Oh, Goodness, My Mitosis

So, it turns out cells can do just about anything a living organism needs to: they have metabolism (which means they can get and use energy), sense and respond to their environment, and grow and reproduce. It is this last bit where things get complicated enough to need their own explanation.

The simplest form of reproduction is at its core pretty obvious: the cell makes a second copy of everything inside of it (like the different organelles and DNA), and then splits in half so each side gets one of the copies. Bam. Done. It just makes a clone, a copy, a dupe! Of course, it is a great deal more complicated than that in reality. How exactly do all these cell parts get divvied up? In what order does all this happen?

Happily, it is pretty easy to break up the process of Mitosis (which is just when a cell makes an exact copy of itself,) into discrete stages or phases. Heck, let's start even before we get to the actual steps of Mitosis. Let's start with a brand new cell, just copied from its “mother” cell. We shall call it a sister cell because since it is more or less identical to the original cell, and therefore is more like an identical twin than an offspring. So, the original cell has split into two sister cells, which are out on their own for the first time. Assuming that the new cell is lucky, and doesn't randomly get slaughtered by the many predators and ill-fortunes that surround her, then the sister cell will be able to move about, endocytosing nutrients and exocytosing waste. Her metabolism will plow ahead, taking in sugars and breaking them up to free and use energy. She is growing, now, using that energy to fuel chemical reactions that build more proteins, sugars, fats and genetic materials. Each of those new molecules is a building block that can be used to make new organelles, expand the cell membrane, copy DNA, or build other blocks.

This phase where a cell is growing and building and basically just living is usually called interphase, because it occurs between (inter) reproduction. There are more things that can be said, more details to explain, but the important part is to understand that by the end of interphase, the cell will have grown large enough, and built enough copies of her organelles, that she is ready to divide to form sister cells. Her time has come to reproduce.

The last thing to do before the cell splits into new daughter cells is to copy her most precious resource: her DNA. Inside her nucleus, the clicking buzz of thousands of enzymes called DNA polymerase (among many others) might be heard as her DNA is carefully and quickly copied. On the surface, it might seem like she is ready to split, but there are a few obstacles. First off, her DNA is spread out. It is like a tangled clump of Christmas tree lights, or a huge knot of shoelaces, or a pot of spaghetti made only of superlong and supertangled noodles. In short, the copied DNA is a nightmare to separate, and the cell can't really split up until she sorts the tangled mass of DNA chains into packets that can be easily separated.

So, the first phase in Mitosis is simple enough. It comes at the beginning, so it is called prophase (since pro means “first.”) In prophase, a few things occur. Firstly, the DNA gets sorted into larger clumps, so it is easier to move around. These clumps are visible as colored bodies inside the cell if dyes are used to stain them, which is why they are called chromosomes (chromo means color, and soma means body.) At the same time, it is necessary to get to get rid of the container that normally would hold the DNA, otherwise it won't be possible to separate the copies from each other. So, while the DNA is clumping into chromosomes, the nuclear membrane (also sometimes called the nuclear envelope, or the skin of the nucleus) around them is being broken down and recycled by various enzymes. Finally, parts of the cytoskeleton are being reorganized into chains that run from one end (or pole) of the cell to the opposite side (or pole.) These new chains of actin proteins are going to act like rails that various cell parts can move along to get to one of the cell's poles. Overall, this network of thin fibers is called the spindle.

Now that prophase is done, it will be necessary to start organizing parts of the cell for division. Copies will be grabbed by various proteins and attached to the rail lines of the spindle, lining up along the middle of the cell. This line running around the middle of the cell between the poles is sometimes called the equator. It is here that the chromosomes line up, each copy facing its twin across the equatorial divide. It is here in the middle of the cell with everything lined up that metaphase is best represented.

Suddenly, the next phase takes hold, and the proteins that are holding chromosomes and organelles in place along the equator of the cell jerk into motion. Each begins running along the filament of the spindle that it is attached to, moving towards a pole of the cell. This drags the attached cell part along with it, separating it from its copy, which is moving along the spindle in the opposite direction, towards the other end of the cell. This is anaphase, a curiously appropriate name, because as the chromosomes are dragged through the cytosol towards a pole, they bend to look something like tiny A's...

Finally, telophase begins. As the chromosomes arrive at each end of the cell, separated from their copy, they are surrounded by a swarm of enzymes that begin to assemble a new nuclear envelope around the DNA, which will soon be able to safely unravel back into long, loose strands that float there in the nuclear cytoplasm, ready to be copied or transcribed. At the middle of the cell, a chain of proteins begins to tighten like a belt, pinching the cell along the middle until it looks less like one large cell, and more like two cells connected at their edges.

And with that, Mitosis is done. All that remains is a process called cytokinesis (which just means cell-movement), where the cells pinch off and break free of each other, and in general, that isn't even thought of as a part of Mitosis. The cell has grown up, copied herself, and has split into two new sister cells...and her copy is now going on to survive and grow, hoping to also eventually split to form new cells.

Using the personal terms and definitions rubric, create definitions for the following terms using this text and others.

1. Anaphase
2. Chromosome
3. Cytokinesis
4. DNA Polymerase
5. Equator
6. Interphase
7. Metabolism
8. Metaphase
9. Mitosis
10. Nuclear Envelope
11. Organelle
12. Prophase
13. Spindle
14. Telophase