Name:_____ Per:_____ Date:_____

Mitosis- How Each New Cell Gets a Complete Set of Genes

Genes and Chromosomes (H)

Task 1 Background:

You probably already know that genes can influence a person's characteristics. For example, some people have genes that result in sickle cell anemia (a blood disorder) or albinism (very pale skin and hair). In this task you will learn how genes in chromosomes influence our characteristics.

Each cell in your body contains chromosomes. Each **chromosome** contains a long molecule of **DNA**. The arms of a chromosome are held together by a **centromere**. Chromosomes come in pairs of **homologous chromosomes,** one from each parent.

Materials:

Red pipe cleaners	Maternal chromosomes (from mother)
Blue pipe cleaners	Paternal chromosomes (from father)
Red and blue beads	centromeres

Task 1a: Chromosome Structure. Build a pair of single homologous chromosomes from the supply kit provided by teacher and sketch below.

Label the following structures in your sketch: **chromosome arm, centromere, maternal and paternal chromosome and homologous pair**.

If a cell goes through mitosis the chromosomes must be duplicated. Add new chromosome arms to make a duplicated set and sketch below.

Label the following structures in your sketch: **Chromatids (duplicated chromosomes), centromere, and duplicated homologous pair**.

Task 1b: Mitosis Phases

Build a cell and model the phases of the cell cycle

- ☐ Interphase
- ☐ M-phase (mitosis = PMAT + C)
  - ☐ Prophase
  - ☐ Metaphase
  - ☐ Anaphase
  - ☐ Telophase
- ☐ Cytokinesis

Key (use key to assemble the phases)

Cell Structure	**Model Piece (chalk, pipe cleaner, etc)**
Chromosome arms	
Centromere	
Spindle fiber	
DNA	
Nuclear membrane	
Cell membrane	
Centriole	

Task 2 Background:

Each chromosome is made up of many genes. A **gene** is a segment of a DNA molecule that gives us the instructions for making a protein. Different versions of the same gene are called **alleles**. Different alleles give the instructions for making different versions of a protein. Table 1 shows the alleles for two human genes.

Allele	→	**Protein**
A	→	Normal enzyme for producing melanin (pigment molecule that colors our skin and hair)
a	→	Defective enzyme that cannot make melanin
B	→	Normal hemoglobin
b	→	Sickle cell hemoglobin

Task 2: Build a pair of single homologous chromosomes with gene alleles following the key on the laminated directions sheet. Use colored pencils to represent the chromosomes (pipe cleaners) and alleles (colored beads).

1. Genotypes:

aaBb	**AaBb**	**AaBB**
_____	_____	_____
phenotype/appearance	phenotype/appearance	phenotype/appearance

2. What other combinations of alleles from the two traits (albinism and sickle cell anemia) could occur?

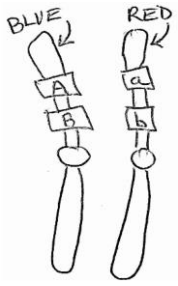
Other Genotype combinations (letters)	Phenotype (appearance)

Question: What observations can you note about the different combinations of alleles in the genotypes and the resulting phenotypes? What consistencies do you notice?

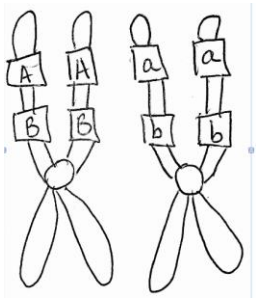
Task 3: Cells & Genes Moving through Mitosis.

Materials:

Red Pipe Cleaners	Maternal (female) chromosome
Blue Pipe Cleaners	Paternal (male) chromosome
Red and blue beads	centromeres
Star bead	centriole
chalk	Cell membrane, spindle fibers
Other colored beads	A=yellow bead (average skin color) a=white/clear bead (albinism) B=green bead (healthy blood) b=purple bead (sickle cell anemia)



1. Remove a single male chromosome #1 with alleles A and B and a female chromosome #1 with the alleles a and b. Be sure to include the centromere for each chromosome. This represents a single parent's cells homologous pair of chromosomes *before cell division*. Parent genotype is **AaBb**.



2. Add another chromosome arm to each so that now the model shows the chromosomes after DNA replication and *entering cell division*. Each duplicated arm should have the exact same alleles as shown to the right. This represents a parent's cell after the DNA has been copied and wound tightly into sister chromatids (copied arms of the chromosome).

3. Begin mitosis by moving the chromosomes through the phases. Use notes or PowerPoint presentation from website if needed.

STOP: Review the phase of mitosis if necessary and ask for assistance if needed. Each phase of mitosis should be represented using the supplies available.

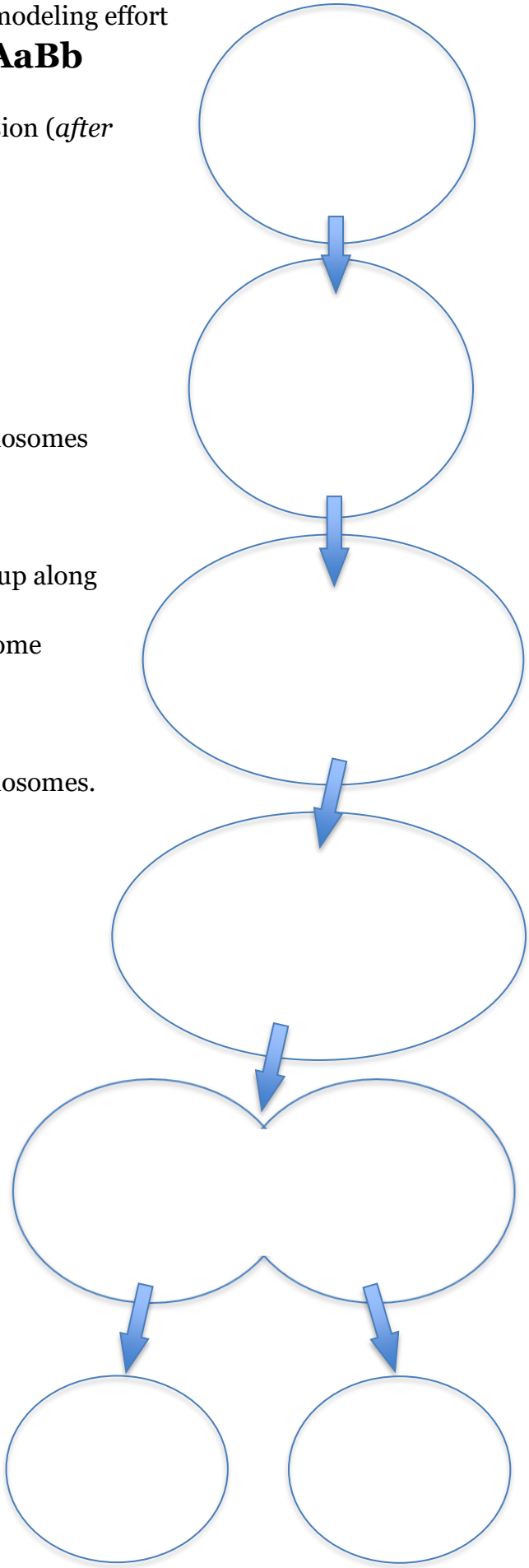
CHECK: When the group feels ready, have your teacher check-in to assess understanding of mitosis phases, chromosome and gene structure.

At this point you should be able to demonstrate:

- ❑ Part/forms of a chromosome (chromatids, centromere)
- ❑ Homologous pair of chromosomes
- ❑ Phases of mitosis (prophase, metaphase, anaphase and telophase)
- ❑ Genes located on each chromosome
- ❑ Different versions of the genes and what they represent

Teacher Initials _____

Task 3 Modeling Results: Record the results of your modeling effort in this diagram. Parent cell genetic makeup of alleles is **AaBb**



Homologous chromosomes in parent cell before cell division (*after homologous chromosomes have duplicated*).

- cell has grown and has duplicated organelles
- DNA has copied itself so 2 copies are present

Phase: _____

Beginning stage of mitosis (or the M-phase)

- DNA has fully condensed into chromosomes
- Nuclear membrane has disintegrated
- centrioles extending spindle fibers toward chromosomes

Phase: _____

Second stage of the M-phase. Sister chromatid pairs line up along the equator of the cell.

- spindle fibers are now attached to each chromosome

Phase: _____

Sister chromatids have separated to form separate chromosomes.

- sister chromatids migrate to opposite poles
- spindle fibers shorten
- "avenue" appears between chromosomes
- cell begins process of cytokinesis

Phase: _____

Sister chromatids have reached opposite poles

- nuclear envelope reforms
- cleavage furrow prominently seen
- cytokinesis nearing completion
- spindle fibers disappear

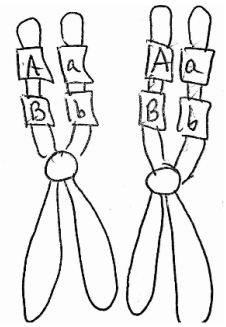
Phase: _____

Last step. Daughter cells formed, cytoplasm completely divided. We call this state: _____

Analysis:

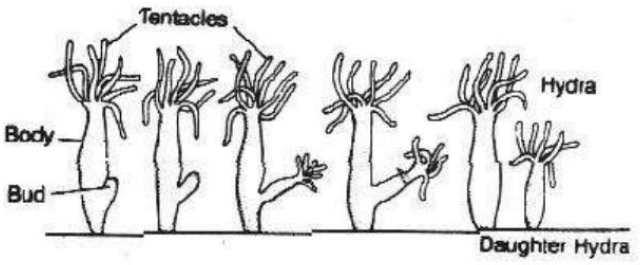
1. Are there any differences in the genetic makeup between the original cell and the daughter cells produced by mitosis? Compare the genotype (letters) of the parent chromosomes and the daughter cells.

2. Suppose that your partner had put the model chromosomes together as shown to the right. What is wrong with this assembly? Explain.



3. Each of the cells in your skin, brain and other parts of your body has a complete set of chromosomes with the same genes and the same alleles that were present in the single cell that developed into your body. Explain how these billions of genetically identical cells were produced. Explain using concepts learned (mitosis, cell reproduction, genes, alleles, parent and daughter cells).

4. Some animals and plants use a combination of mitosis and splitting off to reproduce. For example, a hydra can reproduce by budding. The bud is formed by many repetitions of <u>mitosis</u>, and then the bud breaks off to form a daughter hydra. (A hydra is an animal that lives in the water and uses its tentacles to catch food.)



Will there be any genetic differences between the mother hydra and the daughter hydra? Explain your reasoning.