Cell Cycle and Meiosis Concept Questions

1. Propose a reason for the importance of the high level of regulation of the cell cycle. (For an organism to experience normal growth and development, cell division must be regulated.)
2. You overhear some students talking about cell division before class one day. One student claims all cells in your body divide at the same rate. Respond to the student. (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. Looking under a microscope, you notice that some cells have several nuclei within the cytoplasm of a single cell. Identify the phase of the cell cycle that is most likely not operating correctly to result in such cells. (Cytokinesis has failed to separate the daughter cells.)
4. Propose a reason cytokinesis must occur after, rather than before, mitosis. (Chromosomes must be separated before the cell divides.)
5. 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.)
6. A particular drug interferes with the construction of the mitotic spindle. Predict the effect on cells exposed to this drug. (Cells would be unable to divide because the mitotic spindle is needed to separate chromosomes.)
7. Propose a reason that DNA replication must occur during interphase of cell division. (Each cell needs a complete copy of DNA.)
8. a) A new drug is developed that forces cells to remain in G1 of the cell cycle. A culture of dividing cells is exposed to the drug. Predict the effect on the cells. (The cell would not divide but would be stuck in the cell cycle so it would not perform its function.)
   b) In a different experiment, the drug is administered to live mice. Predict the effect on individual mice. (For the individual, no cells would be replaced. This would mean no growth and no replacement of lost cells.)
9. Identify the signals that control the growth and division of normal cells. (Essential nutrients, growth factors, anchorage dependence, density-dependent inhibition, DNA replication is complete, amount of DNA damage, etc.)
10. Some cells are engineered to ignore the checkpoints. The cells are then placed in a medium that contains all the required nutrients for growth. Predict the results. (The cells would divide under conditions where it was inappropriate to do so. If the daughter cells and their descendants also ignored either of the checkpoints and divided, there would soon be an abnormal mass of cells. (This type of inappropriate cell division can contribute to the development of cancer.))
11. Explain how mutagens can 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, they don't perform their normal function, and they can form tumors. Explain each of these characteristics at the cellular 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) Describe some evidence that suggests that cells are able to count the number of times they've divided. (Cells divide a certain number of times and then they enter apoptosis.)
    b) Explain how a better understanding of how cells count the number of times they've divided might 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. Describe a way stem cells can be used to address 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. 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.)
16. State whether homologous chromosomes have the same number of genes. State whether they have identical genes. Explain your responses. (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.)
17. a) A cell with 10 chromosomes undergoes mitosis. Indicate the number of chromosomes you would expect in each of the daughter cells. (10)
    b) Indicate the number of chromosomes you would expect in each of the daughter cells after meiosis. (5)
18. Explain how traits possessed by parents (such as hair color) can be inherited by their offspring. (During meiosis, parental chromosomes are assorted into gametes. Those chromosomes carry the genes which determine the traits of the offsring.)
19. a) Each parent donates one copy of each chromosome to an offspring. Whereas the daughter cells of meiosis I are already haploid, explain why meiosis II is necessary. (Each parent donates one copy of each chromosome but after meiosis I the daughter cells contain two copies of each.)
    b) Explain why there is 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.)
20. A chicken has 78 chromosomes in its somatic cells.
    a. State the number of chromosomes it inherited from each parent. (36)
    b. Predict the of chromosomes you would find in each somatic cell of the chicken's offspring. (78)
    c. Predict the number of chromosomes you would find in each of the chicken's gametes. (36)
    d. Predict the number of chromosomes you would find in a fertilized chicken egg. (78)
21. a. If a cell has a diploid number of 32, predict the number of chromosomes you would find in a cell in late Prophase I of meiosis. (32)
    b. Predict the number of chromosomes you would find in a cell in Telophase II. (16)
22. Describe some differences and similarities between 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.)
23. 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.)
24. Describe how synapsis can lead to the exchange of genetic material between chromosomes. (During synapsis, crossing over exchanges pieces of homologous chromosomes, resulting in new combinations of alleles.)
25. Meiosis can produce different combinations of alleles. Identify the original source of variation among the different alleles of a gene. (Mutations)
26. A horticulturalist is breeding orchids to try to obtain a plant with a unique combination of desirable traits. After many years, she finally succeeds. To produce more plants like this one, state whether she

should breed it with another plant or clone it. Justify your response. (She should clone it. Crossbreeding increases genetic variability. Cloning produces offspring genetically identical to the donor.)

27. Explain why the offspring of an asexually reproducing eukaryotic organism are genetically identical to each other and to the parents. (Asexual reproduction occurs by mitosis, in which the entire genome is copied. Daughter cells are genetically identical to the parent cell.)
28. Describe what a karyotype is and its purpose. Identify the source of cells for making a karyotype. (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.)
29. 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.)
30. As any pair of chromatids can fail to separate during meiosis, theoretically there are 23 possible kinds of monosomy and trisomy. Propose a reason for the rare (or nonexistent) cases of monosomy or trisomy for most of the 23 chromosome pairs. (Most of them are lethal and the fetus is aborted spontaneously.)