Concepts of Genetics, 11e, Global Edition **(Klug et al.)**
Chapter 2 Mitosis and Meiosis

1) Living organisms are categorized into two major groups based on the presence or absence of a nucleus. What group is defined by the presence of a nucleus?
A) eukaryotic organism
B) virus
C) bacterium
D) prokaryotic organism
E) mitochondrial organism
Answer: A
Section: 2.1

2) What is the name of the membranous structure that compartmentalizes the cytoplasm of eukaryotic organisms?
A) ribosome
B) mitochondria
C) cytosol
D) endoplasmic reticulum
E) nucleoid
Answer: D
Section: 2.1

3) What hypothesis concerns the evolutionary origin of eukaryotic organelles?
A) endosymbiont hypothesis
B) homologous hypothesis
C) analogous hypothesis
D) evolutionary hypothesis
E) Darwinian hypothesis
Answer: A
Section: 2.1

4) The diploid chromosome number of an organism is usually represented as 2n. Humans have a diploid chromosome number of 46. What would be the expected haploid chromosome number in a human?
A) 92
B) 16
C) 12
D) 24
E) 23
Answer: E
Section: 2.2

5) What significant genetic function occurs in the S phase of the cell cycle?
A) cytokinesis
B) karyokinesis
C) DNA synthesis
D) chromosome condensation
E) centromere division
Answer: C
Section: 2.3

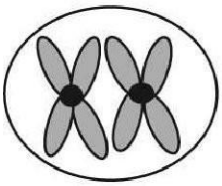
6) During interphase of the cell cycle, _____.
A) DNA recombines
B) sister chromatids move to opposite poles
C) the nuclear membrane disappears
D) RNA replicates
E) DNA content essentially doubles
Answer: E
Section: 2.3

7) If a typical somatic cell has 64 chromosomes, how many chromosomes are expected in each gamete of that organism?
A) 8
B) 16
C) 32
D) 64
E) 128
Answer: C
Section: 2.4

8) In an organism with 52 chromosomes, how many bivalents would be expected to form during meiosis?
A) 13
B) 26
C) 52
D) 104
E) 208
Answer: B
Section: 2.4

9) The ant, *Myrmecia pilosula*, is found in Australia and is named bulldog because of its aggressive behavior. It is particularly interesting because it carries all its genetic information in a single pair of chromosomes. In other words, $2n = 2$. (Males are haploid and have just one chromosome.) Which of the following figures would most likely represent a correct configuration of chromosomes in a metaphase I cell of a female?

A)



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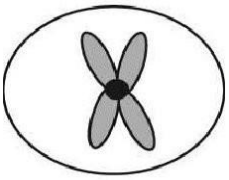

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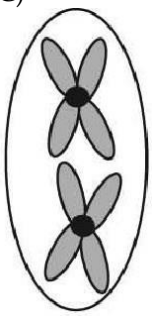

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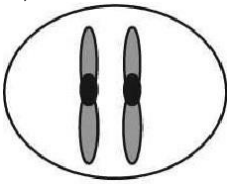
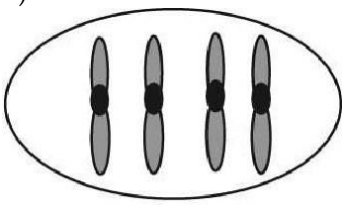


E)



Answer: A
Section: 2.4

10) For the purposes of this question, assume that a G1 somatic cell nucleus in a female *Myrmecia pilosula* contains 2 picograms of DNA. How much DNA would be expected in a metaphase I cell of a female?
A) 16 picograms
B) 32 picograms
C) 8 picograms
D) 4 picograms
E) Not enough information is provided to answer the question.
Answer: D
Section: 2.4

11) *Myrmecia pilosula* actually consists of several virtually identical, closely related species, with females having chromosome numbers of 18, 20, 32, 48, 60, 62, and 64. Assume one crossed a female of species (A) with 32 chromosomes and a male of species (B) with 9 chromosomes (males are haploid, and each gamete contains the *n* complement). How many chromosomes would one expect in the body (somatic) cells of the female offspring?
A) 4.5
B) 9
C) 25
D) 32
E) 41
Answer: C
Section: 2.4

12) What is the outcome of synapsis, a significant event in meiosis?
A) side-by-side alignment of nonhomologous chromosomes
B) dyad formation
C) monad movement to opposite poles
D) side-by-side alignment of homologous chromosomes
E) chiasma segregation
Answer: D
Section: 2.4

13) In a healthy female, how many secondary oocytes would be expected to form from 100 primary oocytes? How many first polar bodies would be expected from 100 primary oocytes?
A) 200; 50
B) 100; 50
C) 200; 300
D) 100; 100
E) 50; 50
Answer: D
Section: 2.5

14) In a healthy male, how many sperm cells would be expected to be formed from (a) 400 primary spermatocytes? (b) 400 secondary spermatocytes?
A) (a) 800; (b) 800
B) (a) 1600; (b) 1600
C) (a) 1600; (b) 800
D) (a) 400; (b) 400
E) (a) 100; (b) 800
Answer: C
Section: 2.5

15) Electron microscopy of metaphase chromosomes demonstrated various degrees of coiling. What was the name of the model that depicted this process?
A) folded-fiber
B) double-stranded
C) chromatid folding
D) packing
E) condensation
Answer: A
Section: 2.7

16) Name two cellular organelles, each containing genetic material, which are involved in either photosynthesis or respiration.
Answer: chloroplasts and mitochondria
Section: 2.1

17) The nucleolus organizer (NOR) is responsible for production of what type of cell structure?
Answer: ribosome
Section: 2.1

18) List four terms used to describe the normal morphologies, with respect to arm ratio, of eukaryotic chromosomes.
Answer: metacentric, submetacentric, acrocentric, telocentric
Section: 2.2

19) Homologous chromosomes are those that can be matched by virtue of their similar structure and function within a nucleus. Which chromosomes making up a genome do not follow the same characteristics of homology?
Answer: sex-determining chromosomes
Section: 2.2

20) In which stage of the cell cycle is G0 located?
Answer: G1
Section: 2.3

21) When cells withdraw from the continuous cell cycle and enter a "quiescent" phase, they are said to be in what stage?
Answer: G0
Section: 2.3

22) The house fly, *Musca domestica*, has a haploid chromosome number of 6. How many chromatids should be present in a diploid, somatic, metaphase cell?
Answer: 24
Section: 2.3

23) How many haploid sets of chromosomes are present in a diploid individual cell with a chromosome number of 46? 32?
Answer: 2; 2
Section: 2.3

24) How many haploid sets of chromosomes are present in an individual cell that is tetraploid *(4n)*?
Answer: 4
Section: 2.3

25) You may have heard through various media of an animal alleged to be the hybrid of a rabbit and a cat. Given that the cat (*Felis domesticus*) has a diploid chromosome number of 38 and a rabbit (*Oryctolagus cuniculus*) has a diploid chromosome number of 44, what would be the expected chromosome number in the somatic tissues of this alleged hybrid?
Answer: 41
Section: 2.3

26) Regarding the mitotic cell cycle, what is meant by a checkpoint?
Answer: A checkpoint is the portion of a cell cycle that is sensitive to a variety of conditions that impact the eventual health of the cell or individual. Such checkpoints often restrict passage to the next event in the cell cycle.
Section: 2.3

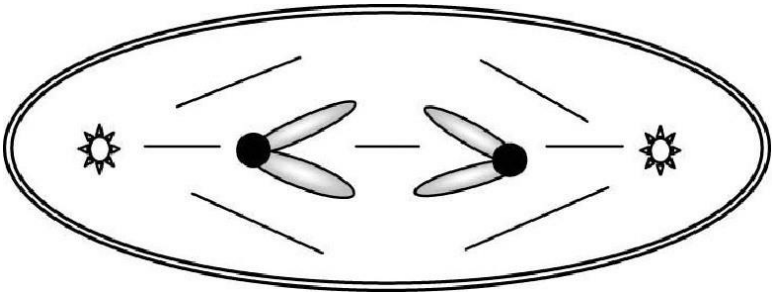
27) Assume that the somatic cells of a male contain one pair of homologous chromosomes (e.g., AaAb), and an additional chromosome without a homolog (e.g., W). What chromosomal combinations would be expected in the meiotic products (spermatids) of a single primary spermatocyte? (There may be more than one answer.)
Answer: A^aW, A^aW, A^b, A^b or Aa, Aa, AbW, AbW
Section: 2.4

28) Trisomy 21, or Down syndrome, occurs when there is a normal diploid chromosomal complement of 46 chromosomes plus one (extra) chromosome #21. Such individuals therefore have 47 chromosomes. Assume that a mating occurs between a female with Down syndrome and a normal 46-chromosome male. What proportion of the offspring would be expected to have Down syndrome? Justify your answer.
Answer: One-half of the offspring would be expected to have Down syndrome because of 2 × 1 segregation of chromosome #21 at anaphase I.
Section: 2.4

29) The accompanying sketch depicts a cell from an organism in which $2n = 2$ and each chromosome is metacentric.

a) Circle the correct stage for the cell in this sketch:
anaphase of mitosis
anaphase of meiosis I
anaphase of meiosis II
telophase of mitosis

b) Given that each G1 nucleus from this organism contains 16 picograms of DNA, how many picograms of chromosomal DNA would you expect in the cell shown below?



Answer: (a) anaphase of meiosis II (b) 16
Section: 2.4

30) The horse (*Equus caballus*) has 32 pairs of chromosomes, whereas the donkey (*Equus asinus*) has 31 pairs of chromosomes. How many chromosomes would be expected in the somatic tissue of a mule?
Answer: 63
Section: 2.4

31) Name two evolutionarily significant benefits of meiosis that are not present in mitosis.
Answer: reshuffling of homologous chromosomes and crossing over
Section: 2.4

32) What is meant by the term *chiasma*?
Answer: areas where chromatids intertwine during meiosis
Section: 2.4

33) After which meiotic stage (meiosis I or II) would one expect monads to be formed?
Answer: meiosis II
Section: 2.4

34) List in order of occurrence the phases of (a) mitosis and (b) prophase I of meiosis.
Answer:
(a) prophase, prometaphase, metaphase, anaphase, telophase
(b) leptonema, zygonema, pachynema, diplonema, diakinesis
Section: 2.4

35) Two terms, *reductional* and *equational*, generally refer to which stages of meiosis (I or II)?
Answer: meiosis I and meiosis II, respectively
Section: 2.4

36) Normal diploid somatic (body) cells of the mosquito *Culex pipiens* contain six chromosomes. Assign the symbols A^mA^p, B^mB^p, and C^mC^p to the three homologous chromosomal pairs. The "m" superscript indicates that the homolog is maternally derived; the "p" indicates a paternally derived homolog. Assume that in the genus *Culex*, the sex chromosomes are morphologically identical.

a) For each of the cell types given below, draw and label (with reference to the symbols defined above) an expected chromosomal configuration.

Mitotic metaphase

Metaphase of meiosis I

Metaphase of meiosis II

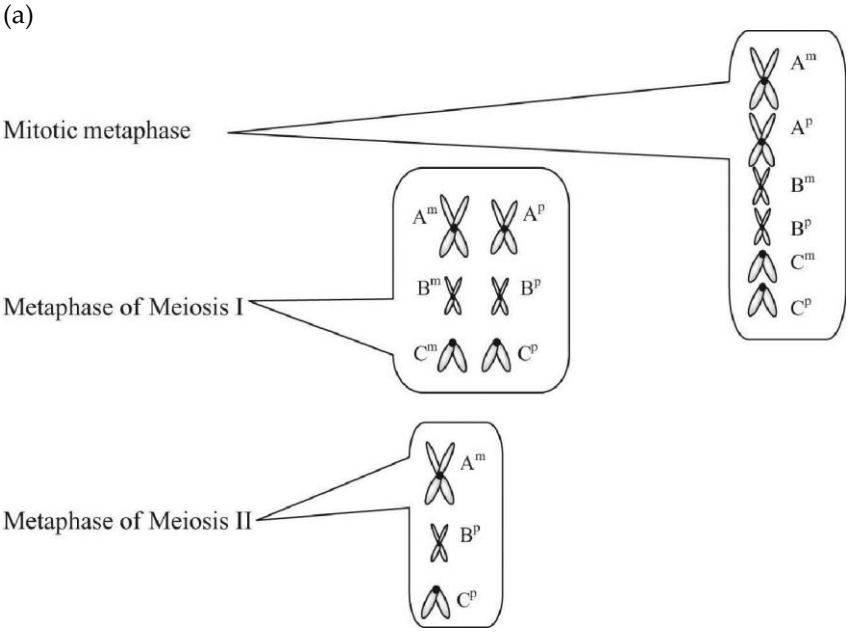
b) The stage at which "sister chromatids go to opposite poles" immediately follows which of the stages listed in (a)?

c) Assuming that all nuclear DNA is restricted to chromosomes and that the amount of nuclear DNA essentially doubles during the S phase of interphase, how much nuclear DNA would be present in each cell listed above? Note: Assume that the G1 nucleus of a mosquito cell contains 3.0×10^{-12} grams of DNA.

d) Given that the sex of *Culex* is determined by alleles of one gene, males heterozygous, *Mm*, and females homozygous, *mm*, illustrate a labeled chromosomal configuration (involving the symbols A^mA^p, B^mB^p, and C^mC^p and the *M* locus) in a primary spermatocyte at metaphase. Assume that the M locus is on the A^mA^p chromosome and that crossing over has not occurred between the *M* locus and the centromere.

Answer:

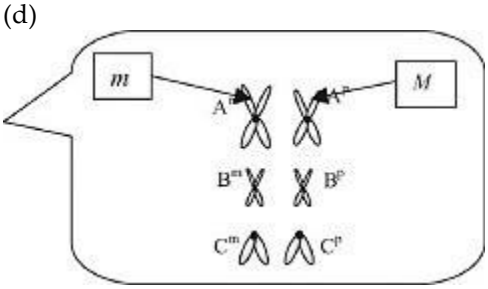
(a)



(b) Metaphase of meiosis II and mitotic metaphase

(c) 6, 6, 3

(d)



Section: 2.5

37) *Drosophila melanogaster*, the fruit fly, has a *2n* chromosome number of 8. Assume that you are microscopically examining the mitotic and meiotic cells of this organism. You note that in the female, two chromosomal pairs are metacentric and that two pairs are acrocentric.

a) Draw the chromosomal configurations as you would expect to see them at the stages listed:

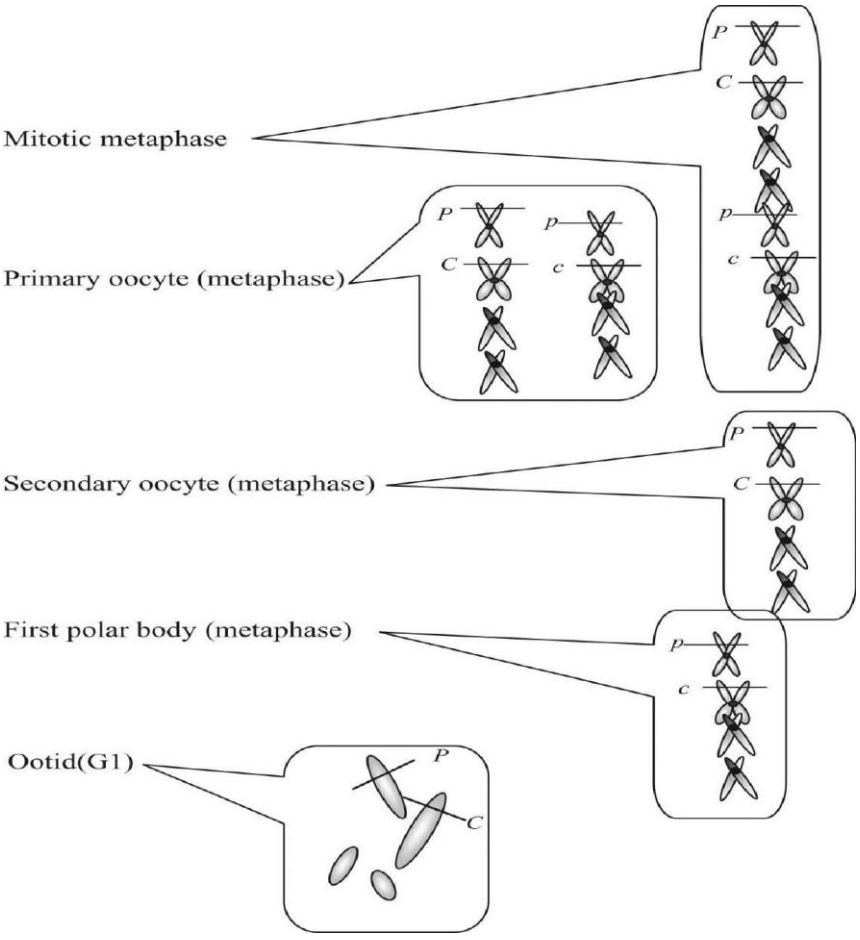
Mitotic metaphase First polar body (metaphase)
Primary oocyte (metaphase) Ootid (G1)
Secondary oocyte (metaphase)

b) Given that the above-mentioned cells are from individuals heterozygous for two independently segregating, autosomal loci, plum eyes and curled wings, place appropriate symbols (of your designation) on chromosomes in the drawings you made in part (A) above. Assume no crossing over, and there may be more than one correct answer in some cases.

c) Assuming that a somatic G2 nucleus from one of the individuals in this scenario contains about 8.0 picograms of DNA, how much nuclear DNA would you expect in each of the cells mentioned above?

Answer:

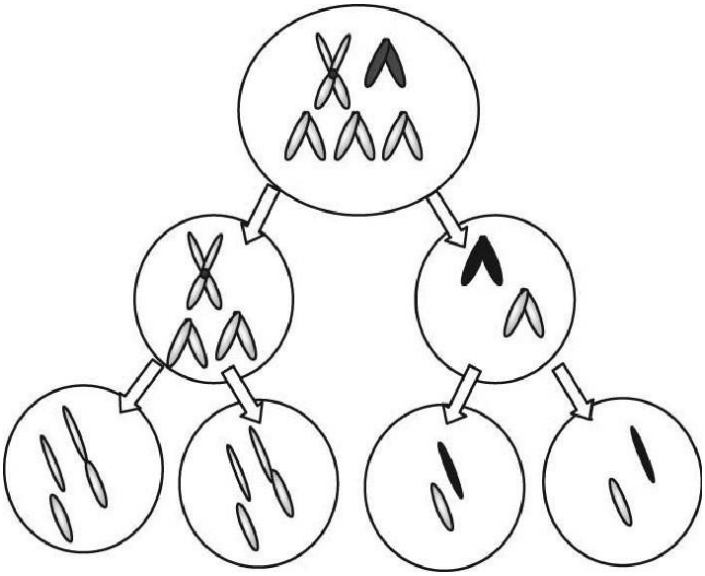
(a) & (b)



(c) 8, 8, 4, 4, 2

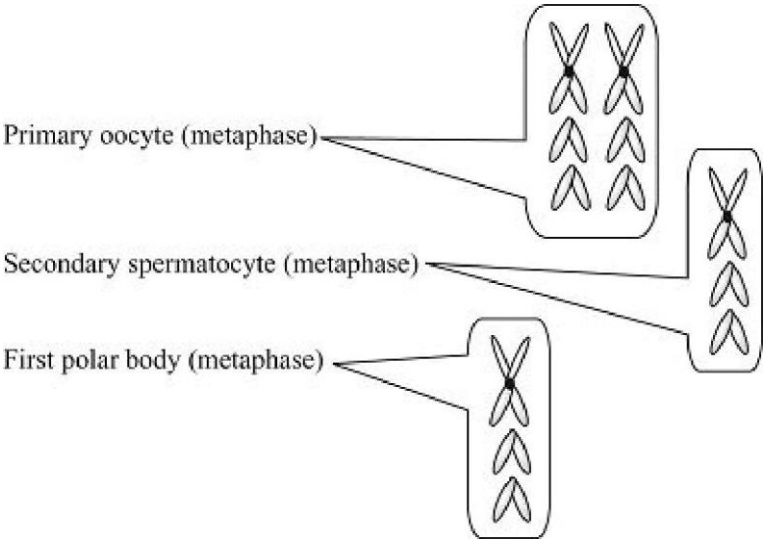
Section: 2.5

38) Down syndrome, or trisomy 21, in humans is caused by an extra copy of the relatively small, acrocentric chromosome #21. Including only chromosome #21, the X chromosome (medium in size and somewhat metacentric), and the Y chromosome (small and acrocentric), draw one possible array of chromosomes in the four sperm cells produced by the complete meiosis of one primary spermatocyte. For the purposes of this question, assume that males with Down syndrome produce normal ratios of sperm cells. (More than one answer is possible.)
Answer:



Section: 2.5

39) Assume that an organism has a diploid chromosome number of six. Two chromosomal pairs are telocentric, and the other pair is metacentric. Assume that the sex chromosomes are morphologically identical. Draw chromosomes as you would expect them to appear at the following stages:
Primary oocyte (metaphase)
Secondary spermatocyte (metaphase)
First polar body (metaphase)
Answer:



Section: 2.5

40) There is about as much nuclear DNA in a primary spermatocyte as in _____ [number] spermatids?
Answer: 4
Section: 2.5

41) List, in order of appearance, all the cell types expected to be formed during (a) spermatogenesis and (b) oogenesis.
Answer:
(a) spermatogonia, primary spermatocyte, secondary spermatocyte, spermatid, spermatozoa (b) oogonium, primary oocyte, secondary oocyte and first polar body, ootid and second polar body
Section: 2.5

42) If a typical G1 nucleus is 2n and contains 2C (two complements) of DNA, a prophase I cell is 2n and contains 4C of DNA.
Answer: TRUE
Section: 2.3

43) S phase is the part of interphase when DNA duplication takes place.
Answer: TRUE
Section: 2.3

44) The centromere of a chromosome separates during anaphase.
Answer: TRUE
Section: 2.3

45) A chromosome may contain one or two chromatids in different phases of the mitotic or meiotic cell cycle.
Answer: TRUE
Section: 2.4

46) If a typical G1 nucleus contains 2C (two complements) of DNA, a gamete that is haploid (*n*) contains 1C of DNA.
Answer: TRUE
Section: 2.4

47) During meiosis, chromosome number reduction takes place in anaphase II.
Answer: FALSE
Section: 2.4

48) A bivalent at pachytene contains four chromatids.
Answer: TRUE
Section: 2.4

49) The meiotic cell cycle involves two cell divisions but only one DNA replication.
Answer: TRUE
Section: 2.4

50) An organism with a haploid number of 10 will produce 1024 combinations of chromosomes at the end of meiosis.
Answer: TRUE
Section: 2.4

51) An organism with a diploid chromosome number of 46 will produce 223 combinations of chromosomes at the end of meiosis.
Answer: TRUE
Section: 2.4