 1/4
B. 1/6
C. 1/8
D. 1/12
E. 1/24

2/3 chance Carlos is a carrier, ¼ chance that they will then have an affected child.

24. Consider a trihybrid plant (**AaBbCc**) in which each of the three genes is on a different chromosome. How many different gametes would this plant produce?

A. 2
B. 4
C. 6
D. 8
E. 9

25. Consider a trihybrid organism (**AaBbCc**) in which all three genes are on the same chromosome. How many different recombinant gametes would such an organism produce?

A. 2
B. 3
C. 4
D. 6
E. Can't predict without knowing "cis" or "trans" linkage arrangement.

Always 8 different combinations, always only two non-recombinant combinations, therefore always six different recombinants.

*26. If the trihybrid plant from the previous question (**AaBbCc**) were to fertilize itself, what would be the proportion of trihybrids among the seeds produced?*

A. none
B. $(1/2)^2$
C. $(1/2)^3$
D. $(3/4)^3$

E. All

Question omitted since out of order. Meant to refer to Q 24.

27. Consider a dihyrid test cross (**AaBb** x **aabb**) in which the 1000 progeny fall into four classes as shown below.

Progeny	Number	Progeny	Number
AaBb	46	**aaBb**	442
Aabb	458	**aabb**	54

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

A. 0.1
B. 10
C. 20
D. 100
E. Can't tell without knowing cis vs trans linkage in dihybrid.

Gene Pair	Recombination Frequency (%)
A and W	5
W and G	15
E and G	12
W and E	3
A and G	20

28. Mapping experiments have revealed the following recombination frequencies for the pairs of genes shown at right.

What is the predicted map distance (cM) separating genes **A** and **E**?

A. 2
B. 5
C. 8
D. 12
E. 14

29. Consider two fruit flies that are each heterozygous for two autosomal genes, L and Y. The two genes are linked at 20 map units. If one fly carries the genes linked in "cis", while the other fly carries the genes linked in "trans", what would be the expected frequency of llyy offspring from a cross?

A. 1%
B. 4%
C. 8%
D. 10%
E. 16%

Similar to example from clicker question. ly would be recombinant from one parent, parental from other, 10% x 40% = 4%

30. In which of the following organisms do males and females have the same type and number of chromosomes?

A. Grasshoppers
B. Honey bees
C. Fruit Flies
D. Chickens
E. None of the above.

31. A human cell containing both a Barr body and a Y chromosome would likely be from a(n)

A. fertilized zygote.
B. aneuploid.
C. woman.
D. cancerous tumor.
E. tetragametic chimera.

32. Notice the biochemical pathway below showing the action of the products of two genes controlling pigmentation. Note that the two genes act on the same step in the pathway; the dominant allele of Gene **R** converts a colourless chemical into a red pigment while the dominant allele of Gene **C** blocks this activity.

Gene R Gene C

Colourless Precursor --- -------|| Red Pigment

What would be the expected distribution of colourless: red offspring resulting from a cross of two dihybrid individuals (assume independent assortment and complete dominance)?

A. 8:8
B. 9:7
C. 10:6
D. 12:4
E. 13:3

Only R cc are red.

33. Lichens are actually a mutualistic combination of two organisms: an algae and a fungus. The cells of both of these organisms would contain

1. ribosomes.
2. mitochondria.
3. a DNA genome.
4. chloroplasts.

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

No chloroplasts in fungi.

34. Eukaryotic cells may activate apoptosis if they are

1. infected by a virus.
2. functional only as dead cells.
3. surplus (not needed) to development.
4. suffering DNA damage.

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

35. Which of the following enzymes does not require a previously paired base in order to add a new base?

1. telomerase
2. primase
3. DNA polymerase I
4. RNA polymerase

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

36. The DNA template strand that was replicated discontinuously was the only one that was

1. complementary to an RNA primer.
2. read 3' to 5'.
3. read by DNA Polymerase I.
4. complementary to Okazaki fragments.

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

All DNA is always read 3' to 5'.

37. Meristem tissue can be found in mature maple trees in

1. buds.
2. trunk.
3. root tips.
4. autumn leaves.

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

In woody plants, meristem tissue provides vascular tissue in the trunk.

38. The haploid cells that fuse to form a zygote during fertilization are called gametes. Which of the following organisms makes their gametes by mitosis?

1. Male honeybees.
2. Mendel's peas.
3. Bread mould fungi.
4. Brock Fenton.

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

Flowering plants have multicellular, microscopic, gametophytes that make gametes by mitosis.

39. Fruit flies are diploid organisms with 2 copies of each of 4 different chromosomes in somatic cells. At metaphase I of meiosis

1. all genes would be present in 2 copies.
2. sister chromatids would carry identical alleles.
3. homologues would undergo recombination.
4. the cell would contain 8 chromosomes.

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

NO RECOMBINATION AT METAPHASE.

40. As its name implies, the "white-eye" allele (***w***) of a sex-linked eye colour pigment gene in *Drosophila* causes fruit fly eyes to appear white. Heterozygotes (**w** w^+) have normal red eyes. How are these two alleles different?

1. One is dominant; the other is recessive.
2. They are at different locations on the X chromosome.
3. They have different DNA sequences.
4. One is sex-linked in cis; the other is sex-linked in trans.

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

41. A large, multigenerational, family in Mexico suffers from a sex-linked dominant disorder, called *hypertrichosis*, in which affected people have thick body hair covering most of their skin. In one rare case, an affected son was born to an affected father and unaffected mother. Karyotype analysis revealed that the son was XXY while both parents were normal.

The error in chromosome partitioning responsible for this rare pattern may have occurred at

1. meiosis II in the mother.
2. meiosis II in the father.
3. meiosis I in the mother.
4. meiosis I in the father.

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

Must be inheritance of both affected X and normal Y from father.

42. Consider a dihybrid Big Brown Bat carrying two genes linked in cis, separated by 65 map units (cM), on Chromosome 2.

1. There will be four different (geno)types of gametes.
2. Different types of gametes will be equally frequent.
3. Two dominant alleles are on the same homologue at the end of S Phase.
4. A dihybrid cross would give a typical epistatic ratio (i.e. 9:3:4).

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

43. If a species is gynogenetic, the incidence of males in the population will be

A. 0%
B. 25%
C. 50%
D. 10%
E. 100%

44. If a population of animals includes many homozygotes ("clones") along with a variable smaller number of heterozygotes (both males and females), the species is

A. normal.
B. bisexual.
C. gynogenetic.
D. androdioecous.
E. hermaphroditic.

45. The correct representation of a scientific name is

A. Big Brown Bat.
B. Eptesicus fuscus.
C. *Eptesicus fuscus.*
D. Eptesicus fuscus Palisot de Beauvois.
E. *Eptesicus fuscus* Palisot de Beauvois.

46. Captioned "Major collection localities for calcified lichens in British Columbia and the adjacent U.S.A".

A. the distribution of the lichen
B. places sampled for the lichen
C. places where the lichen does not occur
D. the site(s) where the lichen occurs
E. All of A, B, C and D are correct.

47. In this phylogeny, based on molecular genetic data, the population from Italy is most distant from

A. Gough.
B. Netherlands.
C. UK.
D. Madeira.
E. Azores.

Both OK

48. In this phylogeny based on molecular genetic data, the population from Portugal is most closely related to the one from

A. Spain.
B. the UK.
C. Tristan.
D. Gough.
E. Italy.

49. An example of successful breeding between species has been demonstrated in

A. different breeds of dogs
B. some species of Darwin's finches
C. Asian and African elephants
D. 10% of birds
E. B and D only are correct.

50. Although the species concept is central to Biology, developing a robust definition of species is challenging because

A. species are units of convenience.
B. not all organisms reproduce sexually.
C. we cannot demonstrate gene flow in fossil populations.
D. evolution is constantly producing new species in an ongoing process.
E. E. All of A, B, C and D are correct.