Cell Cycle and Meiosis Concept Questions

1. What functions does cell division accomplish? (Growth of the organism, maintenance and repair of lost or damaged cells, reproduction.)
2. Do all of the cells in your body divide at the same rate? Explain. (Some divide quickly (*e.g.*, blood cells, skin cells) while some never divide (*e.g.*, nerve cells). Cells have different functions which require some to divide more quickly than others.)
3. State the phase that is described by each of the following events during mitosis.
a) The chromosomes move apart and go to opposite poles of the cell. (anaphase)
b) The nucleolus and nuclear envelope reappear. (telophase)
c) The centrioles complete their own replication. (interphase)
d) The cell grows in size. (interphase, G1)
e) The spindle has reached its full development. (metaphase)
f) Chromosomes becomes shorter and thicker strands (prophase)
4. Looking under a microscope, you notice that some cells have several nuclei within the cytoplasm of a single cell. Which phase of the cell cycle is not operating correctly to form such cells? (Cytokinesis has failed to separate the daughter cells.)
5. Why must cytokinesis occur after, rather than before, anaphase? (Chromosomes must be separated before the cell divides.)
6. Identify the difference between cytokinesis in animal cells and plant cells. (Animal cells divide by a cleavage furrow whereas plant cells form a new cell wall between the daughter cells.)
7. A drug interferes with the construction of the mitotic spindle. What effect would this drug have on cells? (Cells would be unable to divide because the mitotic spindle is needed to separate chromosomes.)
8. Why is it so important that DNA replication occur during interphase of cell division? (Each cell needs a complete copy of DNA.)
9. a) Imagine that a drug is developed that forces cells to remain in G1 of the cell cycle. What would be the effect on the cell? (The cell would not divide but would be stuck in the cell cycle so it would not perform its function.)
b) On the individual? (For the individual, no cells would be replaced. This would mean no growth and no replacement of lost cells.)
10. What signals control the growth and division of normal cells? (Essential nutrients, growth factors, anchorage dependance, density-dependant inhibition, DNA replication is complete, amount of DNA damage, *etc*.)
11. How can mutagens cause cancer? (Viruses, chemicals and radiation are the three primary mutagens. and can cause changes to DNA. If they cause mutations in proto-oncogenes or tumor-suppressor genes, cell division becomes unregulated and cancer can result.)
12. Cancer cells are unusual in a variety of ways: they are immortal, they metastasize, don't perform their normal function, and they can form tumors. Explain each of these characteristics at the cell level. (They don't keep track of divisions, making them immortal. They don't stick together and have no anchorage dependance, allowing them metastasize. They are stuck in the cell cycle so they usually don't perform any normal function. They have no density-dependant inhibition so they form tumors.)
13. a) What evidence suggests that cells contain a biological clock or counter? (Cells divide a certain number of times and then they enter apoptosis.)
b) How might understanding the biological counter help extend human life span? (Organs begin to fail as cells age and die; extending the life span of cells indefinitely means we could keep living indefinitely.)
14. How can stem cells be used in addressing the problems of organ transplantation? (Totipotent (or pleuripotent cells can be used to produce complete organs, increasing the supply organs for patients who need them. If those cells are taken from the patient himself, the organ would be a perfect match and avoid immune rejection.)

15. What are chromosomes other than sex chromosomes called? (Autosomes.)
16. Distinguish between haploid and diploid cells in humans. Apply them to the terms 'somatic cell' and 'sex cell.' (Haploid cells (sex cells) have half the number of chromosomes while somatic cells (non sex cells) are diploid, having a full set of chromosomes. In humans, haploid cells have 23 chromosomes. The diploid number is 46.)
17. Do homologous chromosomes have the same number of genes? Do they have identical genes? Explain. (The term homologous means that the chromosomes have the same number of genes. They might not be identical because they could have different alleles of some genes. *e.g.*, for the freckle gene one allele might say freckles while the other allele says no freckles.)
18. a) A cell with 10 chromosomes undergoes mitosis. Indicate the number of chromosomes you would expect in each of the daughter cells. (10)
b) What about after meiosis? (5)
19. Match the events to the correct phase of meiosis.
a) pairs of homologous chromosomes line up along the equator of the cell (metaphase I)
b) synapsis occurs and the four chromatids form a tetrad (prophase I)
c) replication of the genetic material (interphase I)
d) homologous pairs become separated (anaphase I)
e) sister chromatids split at the centromere and move toward opposite poles (anaphase II)
20. a) Think about the number of copies of each chromosome each parent donates to an offspring. Why is meiosis II necessary? (Each parent donates one copy of each chromosome but after meiosis I the daughter cells contain two copies of each.)
b) Why is there no DNA replication before meiosis II? (After meiosis I the daughter cells already contain two copies of each chromosome which must be separated. DNA replication would increase the number of copies.)
21. A muscle cell of a mouse has 40 chromosomes. Indicate the number of chromosomes you would expect to find in each of the following cells of the same mouse
a) daughter cell formed after mitosis (40)
b) skin cell (40)
c) egg cell (20)
d) fertilized egg (40)
22. a) If a cell has a diploid number of 32, what would be the chromosome number of a cell in late Prophase I of meiosis? (32)
b) What about at the end of Telophase II? (16)
23. Compare and contrast meiosis and mitosis. (Students should be able to describe that mitosis produces two identical daughter cells that have the same genetic makeup as the parent cell. Meiosis results in 4 haploid cells that have a different genetic makeup from the parent cell. Meiosis contains two divisions in which the homologous pairs are separated first and then the sister chromatids.)
24. Explain how the production of gametes and sexual reproduction increase genetic variation. (Independent assortment, random fertilization, and crossing over result in new combinations of alleles.)
25. Explain how synapsis often leads to the exchange of genetic material between chromosomes. (During synapsis, crossing over exchanges pieces of homologous chromosomes, resulting in new combinations of alleles.)
26. What is a karyotype and for what purpose is it used? Where would one get the cells to make one? (To produce a karyotype, chromosomes are removed from a cell and photographed. They are then arranged in pairs to determine the presence of chromosomal abnormalities. Fetal cells are required and can be taken from the amniotic fluid or from one of the membranes surrounding the fetus.)
27. Describe nondisjunction and its effect on the chromosomal composition of a cell. (Because of an error with the spindle, some homologues fail to separate and end up in the same daughter cell.)
28. As any pair of chromatids can fail to separate during meiosis, theoretically there are 23 possible kinds

of monosomy and trisomy. However, monosomy or trisomy for most of the 23 chromosome pairs are quite rare (or unheard of). Why do you think this is so? (Most of them are lethal and the fetus is aborted spontaneously.)