# The Great Divide (Cell Division and DNA Replication)

**Grade Level or Special Area**: 7th grade Science and Technology

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**Length of Unit**: Three lessons (approximately three weeks (14-17 days), one day= 45 minutes)

## I. ABSTRACT

The focus of this 7th grade science and technology unit is a systematic approach to understanding the topic of cell division. In addition, technology components are included to enhance the understanding of the topics and fulfill the National Standards for Technology Literate Students. Hands-on activities, labs and tricks-of-the-trade will enhance "The Great Divide."

## II. OVERVIEW

A. Concept Objectives (Colorado Model Content Standards for Science, United States Content Standards for Life Science (USCS) and National Performance Indicators for Technology-Literate Students)

1. Students will develop an understanding of reproduction and heredity and the molecular basis of heredity. (USCSC)
2. Students understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment. (CS3)
3. Students understand legal and ethical behaviors when using information and technology. (NPIT3)
4. Students will understand the process of using technology resources to demonstrate and communicate curriculum concepts to audiences inside and outside the classroom. (NPIT6)

B. Content from the *Core Knowledge Sequence* –Science 7th grade p.176

1. Cell Division and Genetics
    a. Cell division, the basic process for growth and reproduction
        i. Two types of cell division: mitosis (growth and asexual reproduction), meiosis (sexual reproduction)
        ii. Asexual reproduction: mitosis; diploid cells (as in amoeba)
        iii. Sexual reproduction: meiosis; haploid cells; combination of traits
        iv. How change occurs from one generation to another; either mutation or mixing of traits through sexual reproduction
    b. Modern understanding of chromosomes and genes
        i. Double helix (twisted ladder) of DNA coding; how DNA makes new DNA
        ii. How DNA sequence makes proteins one gene equals one protein

C. Skill Objectives

1. Students will read and analyze text in different forms for information.
2. Students will take notes on class discussions.
3. Students will observe and analyze observations.
4. Students will participate in discussions.
5. Students will formulate conclusions based on experimentation.
6. Students will make hypotheses based on prior knowledge.
7. Students will use the scientific method to test hypotheses.
8. Students will use gross and fine motor skills to perform experiments.
9. Students will apply these lessons to life situations.

10. Students will hypothesize possible outcomes.
11. Students will record and analyze data and observations.
12. Students will write experimental conclusions in paragraph form.
13. Students will use Microsoft Word to produce neat, complete final products.
14. Students will use the Paint program to illustrate concepts.
15. Students will use interactive web sites to gain information.
16. Students will manipulate objects on the computer using the mouse.

## III. BACKGROUND KNOWLEDGE

A. For Teachers
   1. http://www.cbc.umn.edu/~mwd/cell_www/
   2. Familiarity with Netscape Composer, Microsoft Publisher, Microsoft Office Suite, Paint program, and Internet searches
   3. http://www.eurekascience.com/IcanDoThat/dna_intro.htm and http://academy.d20.co.edu/kadets/lundberg/DNA_animations/DNAreplication.mov

B. For Students
   1. Cells: structures and processes: *Core Knowledge Sequence*, grade 5
   2. Life cycles and reproduction: *Core Knowledge Sequence*, grade 5
   3. Chemical bonds and reactions: *Core Knowledge Sequence*, grade 7
   4. Gregor Mendel's experiments with purebred and hybrid peas
      a. Dominant and recessive genes
      b. Mendel's statistical analysis led to understanding that inherited traits are controlled by genes (now known to be DNA) *Core Knowledge Sequence*, grade 7
   5. Familiarity with Netscape Composer, Microsoft Publisher, Microsoft Office Suite, and Paint program

## IV. RESOURCES

A. Poster or drawing of basic cell and organelles (Lesson One)
B. 1 foot long wooden dowels (Lesson One)
C. Two sizes of plastic tubing (see specs in Chromosome Shuffle website) (Lesson One)
D. Nylon rope (Lesson One)
E. Velcro strips (Lesson One)
F. Nylon cording (Lesson One)
G. Latch hooks and eyes (Lesson One)
H. One bag large white marshmallows (Lesson Two)
I. One bag small colored marshmallows (Lesson Two)
J. Small nails (Lesson Two)
K. Red and blue push pins (Lesson Two)
L. Pipe cleaners cut in half (Lesson Two)
M. Toothpicks (Lesson Two)
N. Moveable/twistable DNA model (see Appendix K) (Lesson Three)
O. Computer (All Lessons)
P. Printer (All Lessons)
Q. Internet Connection (All Lessons)
R. Microsoft Office Suite (All Lessons)
S. Paint Program (All Lessons)
T. Storage media (floppy disk, CD Rom, network storage, etc.) (All Lessons)

## V. LESSONS

### Lesson One: Mitosis (four to five 45-minute class periods)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Students will develop an understanding of reproduction and heredity and the molecular basis of heredity. (USCSC)
   b. Students understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment. (CS3)
   c. Students exhibit legal and ethical behaviors when using information and technology, and discuss consequences of misuse. (NPIT3)
   d. Students design, develop, publish and present products using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom. (NPIT6)
2. Lesson Content
   a. Cell division, the basic process for growth and reproduction
      i. Two types of cell division: mitosis (growth and asexual reproduction), meiosis (sexual reproduction)
      ii. Asexual reproduction: mitosis; diploid cells (as in amoeba)
3. Skill Objective(s)
   a. Students will take notes on class discussions.
   b. Students will read and analyze text in different forms for information.
   c. Students will observe and analyze observations.
   d. Students will participate in discussions.
   e. Students will use gross and fine motor skills to perform activities
   f. Students will make connections between content learned in this lesson and daily life.
   g. Students will use Microsoft Word to produce neat, complete final products.
   h. Students will use the Paint program to illustrate concepts.

B. *Materials*

1. Poster or drawing of a cell showing organelles
2. Photocopies of Appendices A, B and C for students
3. 1 foot long wooden dowels
4. 2 sizes of plastic tubing (see specs in Chromosome Shuffle website)
5. Nylon ropes
6. Velcro strips
7. Nylon cording
8. Latch hooks and eyes
9. Computer
10. Printer
11. Internet Connection
12. Storage media (floppy disk, CD Rom, network storage, etc)

C. *Key Vocabulary*

1. Cell-the building blocks of life: the tiny units of living things that make up tissues
2. Cell division-cell reproduction: cells replicate their DNA, and then divide in two
3. Chromosome-DNA molecules twisted into a small rod shape- the genetic material of the cell
4. Mitosis-cell division in which the resulting daughter cells are nearly identical to the original

D. *Procedures/Activities*

1. Review cells and cell structure from fifth grade. Using a large poster or drawing of a cell, have students point out certain parts of an animal or plant cell, for example, the cell membrane/wall, cytoplasm, nucleus, etc. Review the basic functions of these organelles. Have students fill in the organelle chart in Appendix A during class discussion. If more review or more resources are needed, http://www.cellsalive.com/cells/3dcell.htm is a great site for information, navigates very nicely, and the reading level and subject matter are very well matched to seventh grade. Also, if time permits, you can have students do the WebQuest comparing cells to cities at http://edservices.aea7.k12.ia.us/edtech/teacherpages/cwinstead3/index.html.
2. Introduce cell division and mitosis through the websites listed in Appendix B or your textbook or class discussion. Appendix B contains questions based on the websites that are also covered in many textbooks. This activity can be done completely on the computer using Word and Paint. Appendix D "Making a template" allows you to make templates that students can fill in and may be turned in electronically or printed and turned in by hand. Make sure students save work correctly as it is important that it be found again.
3. Perform and practice the "Chromosome Shuffle" for mitosis as a class. This activity can be performed again after learning meiosis. See http://www.accessexcellence.org/AE/AEC/AEF/1996/meyer_chromosome.html.

E. *Assessment/Evaluation*

1. Teacher will use Rubric, Appendix C, to determine application of skills evaluated. The grade will be determined from the rubric.
2. The Chromosome Shuffle will be used as a hands-on evaluation of understanding as groups are able to perform the step without teacher input.

**Lesson Two: Meiosis (five to six 45-minute class periods)**

A. *Daily Objectives*

1. Concept Objective(s)
   a. Students will develop an understanding of reproduction and heredity and the molecular basis of heredity. (USCSC)
   b. Students understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment. (CS3)
   c. Students exhibit legal and ethical behaviors when using information and technology, and discuss consequences of misuse. (NPIT3)
   d. Students design, develop, publish and present products using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom. (NPIT6)
2. Lesson Content
   a. Cell division, the basic process for growth and reproduction
      i. Two types of cell division: mitosis (growth and asexual reproduction), meiosis (sexual reproduction)
      ii. Asexual reproduction: mitosis; diploid cells (as in amoeba)
      iii. Sexual reproduction: meiosis; haploid cells; combination of traits
3. Skill Objective(s)
   a. Students will read and analyze text in different forms for information.
   b. Students will apply the lesson to life situations.
   c. Students will hypothesize possible outcomes.
   d. Students will record and analyze data and observations.

e. Students will use Microsoft Word to produce neat, complete final products.
f. Students will use interactive web site to gain information.
g. Students will use the Paint program to illustrate concepts.
h. Students will formulate conclusions based on experimentation.
i. Students will use gross and fine motor skills to perform experiments.
j. Students will manipulate objects on the computer using the mouse.

B. *Materials*

1. Appendix E and student worksheets from http://www.netlabs.net/hp/ebend/genetics/ReeBops.html photocopied for students
2. One bag large white marshmallows
3. One bag small colored marshmallows
4. Small nails
5. Red and blue push pins
6. Pipe cleaners, cut in half
7. Toothpicks
8. Computer
9. Printer
10. Internet connection
11. Storage media for computer data

C. *Key Vocabulary*

1. Meiosis-cell division in which the resulting daughter cells contain half of the genetic information from the original
2. Somatic cell-"normal" cell - body cells not involved in reproduction
3. Gametes (sex cells)-the cells involved in sexual reproduction (contain half of the genetic information of somatic cells

D. *Procedures/Activities*

1. Introduce the need for meiosis in producing new organisms by sending students to the sites listed in Appendix E and answering the questions there. This activity can be done completely on the computer using Word and Paint. Appendix D "Making a template" allows you to make templates that students can fill in and may be turned in electronically or printed and turned in by hand. Make sure students save work correctly as it is important that it be found again. Use the rubric from Appendix C to evaluate and assign grades.
2. Repeat the "Chromosome Shuffle' activity http://www.accessexcellence.org/AE/AEC/AEF/1996/meyer_chromosome.html. except have the students do meiosis. Also, the opportunity can be taken to review the steps of mitosis and compare the two.
3. If the chromosome shuffle is not possible, have the students practice mitosis and meiosis at http://www.sp.uconn.edu/~bi107vc/sp99/saul/experimental/Celldiv.html.
4. Visit http://www.iloveteaching.com/writesci/Rebops and have students raise and cross some Reebops. The original concept and more background information can be found at http://www.wisc.edu/cbe/Publications/Reebops.pdf. http://www.netlabs.net/hp/ebend/genetics/ReeBops.html has very good directions and ready-made handouts and worksheets.

E. *Assessment/Evaluation*

1. Teacher will use Rubrics, Appendix C and Appendix H to determine application of skills evaluated. The grade will be determined from the Rubric.
2. The Chromosome Shuffle will be used as a hands-on evaluation of understanding as groups are able to perform the step without teacher input.

**Lesson Three: DNA Replication and Protein Synthesis (five to six 45-minute class periods)**

A. *Daily Objectives*

1. Concept Objective(s)
   a. Students will develop an understanding of reproduction and heredity and the molecular basis of heredity. (USCSC)
   b. Students understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment. (CS3)
   c. Students exhibit legal and ethical behaviors when using information and technology, and discuss consequences of misuse. (NPIT3)
   d. Students design, develop, publish and present products using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom. (NPIT6)
2. Lesson Content
   a. Modern understanding of chromosomes and genes
      i. Double helix (twisted ladder) of DNA coding; how DNA makes new DNA
      ii. How DNA sequence makes proteins one gene equals one protein
3. Skill Objective(s)
   a. Students will take notes on class discussions.
   b. Students will observe and analyze observations.
   c. Students will participate in discussions.
   d. Students will formulate conclusions based on experimentation.
   e. Students will make hypotheses based on prior knowledge.
   f. Students will use the scientific method to test hypotheses.
   g. Students will use gross and fine motor skills to perform experiments.
   h. Students will hypothesize possible outcomes.
   i. Students will record and analyze data and observations.
   j. Students will write experimental conclusions in paragraph form.
   k. Students will use Microsoft Word to produce neat, complete final products.
   l. Students will use the Paint program to illustrate concepts.
   m. Students will use interactive web sites to gain information.
   n. Students will manipulate objects on the computer using the mouse.

B. *Materials*

1. Appendices F, G, I and J photocopied for students
2. Moveable/twistable DNA model (see Appendix K)
3. Computer
4. Printer
5. Internet connection
6. Storage media for computer data

C. *Key Vocabulary*

1. DNA-Deoxyribonucleic acid-the chemical that makes up genetic material-contains genes
2. Replication-to make a copy of
3. Synthesis-to make a new object out of parts

D. *Procedures/Activities*

1. Visit http://www.eurekascience.com/ICanDoThat/dna_intro.htm as a class and read and talk through the first five pages, covering DNA Introduction, Structure, Genes, Replication and Detail, then skip down on the left side of the screen to

Synthesis-RNA, Protein Synthesis and Detail. This is a great way to teach DNA, enzymes, proteins, replication, RNA, and protein synthesis. You may have students take notes as you go.

2. Using a moveable model of DNA, show students how the straight, flat ladder of DNA twists upon itself to become a much shorter and more compact double helix so that it will be ready for cell division. Talk about why exactly DNA is called a "double" helix: the two strands of chemically bonded sugars and phosphate groups make the sides of the ladder, and the nitrogen bases make the rungs of the ladder. If you do not have a moveable DNA model, available widely in supply catalogues, see Appendix K for directions on how to make your own. Warning: making your own may be more expensive than buying one.
3. Students should label the diagram of DNA in Appendix F. This activity can be done completely on the computer using Word and Paint. Appendix D "Making a template" allows you to make templates that students can fill in and may be turned in electronically or printed and turned in by hand. Make sure students save work correctly as it is important that it be found again. Teacher note: circles are phosphate groups, pentagons are pentose (deoxyribose), then choose which arrows and other symbols in the center are adenine, guanine, thymine and cytosine.
4. Review that in both mitosis and meiosis the chromosomes must make copies of themselves to start the whole process. This copying process is called DNA replication. If possible, show a video clip of DNA replication or visit http://www.seinan-gu.ac.jp/~djohnson/DNARepl.html and http://academy.d20.co.edu/kadets/lundberg/DNA_animations/DNAreplication.mov as a class and talk about the processes as they happen.
5. Have students complete the lab: DNA replication and protein synthesis from Appendix G. Templates for DNA parts, RNA and ribosomes are included in Appendix J. If you have the students cut out all the pieces themselves, it will take nearly an entire class period. You may want to have this done before class, and have a set for each lab group already in envelopes to keep. You may even want to laminate the pieces for reuse. If you are really daring, you could make the pieces out of plastic. If you would rather not deal with small pieces of molecules or would like students to do a computer activity, http://www.pbs.org/wgbh/aso/tryit/dna/# has an interactive workshop activity where the students plug in nucleotides and perform the other processes of replication and synthesis.
6. Give DNA quiz: allow students to use any notes they took during this lesson.

E. *Assessment/Evaluation*

1. Teacher will use Rubrics, Appendix C and Appendix H to determine application of skills evaluated. The grade will be determined from the Rubric
2. Teacher will use the key for DNA Quiz to assign grades.

## VI. CULMINATING ACTIVITY

A. The students will create a PowerPoint presentation, Newsletter, Brochure, or website to bring together all of the concepts, vocabulary and applications from the unit. See Appendices L-Q.

B. Written test: Cell Division

## VII. HANDOUTS/WORKSHEETS

A. Appendix A: Organelles Chart

B. Appendix B: Cell Division Notes

C. Appendix C: Rubric for notes in science notebook
D. Appendix D: Making a Template
E. Appendix E: Meiosis Notes
F. Appendix F: DNA Structure
G. Appendix G: Lab: DNA Replication and Protein Synthesis
H. Appendix H: Rubric for Lab Write up
I. Appendix I: DNA Quiz and Key
J. Appendix J: Templates for DNA Replication lab
K. Appendix K: How to make a moveable DNA molecule model
L. Appendix L: Directions for culminating activity
M. Appendix M: Website procedures
N. Appendix N: Newsletter/Brochure Procedures
O. Appendix O: PowerPoint procedures
P. Appendix P: Storyboard
Q. Appendix Q: Rubric for Culminating Activity
R. Appendix R: Cell Division Test

## VIII. BIBLIOGRAPHY


A. Darnell, James, Lodish, Harvey and Baltimore, David. *Molecular Cell Biology*. New York: W.H. Freeman and Company, 1990. 0-7167-1981-9.

B. Hooper, Debi. *Integrating Technology into the Science Curriculum*. Westminster, CA: Teacher Created Materials, Inc, 1999. 1-57690-429-6.

C. Rogers, Kirsteen, Howell, Laura, Smith, Alastair, Clarke, Phillip, and Henderson, Corinne. *The Usborne Internet-linked Science Encyclopedia*. London: Usborne Publishing Ltd, 2000.

D. Strickberger, Monroe W. *Genetics*. New York: Macmillan Publishing Company, 1985. 0-02-418120-X

E. Tortora, Gerard J. and Anagnostakos, Nicholas P. *Principles of Anatomy and Physiology*. New York: Harper & Row, Publishers, 1990. 0-06-046694-4.

F. Wallace, Robert A., King, Jack L. and Sanders, Gerald P. *Biology The Science of Life*. Glenview, IL: Scott, Foresman and Company, 1986. 0-673-16657-0.

Appendix A

# ORGANELLES

| Organelle | Location | Function |
|---|---|---|
| **Cell Membrane/ Wall** | | |
| **Endoplasmic Reticulum** | | |
| **Mitochondria/ Chloroplasts** | | |
| **Golgi apparatus** | | |
| **Lysosomes** | | |
| **Vacuoles** | | |
| **Cytoplasm** | | |
| **Nucleus** | | |

# ORGANELLES (key)

| Organelle | Location | Function |
|---|---|---|
| **Cell Membrane/ Wall** | **Outside layer surrounding cell** | **Protection of cell interior, structure of organism/tissue** |
| **Endoplasmic Reticulum** | **Looks like stacks of pancakes surrounding the nucleus** | **Transport of materials in cell; Rough processes protein, Smooth processes lipids and carbohydrates** |
| **Mitochondria/ Chloroplasts** | **Oval shaped organelles. Chloroplasts are green, mitochondria have zigzags** | **Mito:Cellular respiration- extracting energy from sugars Chloro: photosynthesis-putting energy into sugar** |
| **Golgi apparatus** | **Stacks of flat membranes in the cytoplasm** | **Prepares materials for transport throughout the cell** |
| **Lysosomes** | **Small round organelles in nucleus** | **Digestion of waste matter and worn out organelles** |
| **Vacuoles** | **Large fluid filled sacs, in plants can be larger than nucleus** | **Stores fluids and nutrients, in plants provides stiffness** |
| **Cytoplasm** | **jello-like fluid that fills the cell** | **Holds and cushions other organelles, provides structure** |
| **Nucleus** | **Largest and most obvious organelle, usually near center** | **Control center of the cell** |

Appendix B

# Cell Division

**A. Go to http://www.sfscience.com/english/grade_6/unit_A/chap_2/act_1/1.htm**
**Answer the following questions (Remember, no copy and paste! Answer in your own words.):**

1. **How do all organisms begin?**
2. **Why do cells need to split?**
3. **What are the special things that happen when a cell splits?**
4. **Exactly when do single celled organisms divide?**
5. **Mitosis is the process by which what happens?**

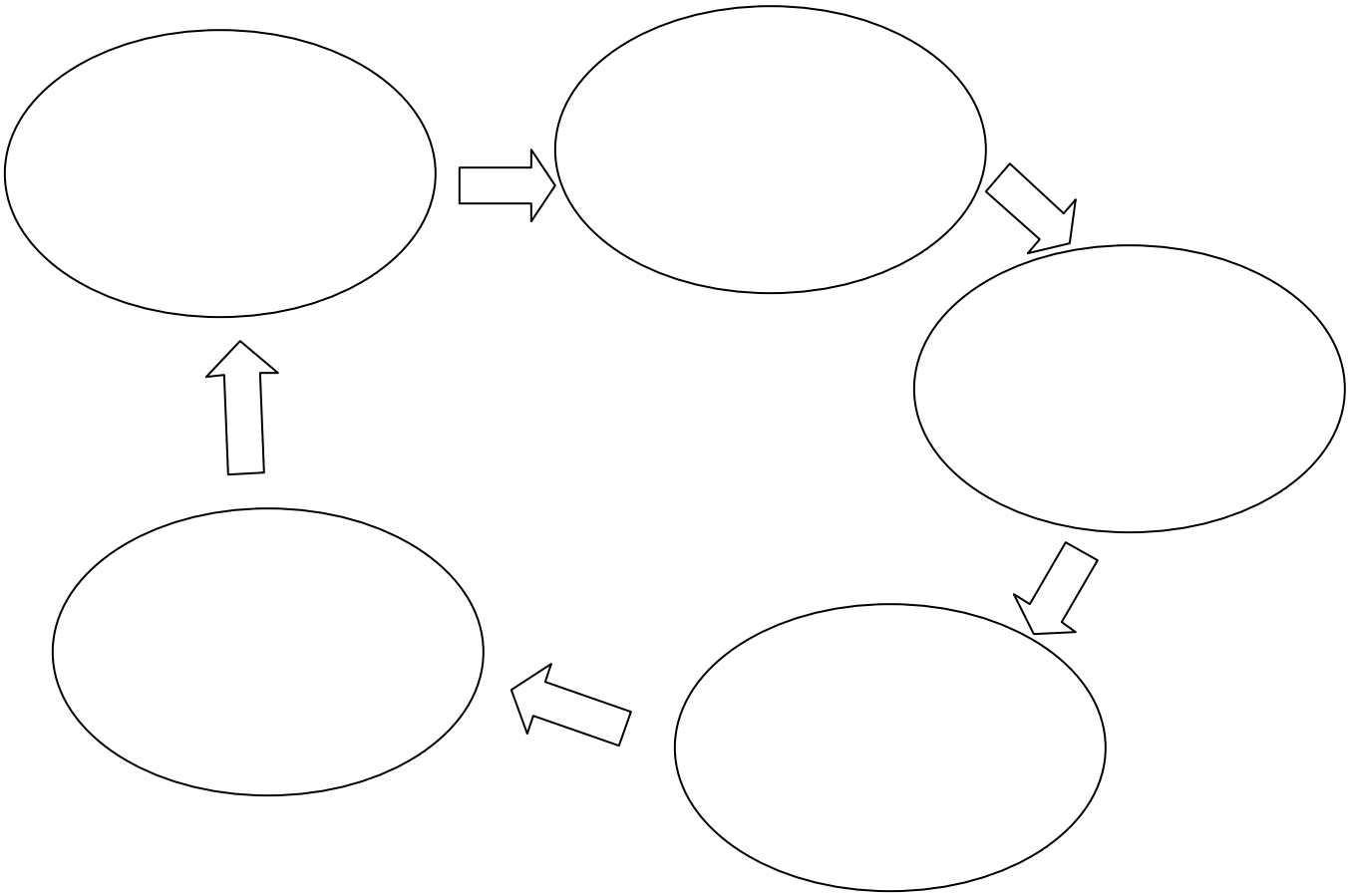
**B. Go to http://www.biology.arizona.edu/cell_bio/tutorials/cell_cycle/cells3.html and http://www.cellsalive.com/mitosis.htm.**
**Fill in this chart of the steps involved in mitosis, and make sure you click on "Mitosis Animation" to see mitosis in action-it is shown at high speed, so you can see it slower by clicking on the pause/forward and pause/back buttons below the animation to see it frame by frame.**

| Step name | Actions |
|---|---|
| 1. | |
| 2. | |
| 3. | |
| 4. | |
| 5. | |

| | |
|---|---|
| **6.** | |
| **7.** | |

**C.** **Go to http://www.accessexcellence.com/AB/GG/mitosis.html, http:www.iacr.bbsrc.ac.uk/notebook/courses/guide/mitosis.htm, http://biotech-adventure.okstate.edu/low/basics/mitosis/mitosis-diagram/diagram.gif and http://www.bioweb.uncc.edu/biol1110/d-stages.htm**

**Draw your own diagram of the steps of mitosis in these circles that represent the major steps. Please include as many labels as you can. Hint: these websites do not include many labels.**



**D. To see Mitosis in actual cells, go to http://www.bio.unc.edu/faculty/salmon/lab/mitosis/mitosismovies.html go all the way to the bottom of the page and watch the last three movies of mitosis. The first movie shows the chromosomes lining up, doubling and pulling apart very well, the second movie shows the cell plate forming, and the third shows the spindle fibers.**

**E. Go to http://copland.udel.edu/%7Eapril/mitosis.html. Print it, and do the word search.**

**F. Go to http://bioweb.uncc.edu/biol1110/Stages.htm. List and explain at least three differences between animal cell mitosis and plant cell mitosis.**

Appendix C

# RUBRIC FOR NOTES IN SCIENCE NOTEBOOK

| Category | Outstanding | Accomplished | Developing | Beginning | Total Points | Teacher's Score |
|---|---|---|---|---|---|---|
| **CONTENT** | Contains all content given in class | Contains most content given in class | Contains some content given in class | Contains little or no content given in class | **10** | |
| **NEATNESS** | Neat and easy to read and follow | Neat | Somewhat messy | Messy and unable to follow | **5** | |
| **APPLICATION** | Demonstrates understanding by including additional information whenever possible | Demonstrates understanding by including some information | Very little information included | No additional information included | **8** | |
| | | | | **TOTALS** | **23** | |

Appendix B

Appendix D

## MAKING A TEMPLATE

1. Open document that you want to make a template for.
2. Open **File**.
3. Click **Save As**.
4. Name your document.
5. Under the **File Name** box is a box, which says **Save As** Type. Click on the arrow on the right and find **Document Template**.
6. **Remember this!!** The **Document Template** automatically wants to save your document in the **Office Templates Folder**. This is OK, but it makes it hard for you to find specific templates. Every time you open up a new document you would have this template to chose from in the template folder. It is better to save this template someplace that is easy for you to find. Therefore, up at the top again, where it says **Save In**, find the place you want the template to be saved.

When you open up this template from the folder where you saved it, the information you had will be there. Add new information to this template. The name of the document on the top left will say Document 1 until you save it with a new name. When you save this time, you will be saving your document under a new name, and it won't be a template unless you specify this. After closing, your original template will still be there without any changes.
If you need to change the template for any reason:

1. Instead of opening up your template from the folder you saved in, open up Word.
2. Go to **File** ® **Open** ® Find your template and open. The name at the top of the document should now read the name of your template.

Appendix E

# Meiosis

A. Go to http://faculty.nl.edu/jste/meiosis.htm and answer these questions as you read.

1. How many chromosomes in each human body cell?
2. What is the purpose of meiosis?

3. Why do we have meiosis, anyway? Isn't mitosis good enough?'

4. What is a gamete, and what is contained within it?

5. In body cells, chromosomes occur in _____.
6. Define Homologous Chromosomes:

7. Give an example of the information that might be coded on the chromosomes in a homologous pair, and tell if the information will be identical or not.

8. How many chromosomes in a gamete?
9. Are the chromosomes in a gamete randomly thrown in? Explain why or why not.

10. BEFORE you go to the next page, answer the question in the text: How WOULD you sort the shoes if you were in the shoe store scenario? (Don't come back and fix your answer after you see theirs- remember, there may be more than one way to do it!)

11. How do cells choose which chromosomes go to which daughter cell during meiosis?

12. What is a "diploid" cell? Give an example.

13. What is a "haploid" cell? Give an example.

14. What is the arithmetic symbol given for haploid cells? _____
    What is the arithmetic symbol given for diploid cells? _____
15. Meiosis forms _____ gametes from _____ cells.
16. Answer all four questions on the bottom of this page. If you don't understand the answers, ask your teacher for help.
17. When do chromosomes replicate in both mitosis and meiosis?

18. How many total divisions are there in meiosis?
19. What is the abbreviation for the first meiotic division?
20. What is the whole point of MI? What does that mean?

21. What happens during the second meiotic division (MII)?

22. What is the main thing that happens in prophase I?

23. Tell about "crossing over." What is it, what's the point, and what's the result?

24. List the three ways meiotic prophase I is different from mitotic prophase:

25. Push the play button on the illustration in the bottom left hand corner. Do it several times, studying what happens until you have a clear idea of the process in your head.
26. How is metaphase I different in meiosis from mitosis?

27. What happens during Anaphase I?

28. Run the animation of metaphase and anaphase. Summarize the things that happen in the animation.

29. The anaphase paragraph tells why we are all so different from one another. Why are we all different?

30. Some cells perform telophase at this point, while others don't. What does happen during telophase?

31. What are the two major accomplishments of the completed first stage of meiosis?

32. Why do cells go on to Meiosis II?

33. How many daughter cells are there at the end of Meiosis I? How many at the end of Meiosis II?
34. Meiosis II skips prophase and goes directly on to _____, during which what happens?

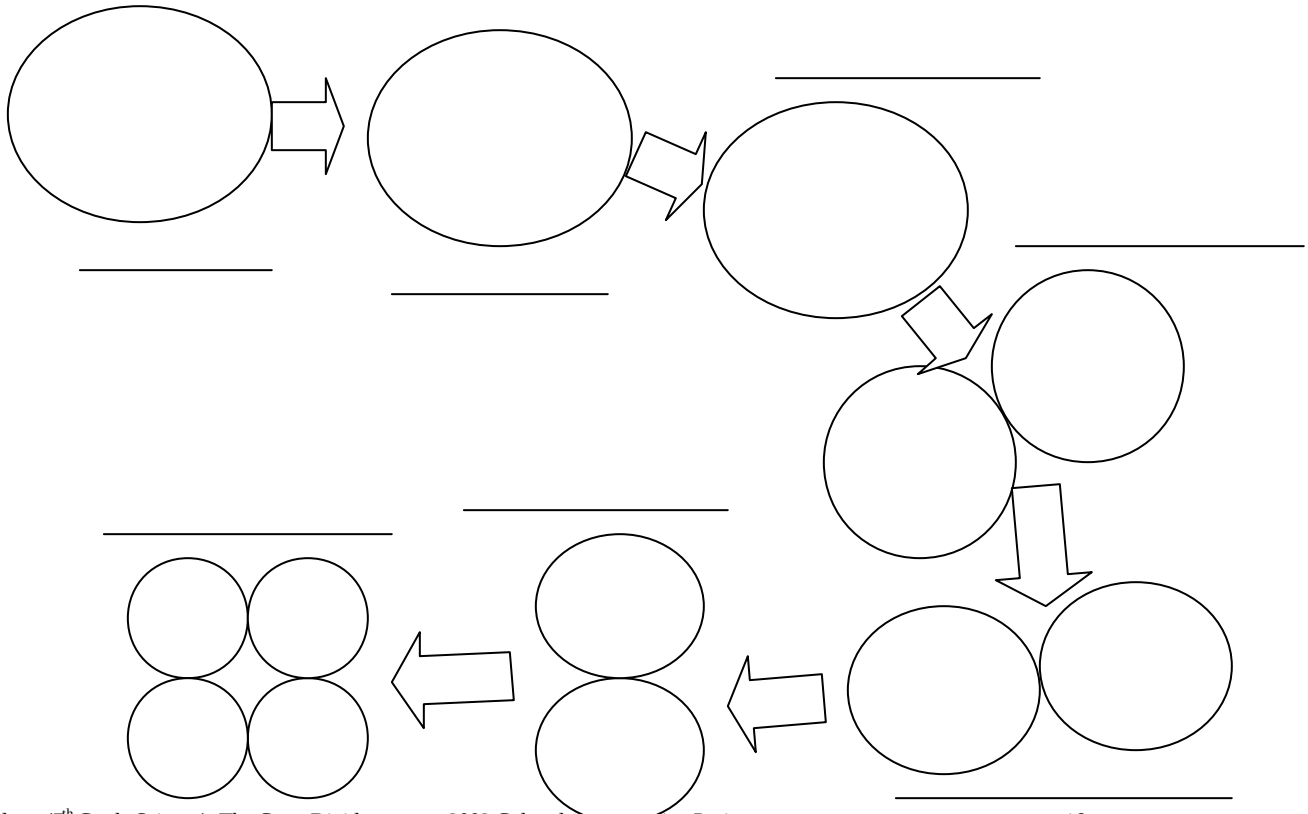
35. What happens during Anaphase II?

36. What actually happens during Telophase II (remember what you've learned before- this is a review)?

37. What is cytokinesis again?

38. Why does meiosis result in four sperm, but only one egg?

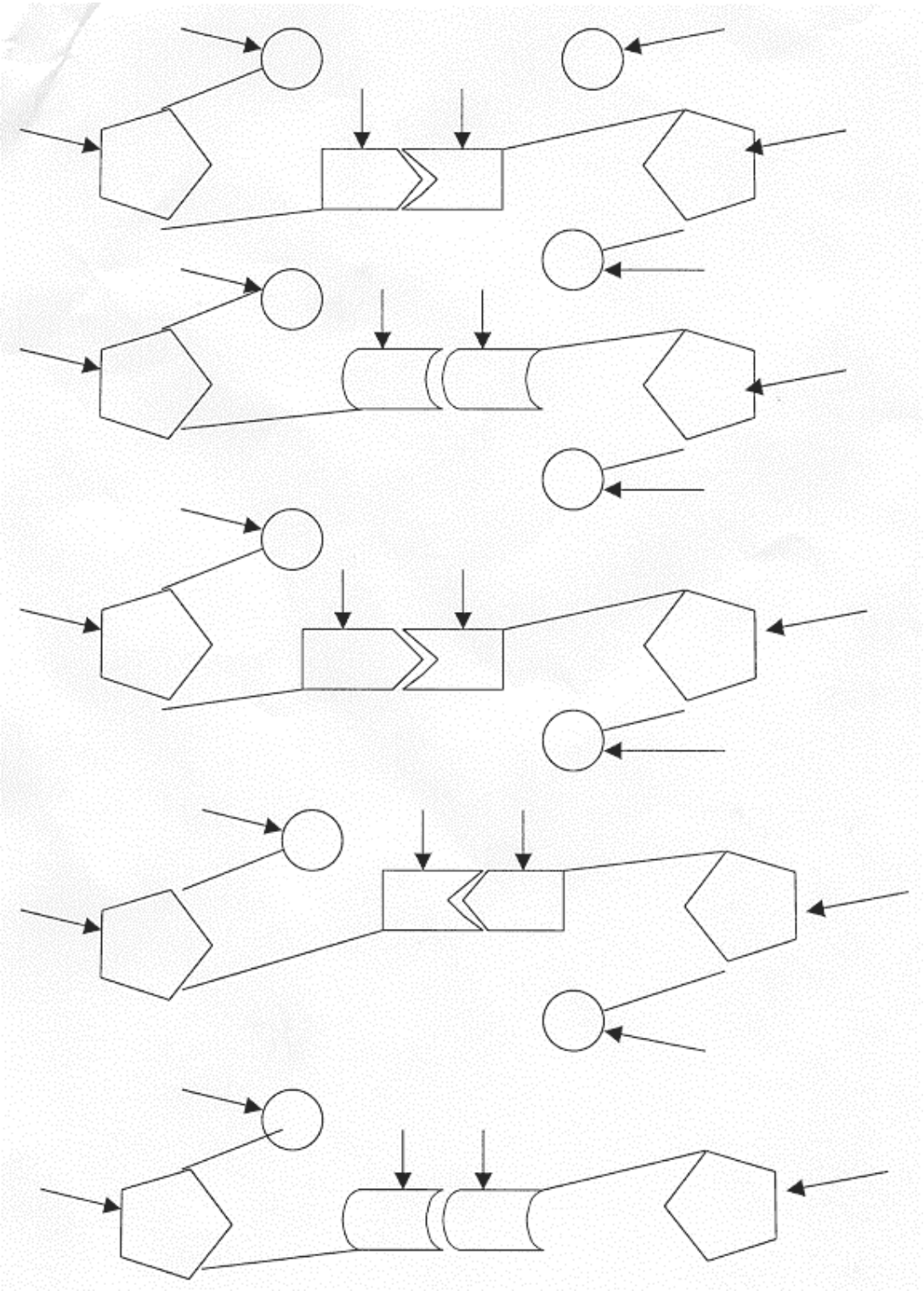
39. Draw in the steps of meiosis here. You may want to look at http://www.accessexcellence.org/AB/GG/meiosis.html, http://www.pbs.org/wgbh/nova/miracle/divide.html#and http://library.thinkquest.org/18258/meiosis.htm for better and close up pictures.



Appendix F

# DNA Structure

**Label each structure at the end of the arrows.**



Appendix G

# LAB: DNA Replication and Protein Synthesis

**Introduction:** Deoxyribonucleic Acid is found in the chromosomes of all living things. It is the chemical of which genes are composed. With an understanding of this all- important molecule, scientists know how chromosomes can duplicate during division and transfer genetic information to new cells.

The DNA molecule is the shape of a double helix (spiral). The molecules that make up DNA are deoxyribose, phosphate, adenine, thymine, cytosine, and guanine. A only goes with T and G only goes with C.

During protein synthesis, ribosomes attach to messenger RNA (mRNA) and read its code to link on amino acids in strings to make proteins.

**Purpose:** In this investigation, you will examine the structure of DNA by building your own model and then replicating it. You will also synthesize proteins using RNA.

HYPOTHESIS: Write a short summary of how DNA replicates itself:

_____

_____

Write a short summary of how new proteins are made:

_____

_____

MATERIALS:

- 24 "deoxyribose" molecules (pink)
- 24 "phosphate" molecules (white)
- 6 "adenine" molecules (green)
- 6 "guanine" molecules (blue)
- 6 "thymine" molecules (yellow)
- 6 "Cytosine" molecules (orange)
- 6 "uracil" molecules (purple)
- 5 tRNA chunks with amino acids attached- methionine, glycine, serine, arginine, valine
- 1 ribosome

PROCEDURE:

1. Work with a partner. Construct two backbones of the DNA molecule by laying two long lines of alternating deoxyribose and phosphate molecules. Raise your hand to have your teacher check your work.
2. Lay one nitrogen base next to each deoxyribose molecule on ONE chain. Place them randomly. They can be upside down, just make sure the flat side is against the phosphate molecules.
3. Lay the match to each of the nitrogen bases next to it like puzzle pieces and lay the long chain on the outside of this, kind of like a sandwich. Raise your hand to have your teacher check your work.
4. You now have a molecule of DNA, even though it's not twisted.
5. Now let's replicate your DNA. Work with another pair of lab partners, share your parts, and choose which molecule to replicate.
6. "Unzip" one molecule of DNA so that the halves are lying pretty far apart. Raise your hand to have your teacher check your work.
7. Using the extra molecule parts from the other team, add the nitrogen bases, deoxyriboses and phosphates needed to make two exactly identical DNA molecules. You will be building the left side of one and the right side of the other. Raise your hand to have your teacher check your work.
8. You have completed DNA replication! Now let's move on to protein synthesis.
9. Divide supplies and people back into groups of two. Make sure each group has all of their original supplies back.
10. Make a string of DNA in this specific order: the right side of the ladder needs to be T-A-C-C-C-G-A-G-G-C-A-T-G-C-A. Raise your hand to have your teacher check your work.
11. Unzip your DNA. Make an mRNA molecule by matching up loose nucleotides, phosphates, and deoxyriboses to the right side. Remember, RNA does not use thymine. Whenever you would normally put a thymine, place a uracil instead. Raise your hand to have your teacher check your work.
12. Clear everything but your new mRNA strand out of the way. Find the tRNA pieces that match up with your mRNA and attach them to your mRNA in order. The tRNA have specific amino acids attached to them that make certain proteins when they are put in the right order. Raise your hand to have your teacher check your work.

13. Write in your observations what order your amino acids ended up in.

DATA AND OBSERVATIONS:

1. Write the DNA sequence you originally came up with: (just one side)

2. After replicating your DNA, how many strands did you have that were in the same order as #1?

3. What do you notice about the two resulting DNA molecules when you compare them to the original?

4. Write out the order of amino acids you came up with after synthesizing a protein:

CONCLUSION:

Write two paragraphs. One telling how to replicate DNA in complete sentences, another telling how to synthesize proteins: (continue on back if needed)

# RUBRIC FOR LAB WRITE UP

| Category | Outstanding | Accomplished | Developing | Beginning | Total Points | Teacher's Score |
|---|---|---|---|---|---|---|
| **Correct Use of Template** | Used template | Used template with assistance | Didn't use template but typed up lab | Didn't use template | **5** | |
| **Hypothesis** | Hypothesis follows correct form and shows outstanding reasoning | Hypothesis follows correct form and shows basic reasoning | Hypothesis doesn't follow correct form and shows some reasoning | Hypothesis doesn't follow correct form and doesn't show reasoning | **10** | |
| **Procedure** | Follows procedure correctly independently and in a timely manner | Follows procedures correctly with some assistance and in a timely manner | Follows procedures with frequent assistance | Doesn't follow procedures and turns in late | **10** | |
| **Observations** | Records data and observations while performing the procedure in the correct form | Records most data and observations while performing the procedure in the correct form | Records most data and observations after performing the procedure. Some problems with form | Records data and observations after performing the procedure. Many problems with form. | **10** | |
| **Conclusion** | Reviews hypothesis, data and observations, and states well-reasoned conclusion in paragraph form. | Reviews hypothesis, data and observations, and states a conclusion in paragraph form. | Missing a few key elements. | Does not come to a valid conclusion. | **10** | |
| | | | | **TOTALS** | **45** | |

Appendix I

## DNA Review Quiz: you may use your DNA notes.

1. What is the main function of DNA?

2. What is "protein synthesis"?

3. What are proteins made out of?

4. How many amino acids are there?
5. Where does protein synthesis take place?
6. What is the first thing that is needed for protein synthesis to happen?

7. What is RNA?

8. What does RNA look like?

9. List all of the differences between RNA and DNA:

10. What form is the information on both DNA and RNA written in?

11. How many possible three-letter codes are there? Write a couple of examples.

## DNA Quiz Key

**1. To direct cells to make certain proteins**
**2. To produce (or put together) proteins**
**3. Chains of smaller molecules called amino acids**
**4. Twenty**
**5. In the cytoplasm outside the nucleus**
**6. A messenger from the DNA in the nucleus to the cytoplasm needs to be made.**
**7. Ribonucleic acid- the messenger that carries the protein "recipe" to the ribosomes in the cytoplasm.**
**8. One side of the DNA ladder- like unzipped DNA**
**9. Shape, RNA and DNA have a different sugar molecule in them, RNA contains uracil instead of thymine**
**10. A code made of three-letter "words" that each specifies a certain type of amino acid.**
**11. Sixty-four. Any groupings are fine.**

**** Teacher has prerogative to change, add to or subtract from anything in this key- quiz keys generally should be made according to how the content was actually taught in class- with the wording used.**

Appendix J

## Templates for DNA replication and protein synthesis lab

Make one copy of each page for each group. This page is PINK.

| | |
|---|---|
| **Deoxyribose** | **Deoxyribose** |
| **Deoxyribose** | **Deoxyribose** |
| **Deoxyribose** | **Deoxyribose** |
| **Deoxyribose** | **Deoxyribose** |
| **Deoxyribose** | **Deoxyribose** |
| **Deoxyribose** | **Deoxyribose** |
| **Deoxyribose** | **Deoxyribose** |
| **Deoxyribose** | **Deoxyribose** |
| **Deoxyribose** | **Deoxyribose** |
| **Deoxyribose** | **Deoxyribose** |
| **Deoxyribose** | **Deoxyribose** |
| **Deoxyribose** | **Deoxyribose** |

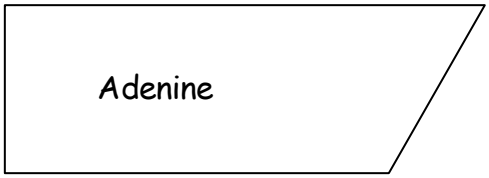
# Templates for DNA replication and protein synthesis lab

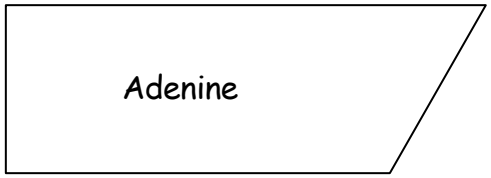
Make one copy of each page for each group. This page is WHITE.

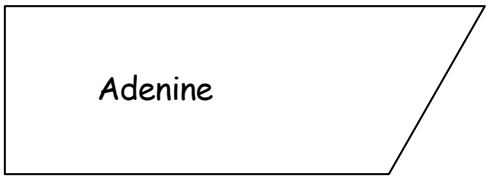
| | |
|---|---|
| **Phosphate** | **Phosphate** |
| **Phosphate** | **Phosphate** |
| **Phosphate** | **Phosphate** |
| **Phosphate** | **Phosphate** |
| **Phosphate** | **Phosphate** |
| **Phosphate** | **Phosphate** |
| **Phosphate** | **Phosphate** |
| **Phosphate** | **Phosphate** |
| **Phosphate** | **Phosphate** |
| **Phosphate** | **Phosphate** |
| **Phosphate** | **Phosphate** |
| **Phosphate** | **Phosphate** |

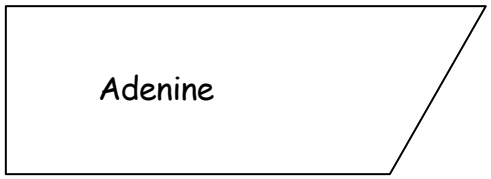
# Templates for DNA replication and protein synthesis lab

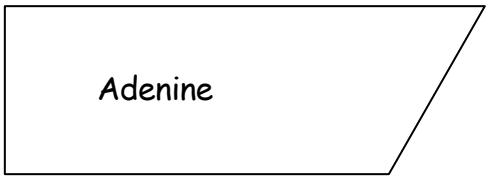
Make one copy of each page for each group. This page is GREEN.

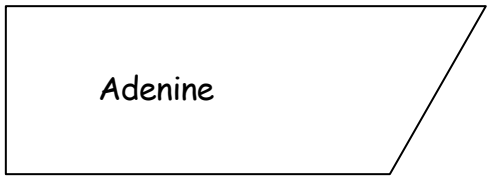


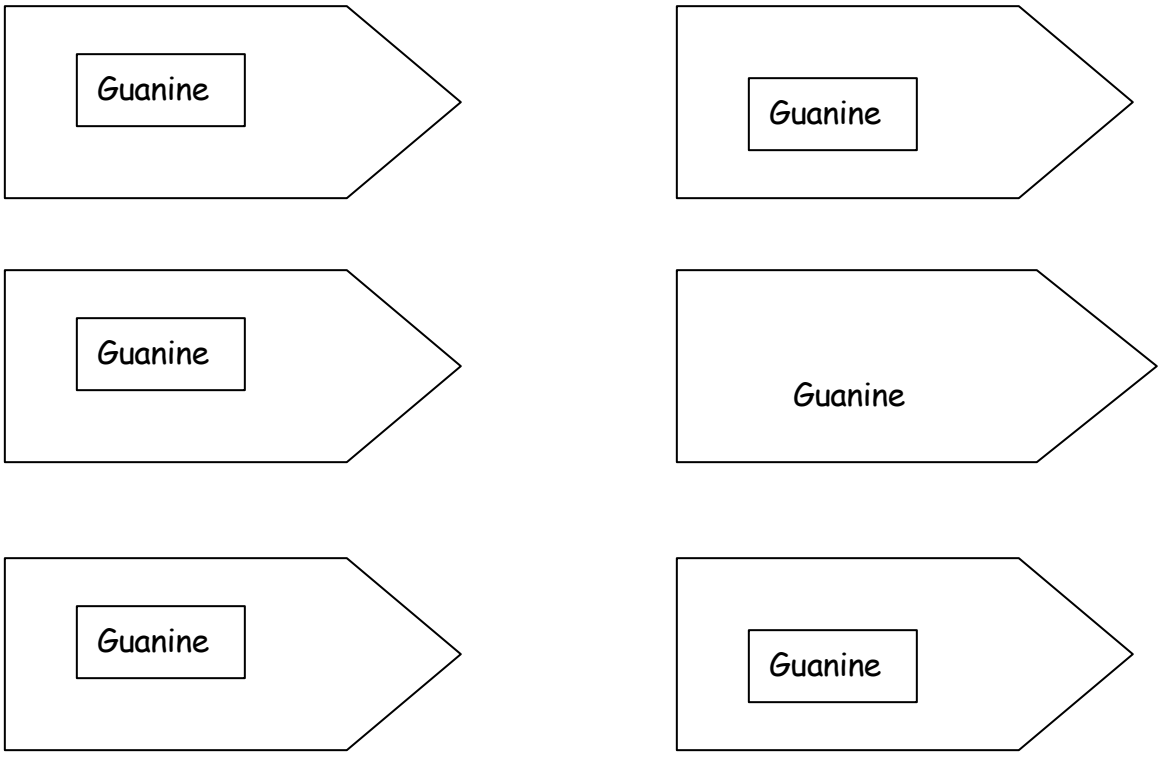



# Templates for DNA replication and protein synthesis lab

Make one copy of each page for each group. This page is BLUE.



# Templates for DNA replication and protein synthesis lab

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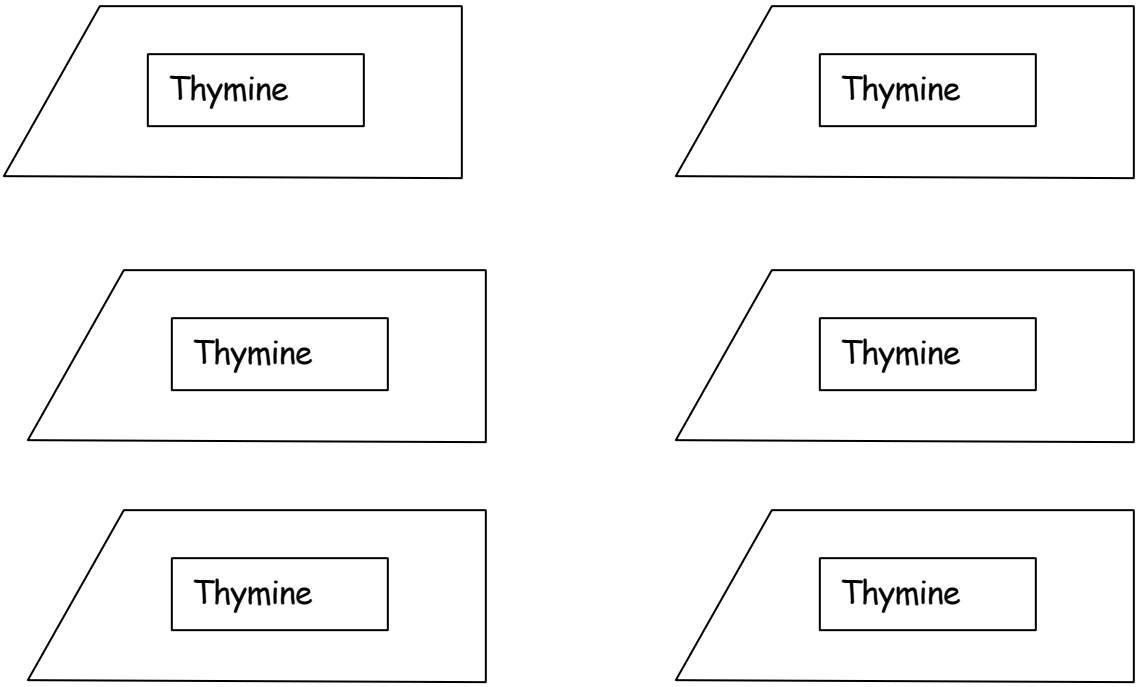

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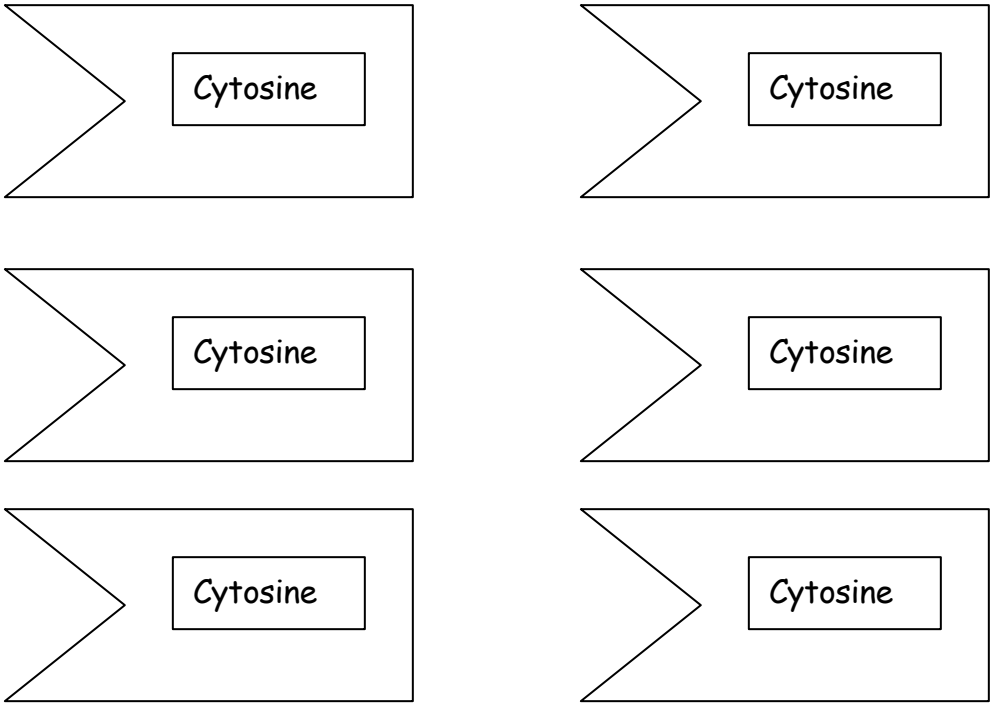

# Templates for DNA replication and protein synthesis lab

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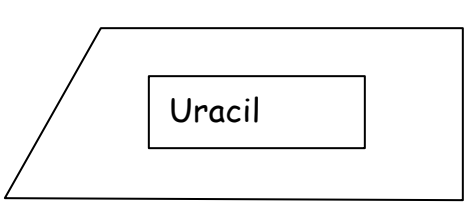
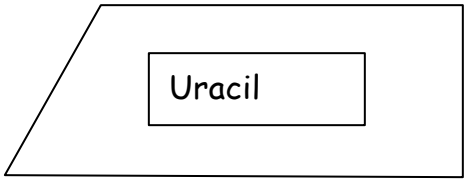
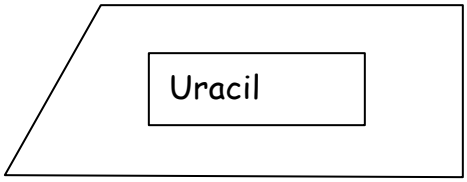
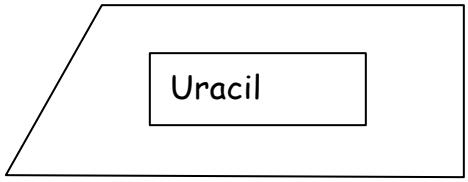
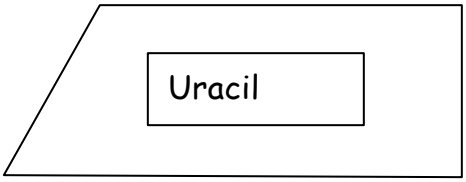
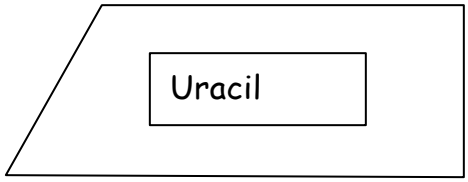


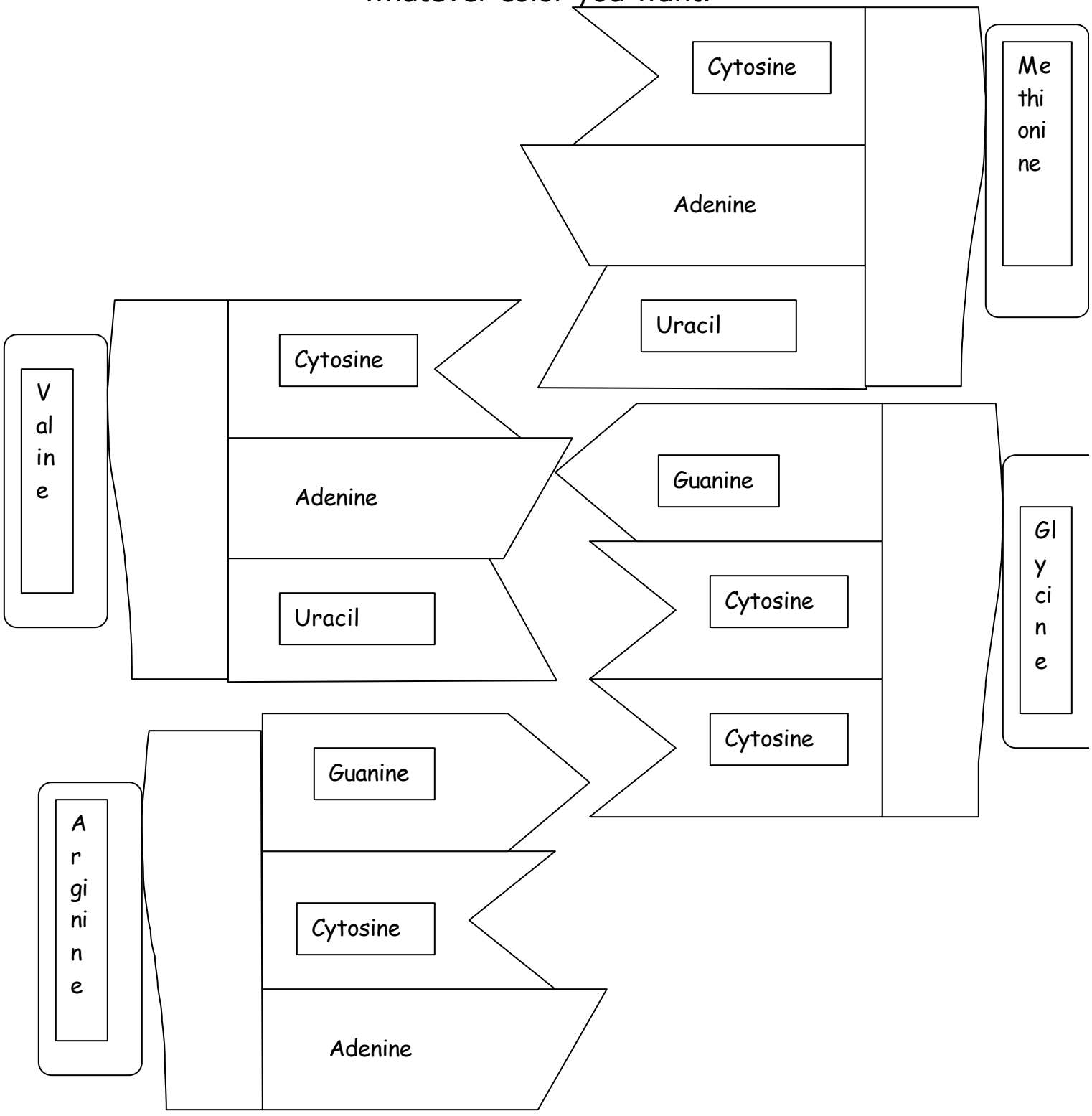



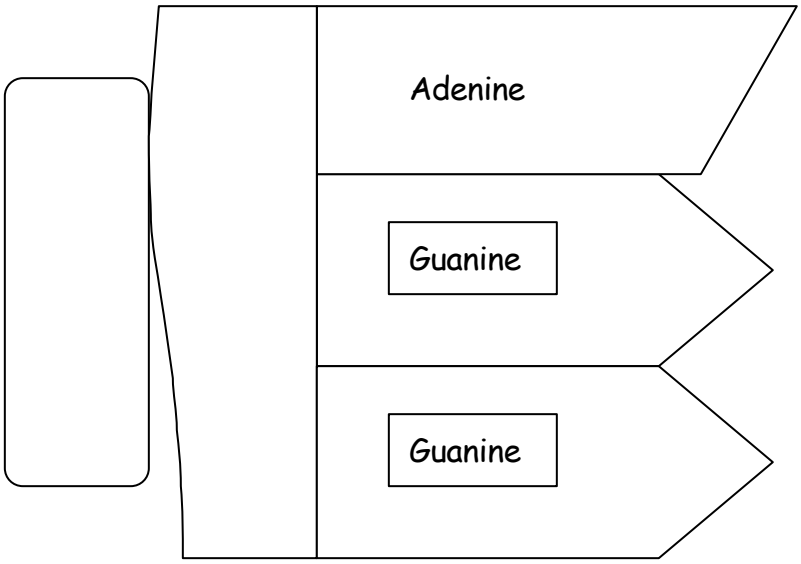
# Templates for DNA replication and protein synthesis lab

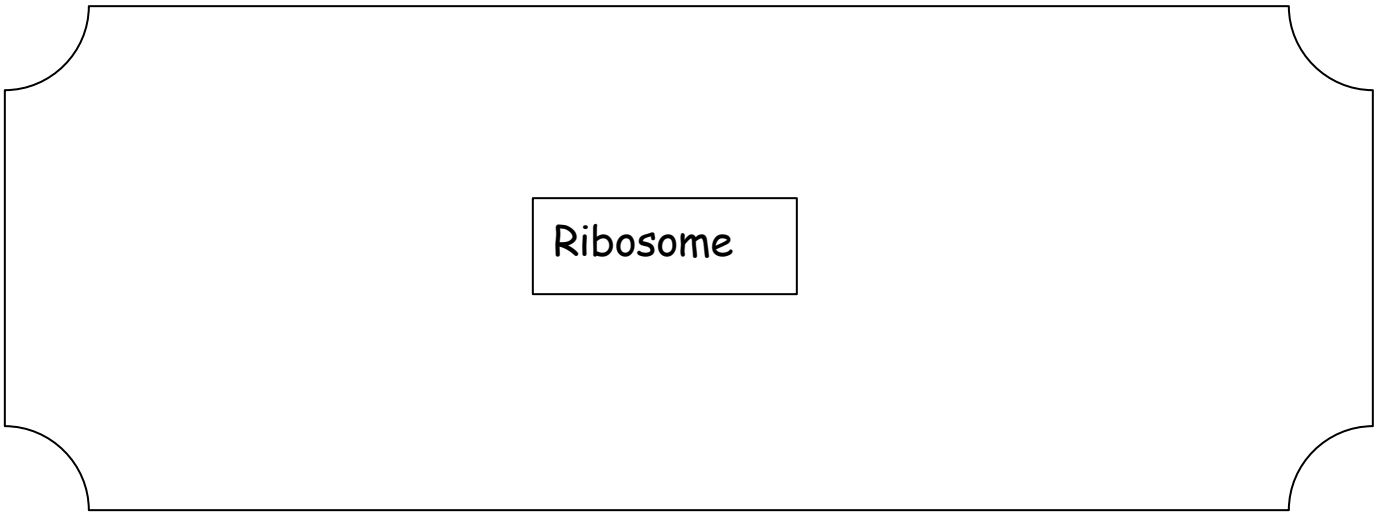
Make one copy of each page for each group. This page is whatever color you want.



# Templates for DNA replication and protein synthesis lab

Make one copy of each page for each group. This page is whatever color you want.



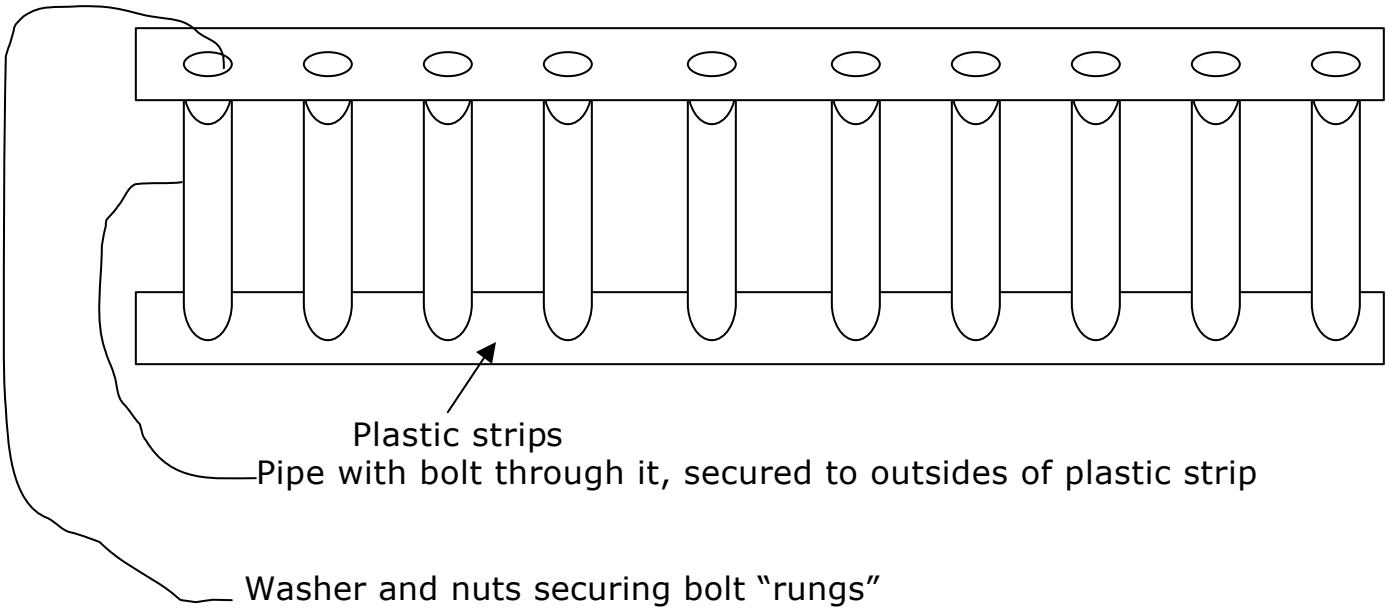



# How to make a moveable DNA molecule model

Materials: (all can be acquired at your local hardware store or home center)
--6' Flexible plastic baseboard cut into two strips lengthwise – remove the molded bent edge OR flexible plastic strips used for covering edges of plastic shower stall components (they are about 1" wide and sometimes have a small ridge along one side)
--10 6" long bolts
--20 washers to fit bolts
--10 nuts to fit bolts
--Approx 50" PVC pipe that will fit somewhat loosely over bolts
--5 colors of latex paint (small amounts- samples?)

When your DNA molecule is lying flat, it should be about 3 feet long.

Put it together like a ladder, drilling or punching holes in the plastic strips to fit the bolts through with the washers keeping them from slipping through. Put the PVC pipes onto the bolts to form the rungs of the ladder. Paint the whole thing to look like DNA. See picture.



Appendix L

# Directions for Culminating Activity

1. Student groups will be randomly assigned either Mitosis, Meiosis, DNA Replication or Protein Synthesis as a major subject.

2. Students must decide in their groups whether to do a website, a newsletter, a brochure or a PowerPoint presentation to fully illustrate their understanding of the concepts, vocabulary, and procedures involved in their topic.

3. See Rubric for specifics on what is required for each presentation.

4. Each group will present their final product to the class.

Appendix M

# WEB SITE PROCEDURES

Students will use Netscape Composer to create a web site. This Web Site will include all concepts, all vocabulary and at least four real life examples for the Great Divide unit.
Remember this will demonstrate what you have learned and be a good review for the unit test.

1. Students will use their notes and labs as their primary resource. They may supplement with Internet resources and outside books.
2. Students will include works cited for all information used.
3. Students will have an Index page that explains what the site is about.
4. Students will have subsequent pages giving concepts, vocabulary and real life examples.
5. Students will include graphics, text, and links appropriate to the unit.

# NEWSLETTER/BROCHURE PROCEDURES

Students will use Microsoft Publisher's Newsletter or Brochure option to create **either** a **newsletter** or **brochure**. This newsletter or brochure will include all concepts, all vocabulary and at least four real life examples.
Remember this will demonstrate what you have learned and be a good review for the unit test.

1. Students will use their notes and labs as their primary resource. They may supplement with Internet resources and outside books.
2. Students will include works cited for all information used.

Appendix O

# POWERPOINT PROCEDURES

Students will work independently to create a multi-media presentation using Microsoft Power Point. This presentation will include all concepts, all vocabulary and at least four real life examples.
Remember this will demonstrate what you have learned and be a good review for the unit test.

1. Students will use their notes and labs as their primary resource. They may supplement with Internet sources and outside books.
2. Students will complete a storyboard.
3. Students will create the outline portion of the Power Point slide.
4. Once completed, students will enhance their presentation with graphics and other tools available in Power Point, including transitions and timing. Microsoft sound is only required for slide #1 and #15.
5. Students will save the presentation to be included in their Science Portfolio.

# STORYBOARD OUTLINE

Sketch your ideas for each slide prior to creating the Power Point outline. Continue drawing boxes with your plan on a separate sheet.

Introduction Slide 1

**THE GREAT DIVIDE**

**Cell division and protein synthesis**

**Name**

Slide 2

Slide 3

Slide 4

Slide 15

**Ending Slide**

Slide 16

**Works Cited**

Appendix Q

# RUBRIC FOR CULMINATING ACTIVITY

| Category | Outstanding | Accomplished | Developing | Beginning | Total Points | Teacher's Score |
|---|---|---|---|---|---|---|
| **Concepts** | Included all concepts | Included most concepts | Included half of the concepts | Didn't include many concepts | 20 | |
| **Vocabulary** | Included all vocabulary | Included most vocabulary | Included half of the vocabulary | Didn't include much of the vocabulary | 20 | |
| **Real Life Examples** | Included four examples | Included three examples | Included two examples | Included one or less examples | 20 | |
| **Neatness** | Extremely neat | Neat | Somewhat messy | Messy | 10 | |
| **Creativity** | Extremely creative | Creative | Somewhat creative | Not creative | 15 | |
| **Turned in on time** | Yes / No | | | | 10 | |
| **Appropriate Graphics** | Extremely good graphics | Good graphics | Some graphics | No graphics | 15 | |
| **Text Format** | Great formatting | Good formatting | Some format | No format | 15 | |
| | | | | **TOTALS** | **125** | |

# Cell Division Test

**Name** _____
**Date** _____
**Period** _____

## I. Fill in the blanks and then answer each question:

**1. The acronym we use to remember the process of mitosis is _____. List the names of the steps here:**

**2. Chromosomes are made up of long strands of _____, which stands for the chemical _____ _____. What shape are chromosomes?**

**3. _____ _____ are the building blocks of protein. There are _____ of them.**

**4. The substance _____ carries the genetic code from the DNA in the nucleus to the cytoplasm during protein synthesis. What does this molecule look like?**

**5. What phase do cells spend most of their cycle in?**

**6. There is at least one major difference between mitosis in plants and mitosis in animals. Name one:**

## II. Multiple choice. Circle the correct answer, and then explain your choice on the lines below the question. You may choose to explain why the other answers are not correct.

**7. In the process of meiosis, the number of chromosomes in a sex cell are**

**a. doubled** **c. reduced by 1/4**
**b. reduced by 1/2** **d. tripled**

**Explain:**

_____
_____
_____

**8. DNA molecules form exact duplicates of themselves in the process of**

**a. replication** **c. meiosis**
**c. nondisjunction** **d. translation**

**Explain:**

_____
_____
_____

**9. The rungs of the DNA molecule are composed of**

**a. acid bases** **c. nitrogen bases**
**b. protein bases** **d. oxygen bases**

**Explain:**

_____
_____
_____

**10. Which of the following is a correct pairing of bases in a DNA molecule?**

**a. Adenine - cytosine** **c. adenine - guanine**
**b. adenine - thymine** **d. adenine - adenine**

**Explain:**

_____
_____
_____

**11. DNA is called the code of life. What does this mean?**

**a. DNA is the powerhouse of the cell.**
**b. All the information needed to make and control every part of an organism is found in DNA.**
**c. DNA is deoxyribonucleic acid and makes up the cytoplasm of the cell.**
**d. The time of death of an organism is contained in DNA's structure.**
**Explain:**

_____
_____
_____

**12. Which are formed by meiosis?**

**a. eggs** **c. neither a nor b**
**b. sperm** **d. both a and b**

**Explain:**

_____
_____
_____

## III. True or false. Write true or false on the first line. If the answer is false, replace the underlined word(s) to make the statement true.

___ _____**13. Hereditary factors are called genes.**

___ _____**14. The main function of chromosomes is to control the production of DNA.**

___ _____**15. During metaphase, DNA duplicates itself.**

___ _____**16. One of the purposes of mitosis is growth.**

___ _____**17. During meiosis, a cell undergoes prophase twice.**

## IV. Short (or long) answer:

**18. What are the sides of a DNA molecule made out of?**

**19. Name two things that the body uses proteins for:**

**20. If a strand of DNA contains the bases TCGGACGT, the strand that it is attached to has what bases? (make sure they're in the right order)**

**21. Explain the purpose of meiosis. What would happen when two sex cells joined if meiosis had not taken place?**

**22. What are the main differences between mitosis and meiosis?**

**23. Describe the process of protein synthesis. You may want to use diagrams to add to your explanation.**