Ep 1 - Script Notes- Cell Cylce, Mitoisis, Meiosis and Giant Chococalte Cakes

Hello - Welcome to the Cell-fie Life. Thank you so much for listening!!! Seriously, My name is Nikaela and today we are going to be reviewing the cell cycle, Meiosis and Mitosis. If you have questions or comments or corrections. Please let me know- the best way to reach me is on insta handle: thiscellfielife this C-E-L-L-fie Life.

Also if you follow me on insta. I post MCAT prep questions on my story just about every morning and I will let you know when a new episodes drop.

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Okay let's do this - Mitosis and Meiosis.

There are two main types of cell division that we humans take part in: Mitosis and Meiosis-

Mitosis - the process of making new body cells, so it is how two identical daughter cells are created from a single cell.

Meiosis - is the type of cell division that creates gametes, eggs, and sperm. Meiosis results in up to 4 non-identical daughter cells.

When I first learned about mitosis and meiosis I could not keep their names straight. Which one happens in somatic cells, and which one creates germ cell? And Because in science we like to name things very close to one another to make things extra fun (that was sarcasm) - just wait till we get to centromeres, centrosomes, centrioles and kinetochores, and we will get to those.

I had to think of a cleaver or dumb way to remember which one is mitosis and which one is meiosis.

And let's be honest, I went with the dumb/ridiculous way to remember - Mitosis and Meiosis. Have you guys ever seen the movie "Singing in the Rain"? There is a song that goes:

"Moses supposes his toeses are roses- but moses supposes erroneously." and for some reason I combined moses and toses when I was singing it and it came out

- Mos-toesis and from there it is a really was a short leap to "Mitosis happens in the toses".

If Mitosis is happening in your toeses, your toes do not need to create sex cells, your toes are somatic cells. In somatic cells Mitosis is what occurs to create genetically identical diploid daughter cells.

So if mitosis is creating somatic cells than Meiosis is happening in germ cells . If my “signing in the rain” song wasn't enough to help you keep mitosis and meiosis straight MeiOOOsis happns in your ovaries- or you know, testes, if you are male.

If you guys want to check out that song I’m talking about singing in the rain, I’ll post the youtube clip on the website: cellfielife.com or its around minute 48 in the film. There is also some excellent tap dancing… you know, if that’s your thing.

https://www.youtube.com/watch?v=zFAlZttXfvE

So now that you will never switch up the location of mitosis and Meiosis - let's get into the nitty gritty.

A lot of people approach the cell cycle with a pie chart, which is great, I love pie, And i'm willing to bet that a lot of you have seen this break down, I’ll post it on my insta and the website but I'm going to approach the cell cycle, not with a pie chart, but with a cake meme.

Remember that cake meme, it's been on the internet for years, its a cartoon one where a slice of cake is cut from a whole cake, and the person, instead of taking that single slice for themselves, removes the rest of the cake and leaves the single slice sitting on the plate. That almost whole cake slice is interphase.

Interphase is where a cell spends most of its life, approximately 90% The single slice left on the serving dish. That would be mitosis. Mitosis is the process where the one nucleus splits into two nuclei.

But first interphase - or how I like to think of it - the correct size of a slice when it comes to chocolate cake.

Interphase is where the cell is really just living as a cell, growing, making proteins, and all the other functions that cell might have.

Interphase can be further divided into G1, S, and G2, phases. And G0. G now is the G with the little 0 after it. The G0 phase is sometimes thought of as outside the cell cycle or an extended G1 phase. G0 is a phase where the cell is not dividing or preparing to divide.Its simply living its life,carrying out its daily functions.

Can you think of any cells that would enter this type of inactive phase and hang out there for their life? I'll give you a hint: think super specialized cells, my favorite example is neurons.

*during interphase the chromosomes aren't tightly bound they are just floating around doing the stuff it does in the nucleus.

Okay G1 - G1 is when you have a new cell and its gonna start growing; it's getting bigger. It's creating more organelles It's called G1 phase because it is the cell's first Growing phase.

S phase - is the phase where the cell replicates its DNA so that it has 2 identical copies. this happens in they synthesis phase. So DNA replication happens before mitosis, this is an important point to remember, DNA replication happens before Mitosis; a cell that enters in G2 phase has twice as much DNA as it did the G1 phase.

DNA replication happens in the S phase, S as in the synthesis phase.

In the S phase, one copy of DNA will become two copies. Once a chromosome replicates, it is still considered one chromosome. For example, let's say we have a cell that has three chromosomes. This cell enters S phase, and all its DNA is replicated. How many chromosomes does this cell have now?

The cell still has 3 chromosomes despite the fact that it has double the amount of DNA. The DNA strands are still attached, so they are still called 1 chromosome. Imagine the traditional-looking chromosomes. But is a stringy, loose spaghetti-type, free-floating right now in the S phase (they won't actually get the super tight X shape until Mitosis). The middle where the x's cross is called the CentroMere. So there are 2 copies of the DNA, that are attached in a specialized reason called the Centromere. Because they are still attached, they are still considered 1 chromosome. Each individual copy can be called a chromatid. So they are sister chromatids (i mean, really they are twins, but they are called sister chromatids). During mitosis, the 2 sister chromatids will get split apart, and then they will be 2 separate chromosomes.

Centromere—the middle point connecting the two sister chromatids. Okay centroMere. M as in middle—this is legit how I remember this. Centromeres are the middle of the two sister chromatids, making them one chromosome. M, centromere, for middle.

With all of this DNA replication happening, there is also some other additional duplicating happening, the Centrosomes duplicate.

Side note: I think of centrosomes as centro -SUMS - like they are just sum organelle hanging out in the cytoplasm. I put the emphasis on pronouncing it incorrectly so that I can remember what it is and what it does.

the centrosomes. (centro - sums) are little organelles close to the nucleus of the cell, which will help in the physical splitting of the genetic material. When the chromosomes get pulled apart in mitosis it is the spindle fibers that are made from microtubules that will pull the chromosomes to opposite sides (we will be going over this is more detail I just wanted to get the word centrosome in early so that we can repeat it so we will have the vocab down.

After the synthesis phase there is one more growth phase. So a second growth phase that is called G2

The cell also checks itself before it wrecks itself.

The cell has checkpoints where it makes sure that it is healthy enough to continue forward. One really important checkpoint is the one between G1 and S. This checkpoint ensures that the DNA looks good, is not damaged, and can be replicated. If the DNA is damaged, the cell cycle is arrested until the DNA can be repaired. The protein that is in charge of this checkpoint is called p53.

Another checkpoint is the one right before the G2/M phase. THis checkpoint also makes sure that there are enough organelles and is large enough to replicate.

So at the end of the G2 phase the cell is now ready for the M phase, Mitosis. YAy!!!

There are 4 phases of mitosis.

Prophase
Metaphase
Anaphase
Telophase

I will talk about each phase individually, but I find it helpful to know what phase is where in the process. For me, I don't have a super clever way of remembering this, I just think PMAT - which sounds kinda like a test, similar to the MCAT and MCAT is always on the brain so PMAT kinda just sticks. But I did google some mnemonic devices, and my favorite was: Pass Me A Taco - if you have a really great way to remember, hit me up on my insta, and I'll share them - Thiscellfielife.

Okay, so PMAT-

Prophase- the DNA goes from its chromatin form, which is the loosey-goosey, just floating around in the nucleus to its condensed form. Remember that we have 2 sister chromatids connected by a centroMere and now it is in its X shape that can be seen by a light microscope. So in Prophase, the chromosomes condense, and the nuclear membrane starts to dissolve. The centrosomes were those little organelles that were hanging out in the cytoplasm, close to the nucleus, and started migrating to opposite sides of the cell.

Metaphase-
M as in Middle again - the chromosomes start lining up in the middle of the cell. The centrosomes, the organelles are now on opposite sides of the cell. Centrioles exist inside the centrosomes, each centrosome has 2 centrioles. I know that naming is cruel and unusual.

Is there a tongue twister for all of this, cause there should be…. Maybe I'll make one. It would go with the singing in the rain clip…

Anaphase-
The centrosomes microtubules pull the sister chromatids apart, so now there are 2 chromosomes. Remember how I told you that the area where the x's cross is called the centroMere, the actual proteins that the microtubules attach to on the chromosome is called a kinetochore. Think of it as the Centromere, which is the city you live in, but the kinetochore, which is the street. Also, in anaphase the cytoplasm starts pinching in a little bit.

Telophase - telophase is basically the opposite of Prophase: so the nuclear envelope starts reforming, and the chromosome starts unwinding into its chromatin, spaghetti form.

You have a mitosis. sandwich where the prophase and telophase make up the bread and do the opposite of each other.

The last part is Cytokinesis- where the cytoplasm finishes pinching together and creates 2 new separate cells. Which puts us back at the beginning of the cell cycle! G1 baby - time for our newly minted baby cells to grow.

Clarification: CentroMeres and centrosomes both have M's in them, in my head to keep them straight I say centroMeres - putting the accent on the M in the middle of the word. And the centrosomes, is spelled like centro - sums - that are just sum organelle in the cytosol.

Before we move on to Meiosis, I want to review a couple of general concepts.

Chromosomes you (humans) have 46 chromosomes grouped into 23 pairs. 22 pairs plus the sex chromosomes.

Cells with all 46 chromosomes are called diploid cells, which just means they contain 2 copies of each chromosome. Cells with 23 are called haploid, and these are your sex cells, sperm, and egg and contain only 1 set of chromosomes.

Diploid cells are referred to as 2n. They have twice the number of chromosomes, or 2 copies, one set from mom and one set from dad. Haploid cells are n cells. They have 1 set of chromosomes and will be combined with another set of chromosomes if fertilization happens to create babies with 2n diploid cells. So, in mitosis, 2n cells create 2 daughter 2n cells.

Meiosis creates gametes, so a 2N cell will create up to 4 cells, all haploid.

** The more specialized a cell is, the less likely it's going to replicate itself - neurons, blood cells

Meiosis

By now, you are a pro at mitosis, so forward on to Meiosis. Meiosis has 2 rounds, so of Prophase, 2 Metaphase, 2 Anaphase and 2 Telophase. so we literally call them meiosis 1 and meiosis 2

Round 1 of Meiosis takes a 2n cell and cretes 2 haploid daughter cells. The daughter cells then undergo meiosis 2 (which is actually super similar to Mitosis, but don't worry we will get into that) and we will end up with up 4 cells all haploid. I say up to 4 because in egg development we get polar bodies that are just discarded, but we will go into the specifics on the next podcast.

So here we are in Meiosis, and just like in mitosis, these cells spend most of their time hanging out in interphase. They are growing and hanging out and synthesizing and growing just like in Mitosis, but with a few differences.

During the s phase of the interphase, you have your DNA, your homologous pairs of chromosomes. This just means you have a copy from your mom and a copy from your dad that codes for the same stuff. They aren't identical, but they code for the same genes.

Understanding check: how many chromatids are there at the end of the G2 phase?

96 chromatids, organized into 46 chromosomes which are in 23 homologous pairs

Now here is where do differences start as we enter Meiosis. Do you remember the phases???

PMAT remember: pass me a taco

Prophase I (because in Meiosis, we undergo to rounds)
Metaphase I
Anaphase 1
TelePhase I

Then

Prophase II
Metaphase II
Anaphase II
Telophase II

So, back to prophase 1 of Meiosis 1
The nuclear envelope starts disappearing, the centrosomes start migrating to the opposite sides of the cell and start forming their spindles. The DNA condenses from its spaghetti form into the recognizable X form.

Now in meiosis, the homologous pairs line up and can undergo genetic recombination. So, the 2 pairs of homologous chromosomes join together in what is called a tetrad. Get it. Tetra 4 has 4 chromatids connected. Homologous points on the chromosomes can cross over. So they switch little parts of each other that code for the same thing. Imagine you are back in elementary

school at lunch and you unpack your lunch with your friends, and your friend has a banana pudding, and you have a chocolate pudding, and you decide to trade. You both still have the same lunch and each has a dessert, but you traded a portion. Now, this metaphor isn't perfect, but I think you get the picture. The homologous pairs can trade puddings. They can trade similar genes in a process called crossing over.

This crossing over is the main difference between prophase 1 in meiosis and prophase in mitosis. If you think about it it makes sense,

You can have traits from both sides of the family- the crossing over results in a mixture of parental characteristics in the offspring.

THis is important - mcat alert

Remember - crossing over happens in prophase I of meiosis - i've heard that this is often tested on the mcat.

If you have some time later and want to see a good visual explanation, check out the khan academy video on crossing over, I'll link it to my notes

Khan Academy video

https://www.youtube.com/watch?v=ijLc52LmFQg&t=10s

Metaphase 1
The nuclear envelope is gone the centrosomes (centro - SUMS) are on opposite sides of the cell and the fibers are growing out and attaching to the kinetochores on centroMeres that holds the sister chromatids together. So the chromosomes are lined up in the middle and getting ready to divide.

Anaphase I
In anaphase of mitosis the sister chromatids are pulled apart. That is not what happens here the entire chromosome (made of 2 sister chromatids) is pulled to opposite sides of the cell. Again there is genetic variation because not all your moms go to one side and not all your dads go to another, it is random and adds to the genetic variation!!!!
MCAT ALERT -

Again the homologous pair is being pulled apart not the sister chromatids in Anaphase 1 of Meiosis

Telophase I
Again, telophase 1 is basically the opposite of prophase. The nuclear envelope starts reforming. The microtubules start to disassemble, cytokinesis is starting so the cytoplasm is splitting and we are going to end with 2 haploid cells.

The cell can now go into interphase 2 where it can take a rest or it can continue on to Meiosis 2 which is super similar to Mitosis. The first phase of Meiosis or Meiosis 1 is also called reductional division. Which makes total sense because the number of chromosomes is being reduced. The daughter cells are haploids.

Meiosis II

Prophase II
The centrosomes have to duplicate, the nuclear envelope needs to dissolve.

Metaphase II
The chromosomes line up in the Middle of the cell. The centrosome's spindle fibers grow out and attach to the kinetochores of the sister chromatids.

Anaphase II
The spindles pull the sister chromatids apart, just like it mitosis.

Remember that in anaphase I the homologous pairs were separated, and in anaphase II the sister chromosomes are pulled apart. The sister chromosomes are separated.

Telophase II
The opposite of prophase, the nuclear envelope reforms, the extra centrosomes disintegrate, and then cytokinesis happens.

So now we have 4 cells that all have one copy of all the chromosomes. They are haploid. Also notated as n. These are called gametes, and we will talk extensively about them in the next podcast.

Just like that, you have made it through the cell cycle, mitosis, and meiosis.

So interphase - is the big piece of cake it has the growth phases and they synthesis phase where the DNA is replicated.

The following phases are part of the interphase. And proceed in this order: G1 (for growth phase 1), S (for synthesis, like DNA synthesis) , G2 (growth 2)
Now, Mitosis, is the single slice of cake left on the plate. It might be a single slice but it is very important.

Ya, i'm also going to put that clip up on the notes

https://www.youtube.com/watch?v=EOQeU_6vbeg

WRAP UP

If you were reading about the cell cycle and you came across the term nondisjunction? Just from the words alone, what would you think they mean? Assuming you don't already know what this means?

Nondisjunction - so something not working; some sort of junction didn't come apart correctly. What is pulled apart in mitosis or meiosis? Pairs of homologous chromosomes or sister chromatids. So nondisjunction would be the failure of homologous chromosomes or sister chromatids to separate normally during nuclear division, usually resulting in an abnormal distribution of chromosomes in the daughter nuclei.

Mitosis is the process by which one nucleus becomes 2 nuclei each of which have the original genetic information

After we exit mitosis, we get into cytokinesis, which splits the cytoplasm in two creating two whole individual cells.

Let's see if we have a firm grasp on the number of chromosomes in the following phases-
Before replication? - 46
After replication…..? Still 46…. they are still connected by the centroMere. So basically as long as the dna is connected it's still considered 46 chromosomes they can also call it sister chromatids.

Vocab -
-chromatin
-diploid
-haploid
-homologues
-sister chromatids
-centromere
-Kinetochore

When you get like 30 seconds today, sketch out what each phase of mitosis would look like and then check your answers tonight. The test is known for giving pics and than making us identify the phase. Remember PMAT
P-prophase - chromosomes condense, and the nuclear envelope dissolves
M- metaphase, the chromosomes line up in the Middle
A- In anaphase, the sister chromosomes are pulled apart to the opposite sides of the poles

T- telophase nuclear envelope reform, the chromosomes decondense, and cytokinesis, the cytoplasm splitting, and 2 cells are created.

Oo, tag me on your drawings, and I'll repost some of them on insta @thecellfielife

One last thing that I really want you to remember: When does crossing over occur? Crossing over occurs in meiosis, prophase I.