Section A: Why must a cell divide?
Cells are limited in size because the membrane must transport materials to the inside of the cell. As a cell gets bigger, the outside is unable to keep up with the inside, because the inside grows at a faster rate than the outside. As cells get larger, the surface to volume ratio gets smaller, meaning the cell membrane cannot supply the inside with what it needs to survive. Cell division occurs so multicellular organisms can grow and repair damaged tissue. In multicellular organisms, division occurs to produce egg and sperm for reproduction. In unicellular organisms, division is needed to reproduce the organism.

1. In multicellular organisms, why do cells need to divide?
   _____________________________________________
   ________________________________________________
   _____________________________________________________

Section B: Vocabulary
1. Explain the relationship between chromosomes, genes and DNA. ___________________________________________________
   ___________________________________________________
   ___________________________________________________

2. Define diploid.
3. Define haploid.
4. Check the correct box that matches the description of the two types of Eukaryotic cells.
5. Why is the chromosome number in each animal cell an even number?
   _______________________________________________________
   _______________________________________________________

6. Why is it important that gamete cells have only one set of chromosomes?
   _______________________________________________________
   _______________________________________________________

7. What are the two types of gametes?
   _______________________________________________________

8. What process is the fusion of gametes that create a zygote? ________________ Is a zygote a diploid or haploid cell? ________________

9. The data table shows the number of chromosomes for somatic cells.
   a. Chromosome # for diploid human cell? _______
   b. Chromosome # for haploid pea plant? _______
   c. Chromosome # for dog gamete? _______
   d. Chromosome # for diploid frog cell? _______
   e. If a frog cell had 26 chromosomes, then the cell is diploid or haploid.
      ______________________________________________
   f. If a mosquito cell had 3 chromosomes, then it would be a gamete or somatic cell. ________________
   g. If an orangutan cell had 24 chromosomes, then the cell is diploid or haploid. ________________
   h. If a corn cell had 20 chromosomes, then the cell is diploid or haploid. ________________

10. In the karyotyping activity, identify the diploid number, gender and chromosomal abnormality in each patient.
    a. Patient A - ________________________________
    b. Patient B - ________________________________
    c. Patient C - ________________________________
    d. Patient D - ________________________________

11. Label the sister chromatids and the centromere on the duplicated chromosome. Label the chromatid and centromere on the single chromosome.

12. ________________ is a segment of DNA that codes for a protein.

13. What are homologous chromosomes? _____________________
Section C: Cell Cycle
The cell cycle is the series of events that take place in a eukaryotic cell between its formation and the moment it replicates itself. These events can be divided into three main parts: (1) interphase (includes G1 phase, S phase, G2 phase), during which the cell is forming and carries on with its normal metabolic functions; (2) the M phase (mitosis or meiosis), during which the nucleus is dividing, and (3) cytokinesis, during which the cytoplasm divides and new daughter cells are formed. Thus, cell-division cycle is an essential process for repair and growth in eukaryotic organisms. It is also the process where unicellular or multicellular organisms reproduce asexually. Sometimes the cells exit the cell cycle and enter the G0 phase. In the G0 phase, cells are alive and metabolically active, but do not divide. In this phase cells do not copy their DNA and do not prepare for cell division. Many cells in the human body, including those in heart muscle, eyes, and brain are in the G0 phase. If these cells are damaged they cannot be replaced.

1. What are the three steps of cell cycle? _________________________________________
2. What occurs during interphase? ______________________________________________________
3. What occurs during M phase? ___________________________________________________________________
4. What occurs during cytokinesis? _________________________________________________________________
5. What is the G0 phase? _____ ___________________________________________________________________
6. What type of cell enters the G0 phase? ____________________________________________________________

Section D: Interphase
The G1 phase is the major period of cell growth. During this stage new organelles are being synthesized, so the cell requires both structural proteins and enzymes, resulting in great amount of protein synthesis. The S phase (synthesis phase) is when DNA synthesis or replication occurs. At the beginning of the S stage, each chromosome is composed of one coiled DNA double helix molecule, which is called a chromatid. At the end of this stage, each chromosome has two identical DNA double helix molecules, and therefore is composed of two sister chromatids. During S phase, the centrosome is also duplicated. G2 phase is the shortest subphase during interphase in which the cell undergoes a period of rapid growth to prepare for the M phase. Although chromosomes have been replicated they cannot yet be distinguished individually because they are still in the form of loosely packed chromatin fibers.

1. When are chromosomes duplicated? ______________________
2. If the parent cell has 20 chromosomes in G1, how many chromosomes will it have in the G2 phase? __________
3. Which phase is the longest in interphase? __________
4. Are chromosomes visible during interphase? _________
5. What are chromatin? __________________________________________
6. Which phase is protein synthesis going on? ______________
7. Which phase is the cell preparing for division? _______________

Section E: Cell Cycle Webquest
On "Websites-Geneatics" page, click on `Cell Cycle`. Use the animation to answer these questions.

1. What are the 3 phases of the cell cycle? ______________
2. Interphase includes ________, ________, and ________ phases.
3. How long does it take for DNA replication to occur? __________
4. What occurs in G1 phase? __________________________
5. What occurs in G2 phase? __________________________
6. What is the purpose of the M phase? __________________________
7. What is the G0 phase? __________________________
8. Give an example of cells that enter the G0 phase? __________________________
9. What is apoptosis? ___________________________________________________________________
10. Why is apoptosis an important process? __________________________
Section F: Mitosis Webquest
On “Websites-Genetics” page, click on ‘Mitosis’. Use the animation to answer these questions.
1. What is divided in mitosis? _____________________
2. What is divided in cytokinesis? _______________________
3. What are the stages of mitosis? ______________________________________________________________
4. What happens during prophase? _______________________________________________________________________
5. What happens during metaphase? ____________________________________________________________
6. What happens during anaphase? ______________________________________________________________
7. What happens during telophase? ___________________________________________________________________________
8. In which phase do chromosomes become visible? _________________________________
9. What is the purpose of spindle-fibers (microtubules)? ______________________________________________________________________________
10. If the spindle fibers malfunction, how would the malfunction affect nuclear division? _________________
11. What is cytokinesis? _____________________________________________________________________________
12. How is cytokinesis in an animal cell different than a plant cell? ___________________________________________

Section G: Onion Root Tip Cell Cycle
On “Websites-Genetics” page, click on ‘Onion Root Tip’. Click next and assort the cell cycle pics.

<table>
<thead>
<tr>
<th>NUMBERS</th>
<th>INTERPHASE</th>
<th>PROPHASE</th>
<th>METAPHASE</th>
<th>ANAPHASE</th>
<th>TELOPHASE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Cell Number</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of Total Cells</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Section H: Mitosis - How many chromosomes?
1. At the beginning of interphase, how many chromosomes are in the parent cell? __________
2. At the end of interphase, how many chromosomes are in the parent cell? __________
3. How many chromosomes are in each daughter cell? ______________________
4. Are the daughter cells genetically identical or different than the parent cell? _________________
5. How many daughter cells are created when a cell undergoes mitosis and cytokinesis? __________
6. A parent cell has 24 chromosomes. When it undergoes mitosis, how many chromosomes will be in each daughter cell? ___________ How many daughter cells will be created? ___________

Section I: Mitosis
1. Fill in the phases and label the diagrams.
Matching: Match the term to the description. Some will be used more than once.

a. G1  d. anaphase  g. mitosis  j. prophase  m. centromere
b. G2  e. telophase  h. spindle fiber  k. metaphase  n. interphase
c. S  f. cytokinesis  i. cell plate  l. chromatid

d. anaphase  g. mitosis  j. prophase  m. centromere

2. Sister chromatids are moving apart. ______
3. New nuclear membrane forms. ______
4. Cytoplasm is being divided. ______
5. Chromosomes become invisible. ______
6. Chromosomes are in the middle. ______
7. Nuclear membrane begins to fade. ______
8. Fibers pull chromatids towards poles. ______
9. Spindles are formed. ______
10. Chromosomes are visible. ______
11. Cell plate divides the cytoplasm. ______
12. Chromosomes replicate. ______
13. Reverse of prophase. ______
14. Cell prepares for division. ______
15. Normal metabolic activities occur. ______
16. Structure that connects chromatids. ______
17. The ½ of the chromosome. ______
18. Connects to centromeres. ______
19. Cells spend the majority of time in. ______
20. Structures centrioles produce. ______
21. Forms in plant cells for cytokinesis. ______
22. Constriction region on chromosome. ______
23. Period of cell growth before division. ______
24. Nuclear division. ______
25. Sister chromatids are together in. ______

Section J: Meiosis
1. At the beginning of interphase, how many chromosomes are in the parent cell? ___________
2. At the end of interphase, how many chromosomes are in the parent cell? ___________
3. How many divisions occur in meiosis? ___________
4. In prophase I, what do the homologous chromosomes do? ____________________________
5. What is crossing over? ____________________________
6. In metaphase I, explain independent assortment. ____________________________
7. How many chromosomes are in each daughter cell at the end of telophase I? ___________
8. How many daughter cells are created at the end of cytokinesis I? ___________
9. How many chromosomes are in each daughter cell at the end of telophase 2? ___________
10. At the end of cytokinesis 2, how many daughter cells are created? ___________
11. Are the daughter cells at the end of meiosis and cytokinesis genetically identical or different? ___________
12. Why is meiosis and sexual reproduction important? ____________________________
13. Why types of cells are produced after meiosis? ____________________________
14. Why is independent assortment important? ____________________________
15. Why is shuffling of the chromosomes [crossing-over] important? ____________________________
16. A parent cell has 24 chromosomes. When it undergoes meiosis, how many chromosomes will be in each daughter cell? ___________ How many daughter cells will be created? ___________

Additional Animations/Tutorials:
http://www.biology.arizona.edu/cell_bio/tutorials/cell_cycle/cells2.html
http://www.biology.arizona.edu/cell_bio/tutorials/meiosis/main.html
http://www.hartnell.edu/tutorials/biology/mitosis.html
http://www.hartnell.edu/tutorials/biology/meiosis.html
http://www.pbs.org/wgbh/nova/miracle/divi_flash.html

Quizzes:
http://www.sciencegeek.net/Biology/review/U3CellReproduction.htm
http://www.sciencegeek.net/Biology/review/U3Meiosis.htm
http://www.sciencegeek.net/Biology/review/U3Review.htm
http://www.neok12.com/quiz/CELDIV05
http://www.neok12.com/quiz/CELDIV03