Let’s talk about sex, baby - Male reproductive System.
Ep 2

Let’s talk about sex- baby let's talk about you and me,- or let's talk about reproductive systems, and hormones, and the anterior pituitary, and the endometrium, and the epididymis.

Welcome to the Cell-fie Life. Thank you so much for listening. If you have questions, or comments, or corrections, please let me know. the best way to reach me is either the website: CellfieLife.com or on insta: thiscellfielife

On the website, I have the script notes from all the episodes, so if you want to print out and use them to aid in your studying, the transcripts are available under the episodes and follow me on insta. I post MCAT prep questions on my story every morning, and I will let you know when a new episode drops, but if you subscribe, they will be automatically downloaded for your listening pleasure. And tell your friends about this podcast. As a nontraditional pre-med I decided to make this podcast because I couldn’t find an MCAT review podcast and I really wanted one so now that I am making it I want other premed students who are out there hustling and busy, like you all are to have this as an added resource for your test prep.

This episode does have sexual health material - so this is your warning. We’re gonna be talking about penises, and vaginas

And one last note before we jump in, this episode is about biological sex not necessarily gender expression, or gender identity.

Anyway let's get down… to business, that is, and the reproductive system.

You guys, I’m gonna try not to do a ton of sex puns but as I was writing this episode, everything sounded like a sexual innuendo. Sorry, not sorry

Okay,

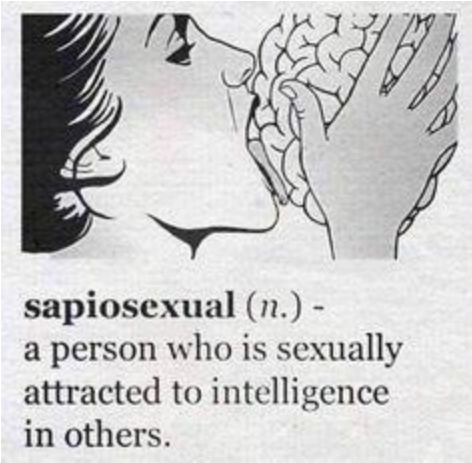
The reproductive system includes sex organs and parts of our brains. We are going to start with males because they are easy. ;)

In my opinion, male reproductive systems and hormones are pretty straightforward so we are going to start with males and then graduate up to females.

Along with what we usually think of as reproduction duties, creating sperm and eggs the reproductive system is also responsible for producing hormones. Because these hormones come from our reproductive system, they are dubbed our sex hormones.

Sex starts in the brain

The sex organs are controlled by the brain.



Specifically the hypothalamus, and anterior pituitary. The hypothalamus is really important. I think of the hypothalamus as an air traffic controller. The air traffic controller sits up in the tower and watches everything that is going on. If a plane is taking a long time on the landing strip the air traffic controller tells the incoming plane to hang on before it lands so that there is not a crash. The hypothalamus does the same thing. It sits up in the brain and monitors what is going on in the body, and gives directions if it sees that something is straying too far from homeostasis.

The hypothalamus regulates body temperature, appetite, physiological cycles, and sexual behavior, to name a few. We will talk more in detail about the hypothalamus later, but I wanted to introduce it because it has a really important role in homeostasis and thus health. Right now, we'll just talk about the hypothalamus's role in the reproductive system.

The hypothalamus is bossy, just like a good air traffic controller. You don't want an air traffic controller that waffles back and forth about whether a runway is clear for a plane to land. The hypothalamus bosses the body around by releasing hormones. In the reproductive system the hypothalamus releases, Gonadotropin Releasing Hormone aka GNRH. GnRH goes to the anterior pituitary through the blood vessels, and these guys are neighbors, so it really doesn't have a long way to travel. You know when you were a kid and your mom sent you next door for

something? Like you had to go borrow an egg or take the neighbor a plate of cookies. This is what GnRH does. It is sent to its neighbor, the anterior pituitary, to deliver a message.

Physiologically the anterior pituitary sits right below the hypothalamus and they have blood vessels connecting them.

The anterior pituitary in response to the GNRH releases Luteinizing Hormone, aka LH, and follicle-stimulating hormone, FSH. It is these 2 hormones, from the anterior pituitary, LH, and FSH that affect the male and female sex organs.

MALES -

male reproductive system “in a nut-shell.”

So male sex organs include the testes and the penis. The testes are super important because the testes are where the sperm form. And the penis, which is used to deliver the sperm. Those are the major male reproductive organs.

In the testes, 2 major things need to occur: sperm needs to be made, and testosterone needs to be secreted.

Let’s take a closer look at the testes and spermatogenisis- this will be a bit of a review- if you haven't listened to the cell cycle, mitosis, and meiosis episode, you might want to check out that episode first. It goes deeper into meiosis and the formation of haploid cells, which in males, are sperm. Did you guys know that technical plural name for sperm is spermatozoon? So singular is spermatozoa and plural is spermatozoon.

In males, sperm are made through a process called spermatogenesis

You guys,

*** Genesis *** anytime you hear/see genesis think the origin of formation of something. So genesis in the bible talks about the forming of the earth. Sidenote: I’m not saying that is how the earth was formed I am saying that the book of genesis in the bible talks about the formation of something so they called in genesis.

So spermatogenesis will be the formation of sperm and this occurs in the testes, specifically in the seminiferous tubules. We pronounce the word, like semi, niferous, but its spelled semin - which is the latin word for semen - you guys, its literally 1 letter off form how we spell semen today. The great thing about a lot of medicine is they literally name it after what it does, just in

Latin, so learning your Latin root words and/or really looking at the word and breaking it down will tell you the answer a lot of the time.

Okay - In the testes, in the Seminerferous Tubules, which are super convoluted, is where the formation of haploid sperm takes place.

Quiz - from episode 1 - how are hapoid sex cells created?

Answer: through Meiosis.

Lets start with the exteral sex organ and zoom in: So we have the scotum, which is where the testes are located, the testes have the seminferous tubules where haploid sperm are made. Along with seminiferous tubules we also have interstitial cells of Lydig. These cells are where testosterone is made. The cells of lydig are just on the outside of the seminiferous tubules.

Wo -- scrotum, where did that come from? You haven't mentioned the scrotum yet. If you're studying for the MCAT I'm gonna assume you're an adult and as an adult, I'm pretty sure that everyone of you knows what the scrotum is. The scrotum is the external pouch that's hanging out, literally, it houses the testes where sperm production occurs. Sperm production has to happen at certain temperatures, which just so happens to be a little cooler than body temperature, about 2-4 degrees cooler, so they are literally hang outside the body as to not get too hot.

I'm not gonna lie, the first time I heard the physiological reason why testes were outside the body my mind was kinda blown and I was like finally, it makes sense, why that thing is hanging there.

What happens when it's cold out? I'm pretty sure I heard you all say shrinkage. But why is this happening? How is this happening? The body always wants to maintain that homeostasis. So if it's too cold the muscles will contract to raise the testis to maintain the proper temperature for sperm development.

So in addition to the spermatogenesis, what is another important function of the testes?

A : the creation of the major male hormone, Testosterone.

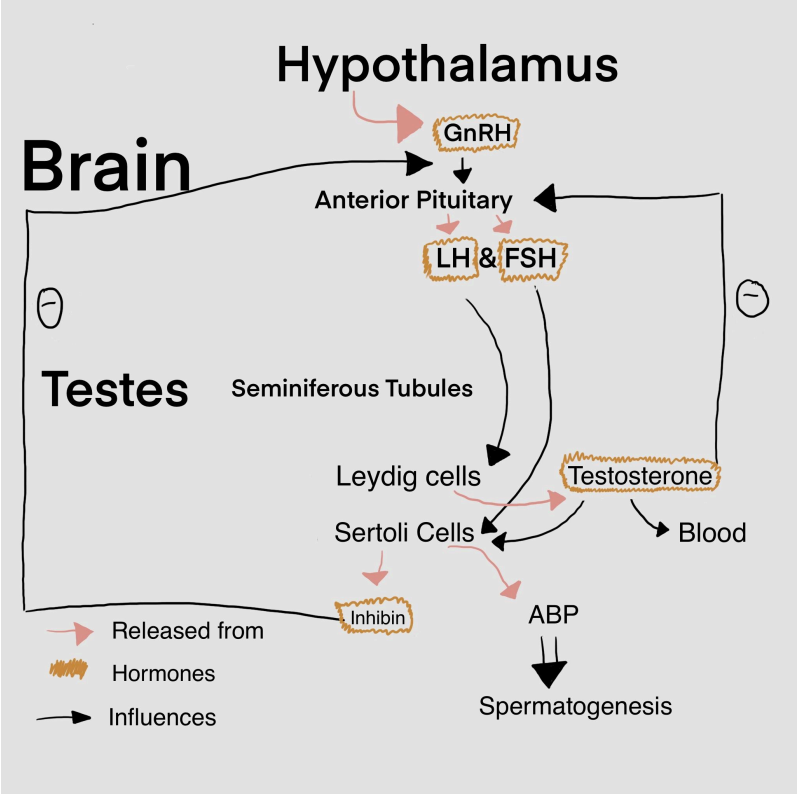
Males' major sex hormone, which is produced in the testes, is testosterone. Testosterone is the most important male androgen. Testosterone has a lot of responsibilities, it helps men maintain libido, it helps in muscle and bone growth, and it is responsible for secondary sex characteristics like facial hair, and deep voices.

Testosterone is produced by the interstitial cells of leydig.

How are we going to remember that? (men, forgive me for this one) Men lie and dig themselves into holes with those lies. (i know, i know, not all men lie and dig themselves into holes, but come on, that's pretty low hanging fruit) when I wrote that, that was not supposed to be a sexual reference to the scrotum but everything can have a dirty meaning if you try hard enough)

So, the LH from the anterior pituitary travels through the blood to the testes and enters the interstitial space, and hooks up with the Leydig cells, and the Leydig cells secrete testosterone. The testosterone enters the blood and influences the "masculine" traits we have already mentioned. It also has some influence on the production of sperm in the seminiferous tubules.

If testosterone levels get to high there is a negative feedback loop with the anterior pituitary. So the anterior pituitary senses the high levels and stops producing LH, which is what stimulated testosterone production in the first place.



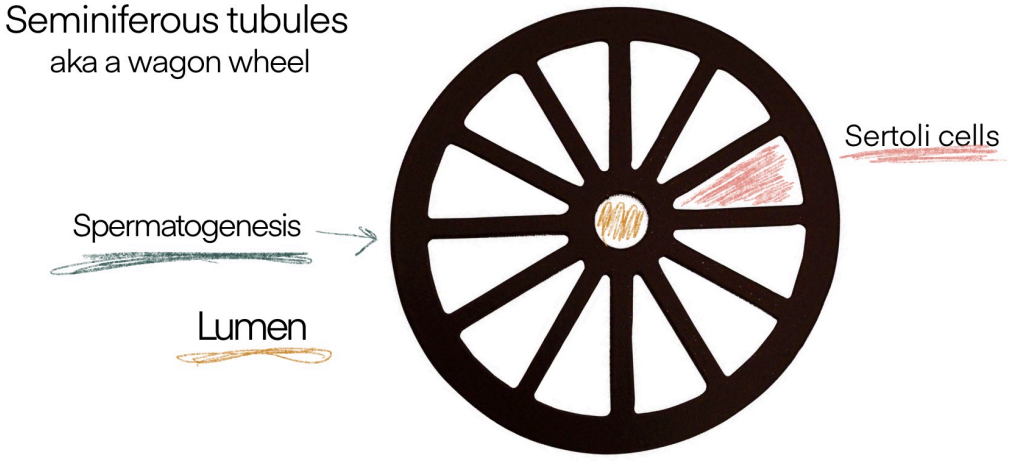
Side note:
Testosterone, in the womb, that pushes the reproductive organs to turn into masculine organs. Which will be important when we talk about embryogenesis.

So the LH and FSH from the anterior pituitary travel to the testes through the blood. In the testes, LH enters the interstitial space. Here, the LH targets the Leydig cells, which secrete testosterone. The FSH acts on Sertoli cells in the seminiferous tubules.

I want to talk go into a little more detail about the spermatogenesis process and make sure that you understand how sperm specific vocab lines up with what you already understand about meiosis.

But I find it helpful if you get a visual of where the spermatogenesis is taking place- think of wheel, like an old school wagon wheel. It has the rim and the spokes and the center. If you don't know what i wagon wheel is imagine a bike wheel, enlarged and made of wood,

Back to the wheel. Ths wagon wheel is a really loose interpretation of what a cross section of the seminiferous tubules look like.



The outside of the wheel, the rim, there is a smooth layer of muscle that will help move sperm along through the peristalsis into the epididymis.

The wedges that make up the wheels negative space are the Sertoli cells.

Now the spokes that go into the center, these are where the sperm actually develop, on these spokes between the two sertoli cells. So the sperm start development at the rim and move down the spoke getting taken care of by the sertoli cells as they move towards the center of the wheel. The center of the wheel is the lumen which will carry them onto their next stop in their journey.

This is just a reminder that Peristalsis is a type of coordinated contraction which wave-like movement pushes the contents forward.

Remember how the FSH acts on the Sertoli cells? The FSH stimulates Androgen binding protein, ABP is released from the sertoli cells, in order for the sertoli cells to make Androgen Binding Proteins the sertoli cells must have FSH and testosterone present. This ABP is what promtes the synthesis of spermatozoa.

Sertoli cells also produce inhibin which, as the name says, inhibits something. Inhibin travels up to the brain and tells it to stop releasing so much FSH, which will decrease sperm development.

okay, you guys don't judge me too much - but how are we going to remember Sertoli cells? Sertoli, that just sounds Italian doesn't it. It's because it is. Enrico Sertoli discovered the cells in the 1800's while studying medicine and the line that came to mind was

"at least buy me dinner first" possibly Italian ….. cause his name is Italian and we are talking about the reproductive organs. Come on, you will be able to pick the italian name out of the lineup if it's an option on the mcat and you can't remember the name outright, right. Sertoli, at least buy me dinner first-

In spermatogenesis, the diploid, 2n, cells are called Spermatogonia - so these are the starting stem cells in sperm formation.

The Spermatogonia cells are the cells that will produce the haploid sperm. The spermatogonia cells also need to ensure that there are always spermatogonia cells to make more sperm.

Males make several million sperm a day for most of their lives, so having Spermatogonia cells is important. So what these cells do is undergo **mitosis**. One of the daughter cells will become another spermatogonium cell and the other will move down the meiosis pathway.

But lets stop and think about this. If the seminiferous tubules are roughly shaped like a wheel and the process of maturation starts at the rim and as it matures it works its way into the center of the wheel, where will the Spermatogonia cells be located?

A: that's right they are located near the rim.

Spermatogonia are just hanging out in interphase, and then they start going through the stages of interphase: G1, S. S is where they replicate their genetic material- and become **primary spermatocytes,** then G2 and finally enter Meiosis.

A quick note here. At first, I was like, why would they change the name of the cell after the DNA has been replicated but before it has done any sort of division? like, this is cheating.

It's because the primary spermatocyte goes through a physical barrier, a tight junction. So once it has its DNA replicated, it now has a ticket and can pass through the security gate (like at the airport). Understanding the anatomy here helped me visualize and understand the difference in names.

The **primary Spermatocytes** then undergo Meiosis I and become **Secondary Spermatocytes** - so now they are haploid (n). So we just finished meiosis 1 and now we have secondary spermatocytes.

Quiz from podcast 1 : where does crossing over occur? A: prophase 1 of meiosis 1.
Follow-up question. What is pulled to opposite poles during anaphase 1? Homologous pairs. If you couldn't answer those 2 questions within a second or two - go review meiosis.

The **secondary spermatocytes** then undergo Meiosis II and become **Spermatids**. Remember these are haploid. The little spermatids undergo some further maturing and are called spermatozoa.

I remember that spermatids come before spermatozoa in the naming convention because you know how in Spanish they add diminutives to words like 'ito' and 'ita' spermatids- at some point, I added spermati-to to it. So they are diminutive, they are small. Seriously, say it out loud, if anyone gives you weird looks, just tell them you're learning Spanish and they will automatically think you are super cool. Spermati-to - so the diminutive would come before the more mature spermatozoa.

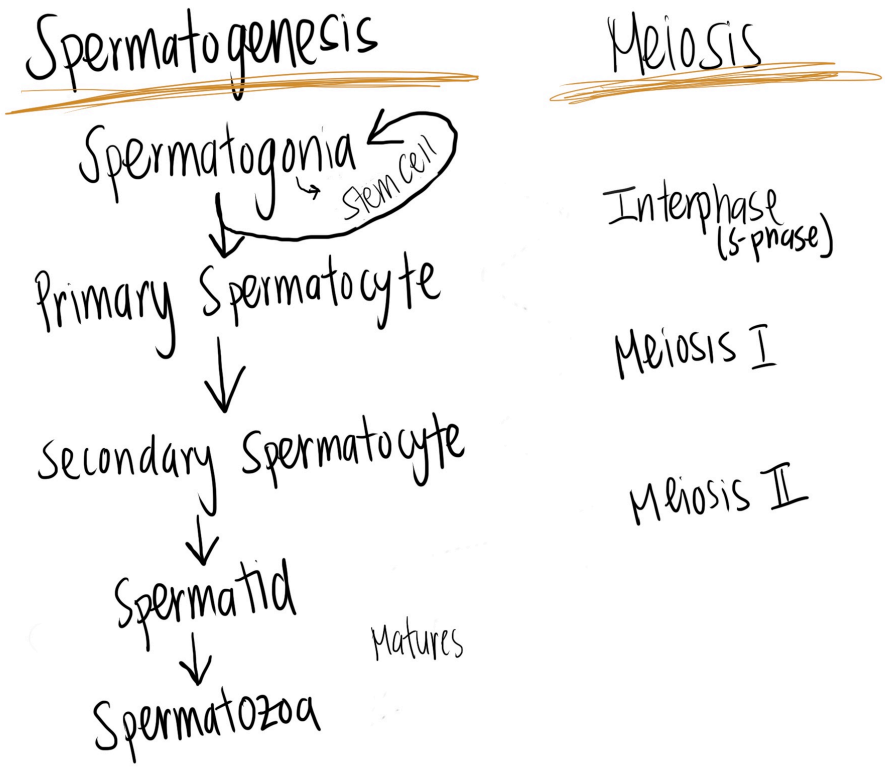
Q: how many chromosomes does a spermatid have?
A: 23 - good job.

Remember that with meiosis, we can end with 4 cells that have the haploid number of chromosomes. In Spermatogenesis 4 sperm (or spermatozoon) result for each spermatogonium.

Let's run through Spermatogenesis names 1 more time, really quick.
Spermatogonia are the stem cells that live the Seminiferous Tubules in the testes. Once the genetic info has been replicated in the S phase of interphase, it develops into a **Primary Spermatocyte.** It goes through Meiosis I and is now a **Secondary Spermatocyte**. The secondary spermatocyte undergoes meiosis II and develops into **spermatids, which mature** into **spermatozoa .**

Spermatogonia, sound like patagonia, which yes, is a clothing brand that one of my brothers is super in to, but it is also a region at the bottom of South America. And for some reason my brain accepts this as a way to remember that the starting cells of spermatogenesis. Is a region at the bottom of the map.
Primary Spermatocyte - cause its first, in the order, its primary.
Secondary Spermatocyte - cause its second
Spermatids- or you know spermatido- to which is the baby sperm before they mature.
Spermatozoa - which is the plural form of sperm and actually the singular of spermatozoa is spermatozoon.

All of this is happening in the testes in the highly coiled Seminiferous tubules. Where there are also **Sertoli Cells** that are helping to facilitate the formation of Spermatozoa.



-There is a flow chart of all of this on the website, and I'll post it on insta too - I think the flow chart helps it line up the general steps of meiosis with specifics of sperm and egg production.

Now that we have sperm, let's talk about the path the sperm take through the male reproductive system - When I originally learned this pathway, I was taught the mnemonic SEVE(n) UP - I'm betting this is the same Mnemonic a lot of you learned, it's an oldie, but a goodie. So let's review SEVEN UP. Did you guys ever play heads up seven up in school?

SEVEN UP-

S- Semiferious tubules - where sperm are nourished by Steroli cells
E-epidiymis - sperm can further develop, gain mitochondria, and develop flagella, and they are stored.
V- Vas deferns - is also sometimes called the ductus deferens which is the muscle around the vas deferns that carries sperm from the epididymis to the ejaculatory duct.
E-Ejaculatory Duct—the ejaculatory ducts fuse to form the urethra. Up to this point, there have been two of everything, one on each side.

N- the N stands for nothing, like literally nothing. Just ignore the N

U-Urethra
P-Penis

A little anatomy for you -

The sperm drains out of the epididymis and then into the ductus deferns. The end of the epididymis forms the vas deferns aka ductus deferens. The vas deferns, is the tube that goes from the posterior of the testes, penetrates the inguinal canal then enters the pelvic cavity and brings the sperm to the posterior side of the bladder. The seminal vesicles are at the base of the bladder and are considered an accessory gland, the seminal vesicle and the ductus deferns form the ejaculatory ducts.

During ejaculation, the ejaculatory duct ejects sperm into the male urethra.

So up to this point, males have had two of everything, one on each side but now the ejaculatory ducts form up to the urethra. The prostate gland surrounds the prostatic urethra. So the ejaculatory ducts join the urethra just below the bladder and the prostate surrounds it. This part of the urethra is known as the prostatic urethra. Makes sense. The prostate is also considered an accessory gland, and the fluid it secretes goes into the prostatic urethra. **Bulbourethral glands** are directly under the prostate, and it's secretions empty into the urethra. The Urethra passes through the penis carrying semen.

Remember, Semen is sperm + fluid secretions from the glands.

In males, the urinary and reproductive tracts share a common pathway. This is not the case for females.

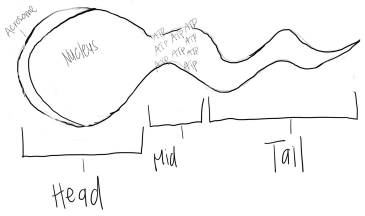
I mentioned 3 accessory glands in passing - these glads provide sperm with things that they need on their journey to fertilize an egg.

Seminal Vesicles - contribute fluid to the sperm, about 60% of semen volume. The fluid here is alkaline to help protect the sperm from the acidic environment of the urethra and female reproductive tract. The seminal vesicle fluid is also very rich in fructose for the sperm to use for energy, on their journey.

The Prostate Gland - makes prostatic fluid - so more fluid

The last of the accessory glands is the **Bulbourethral gland** - also known as a **Cowper's gland** this glad adds lubricant that helps lubricate the urethra.

Now that we know how and where the sperm are produced let's talk about the sperm themselves. I think everyone knows what sperm look like. They have a big head that carries the genetic information and then they have a hat on top of their head called the acrosome which helps in ovum penetration. It's not a top hat it's more of a beanie. On the opposite side of the head is the tail, aka flagellum.



The part of the tail closest to the head is called the connecting piece where the mitochondria are located, and then the long tail to help them swim. Because the sperm have a long way to swim they are going to need a lot of energy which means they are going to have a lot of mitochondria.

Something that I find kinda cool is that the sperm don’t donate mitochondria to the egg, and thus the embryo. This is because the mitochondria are located at the spot where the tail meets the head. The genetic information is the head so very few, if any, mitochondria are from dad. Which means a couple of things: if someone has an inherited mitochondrial disease it’s probably

coming from mom. Also, there is, theoretically, a mitochondrial eve. Google that in your spare time. It's pretty cool.

https://www.sciencedaily.com/releases/2010/08/100817122405.htm

Quick Review-

The Reproductive system is controlled by the brain—the hypothalamus. The Hypothalamus releases gonadotropin-releasing hormone, GnRH.

GnRH goes to its neighbor, the anterior pituitary, and the anterior pituitary releases 2 hormones.

- Leutenizing Hormone -LH
- Follicle stimulating hormone - FSH

These 2 hormones go to the testes.

LH - acts on the interstitial cells of Leydig to secrete sperm
FSH- acts on Sertoli cells that aid in the development of sperm.

Sperm takes the SEVEN UP path during ejaculation.

Sperm contains a head, a midpiece, and a flagellum.
The head is where the genetic material is stored and is covered by the acrosome, which helps the sperm penetrate the ovum.
The midpiece is where all the ATP is generated so it has a lot of mitochondria
The flagella is how the little guy swims/promotes motility.

O my Gosh we made it!!! So because I want to keep these relatively short 20-30 minutes I think I'm going to split this episode into two. We will talk about the female reproductive system in the next episode.

If you are listening to this. I want to genuinely thank you. I am making these podcasts for other students, like myself, and if you are listening, I really appreciate it. It makes it all worth it to know that other people are investing their time in listening to this podcast.

Please subscribe, leave comments, and recommend this podcast to your friends. Let me know if you have any suggestions, or just general comments, or corrections.

Check out the next episode for the female reproductive system.

Study Hard, Friends and do me a small favor and listen to a little Salt-N-Pepa

https://www.youtube.com/watch?v=qzfo4txaQJA