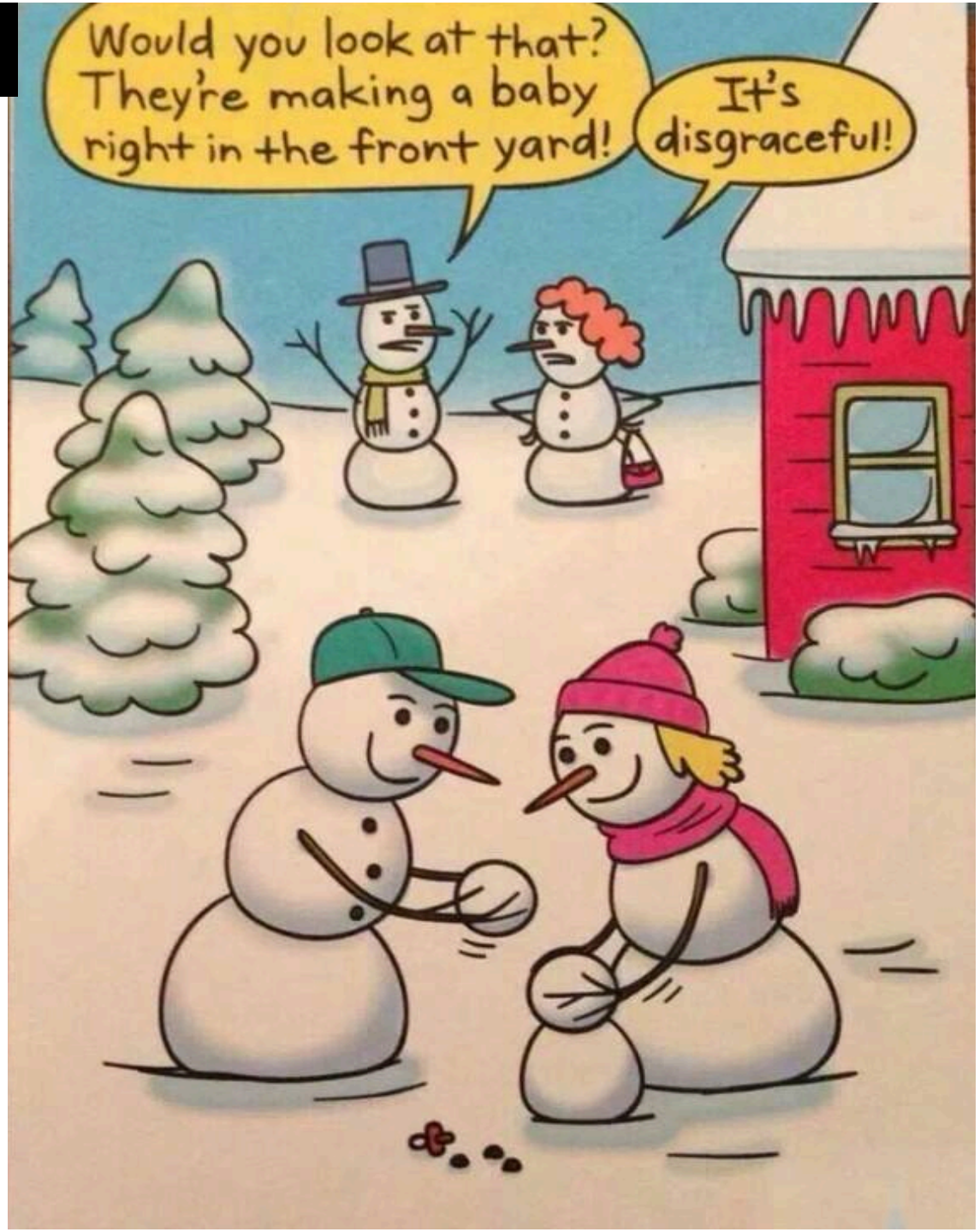
BOOKLET 1

Reproduction & Prenatal Development



Learner outcomes…
What you need to know!

- identify the structures in the human female reproductive system and describe their functions; i.e., ovaries, Fallopian tubes, uterus, endometrium, cervix, vagina

- identify the structures in the human male reproductive system and describe their functions; i.e., testes, seminiferous tubules, interstitial cells, Sertoli cells, epididymides, vasa (ductus) deferentia, Cowper's glands, seminal vesicles, prostate gland, ejaculatory duct, urethra, penis

- distinguish sperm and egg from their supporting structures; i.e., seminiferous tubules, interstitial cells, Sertoli cells, follicle, corpus luteum

Learner outcomes…
What you need to know!

- describe the role of hormones, i.e., gonadotropic-releasing hormone (GnRH), follicle- stimulating hormone (FSH), luteinizing hormone (LH), estrogen, progesterone, testosterone, in the regulation of primary and secondary sex characteristics in females and males
- identify the principal reproductive hormones in the female and explain their interactions in the maintenance of the menstrual cycle; i.e., estrogen, progesterone, FSH, LH
- identify the principal reproductive hormones in the male and explain their interactions in the maintenance and functioning of the male reproductive system; i.e., testosterone, FSH, LH.

Terms you need to know

Vas deferens
Urethra
Penis
Seminal Vesicle
Ejaculatory Duct
Prostate gland
Cowper's Gland
Epididymis
Testis
Scrotum
Semen
Sperm
Ejaculation
Refractory Period

Terms you need to know

Fimbriae
Cervix
Vagina
Endometrium
Myometrium
Oogenesis
Follicle
Ovum
Estrogen
Progesterone
hCG
Menstrual Cycle
Corpus Luteum

Terms you need to know

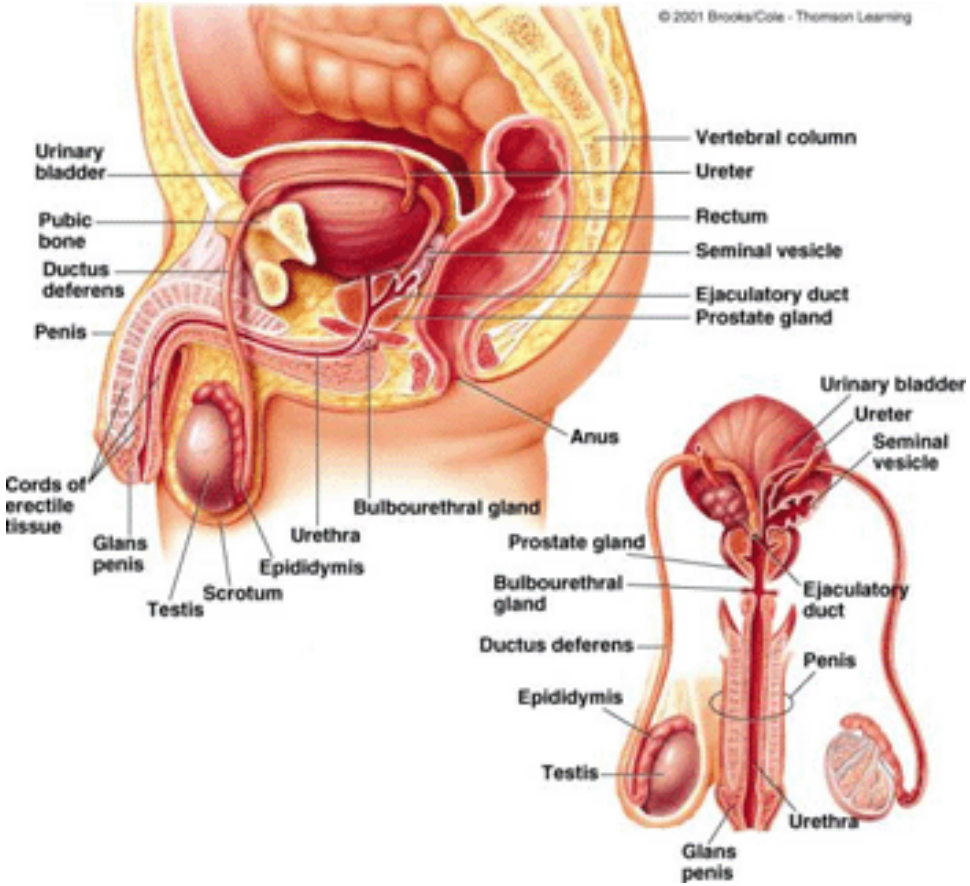
Flow Phase
Follicular Phase
Ovulation
Luteal Phase
Menstruation

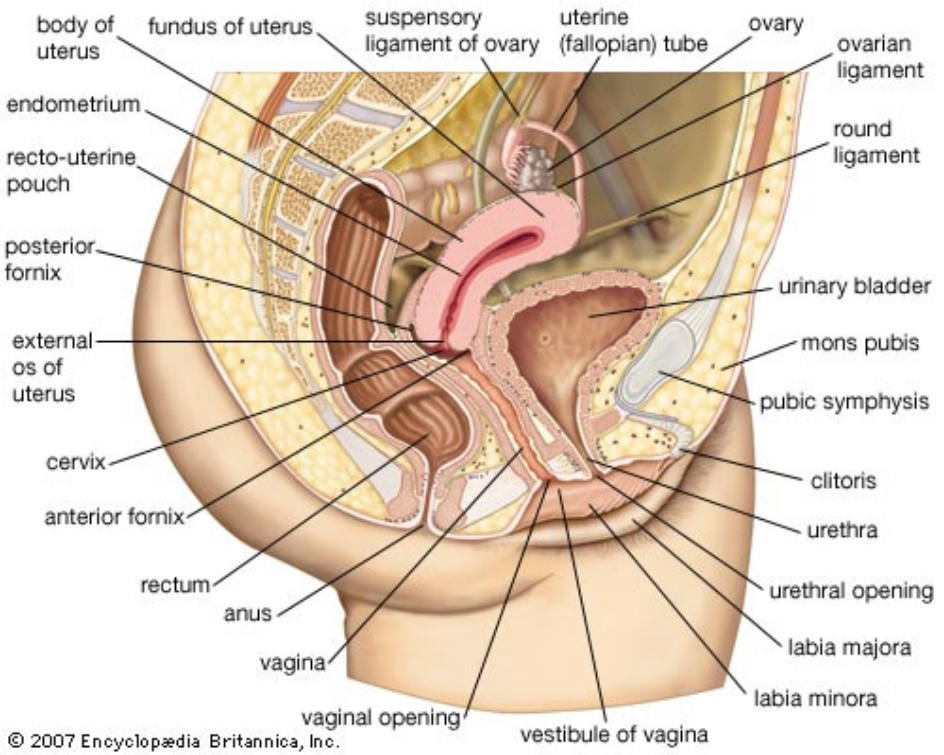
Unit 5: Reproduction

Male Reproductive System

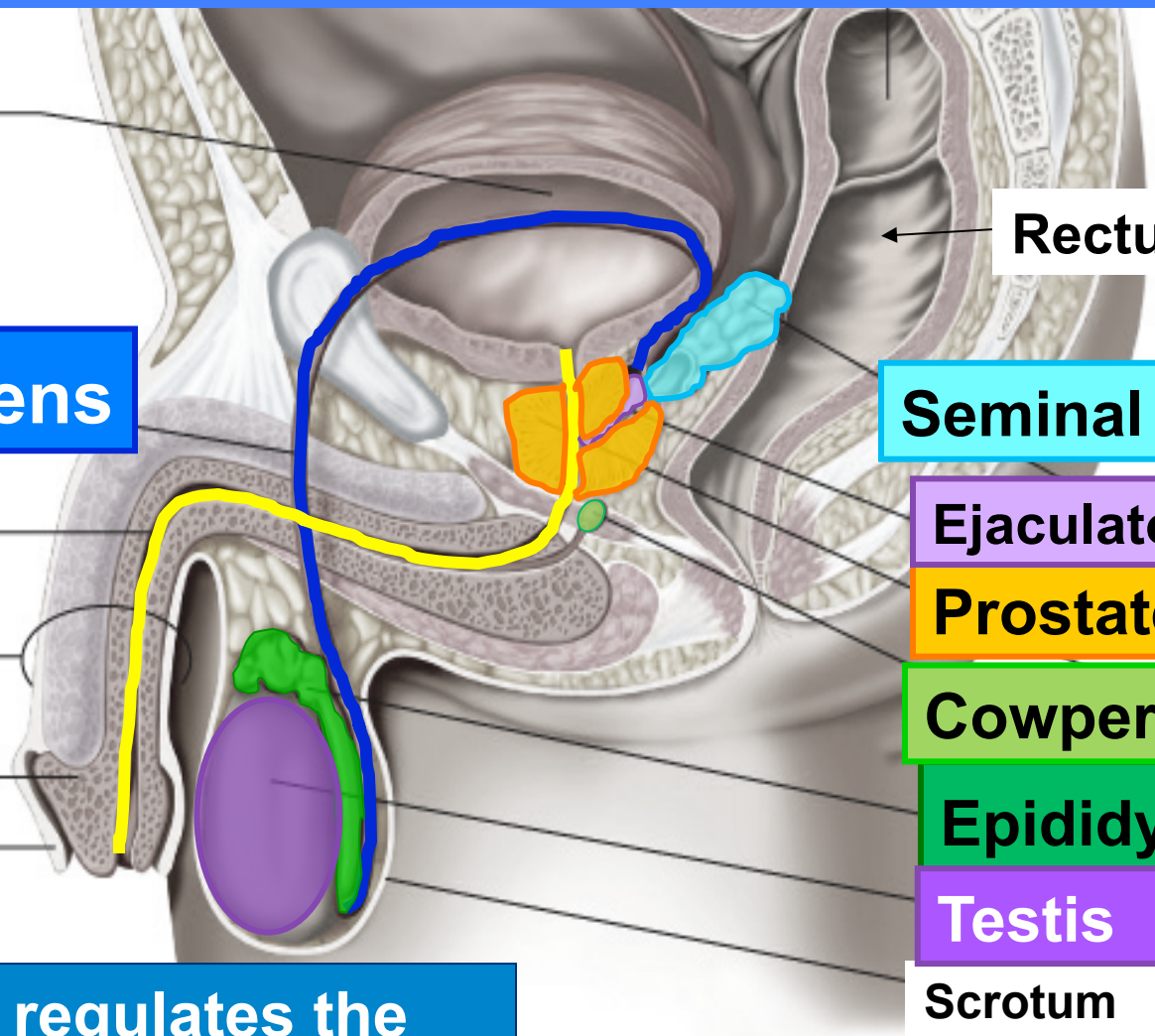
Female Reproductive System

NO DON'T WORRY ABOUT ALL THESE PARTS…YET!!





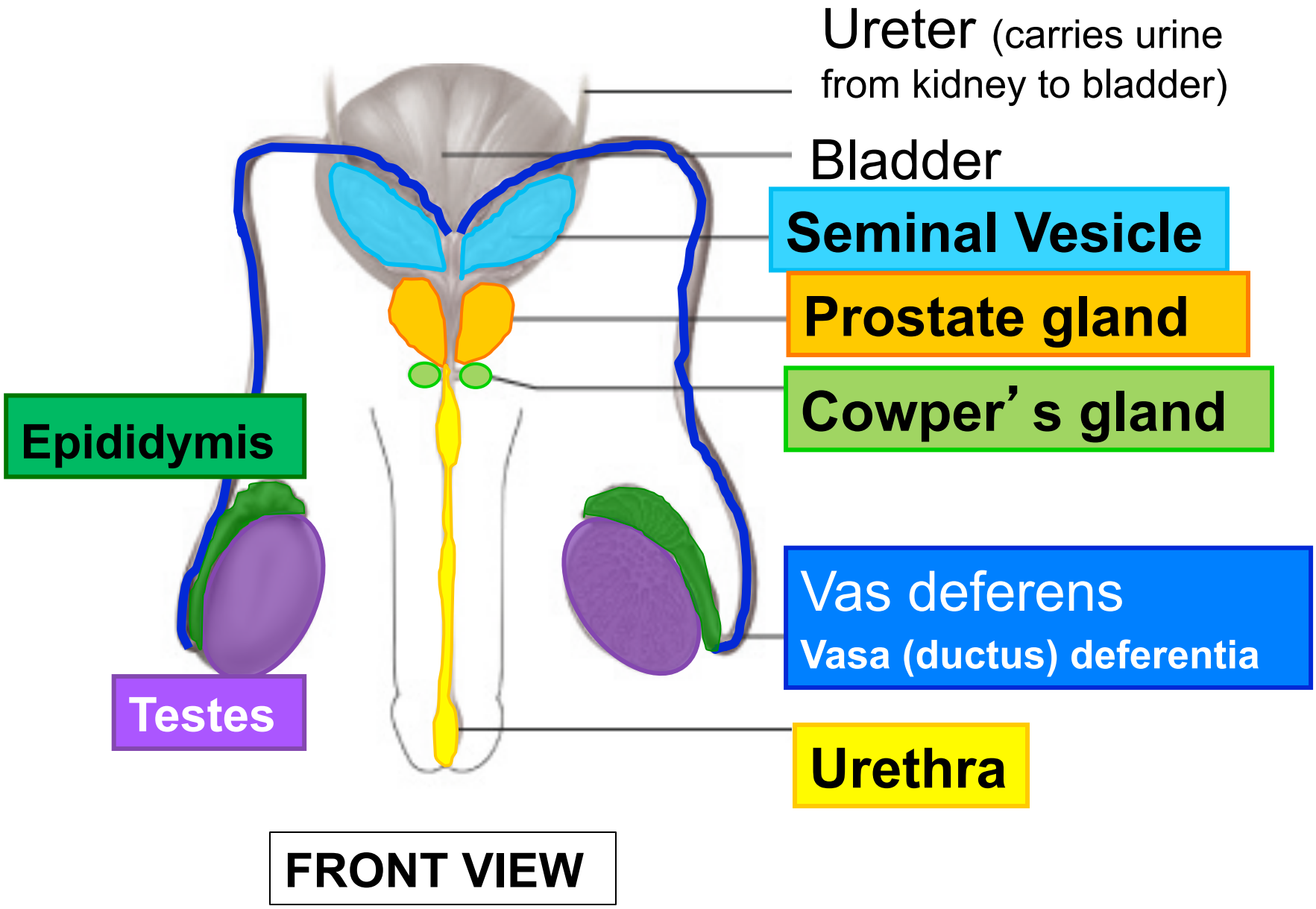
Label the following diagram



The scrotum regulates the temperature of the testes.

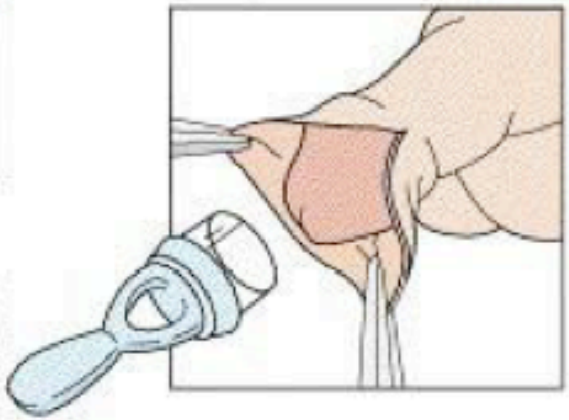
Sperm form best at 35°C.

Label the following diagram



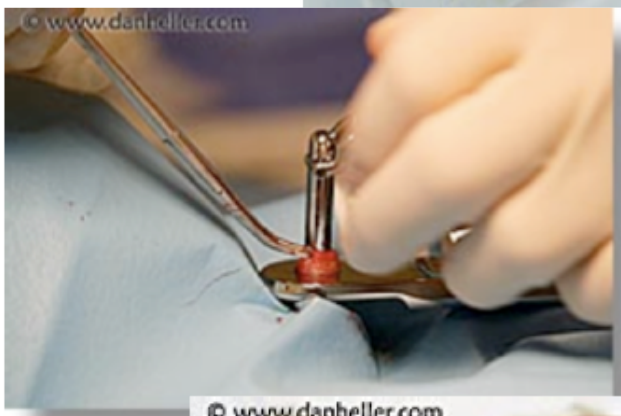
Circumcision

1. An incision is made in the top of the foreskin.



2. The plastibel is placed over the head of the penis and the foreskin is pulled over the plastibel.

3. A suture is tied around the foreskin over the tieing groove in the plastibel. Excess skin beyond the suture is trimmed away. The plastibel falls off 3-7 days later.

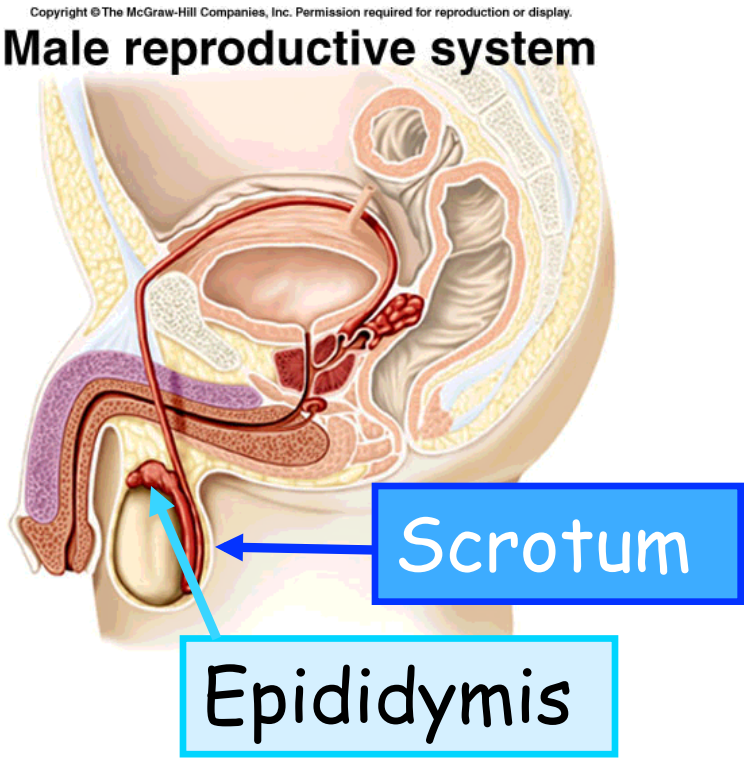


Scrotum and Epididymis

Scrotum

- **Skin and muscle covering the testes**
- Allows sperm to develop at optimal LOWER temperature **(35°C)**

Shrinkage Video

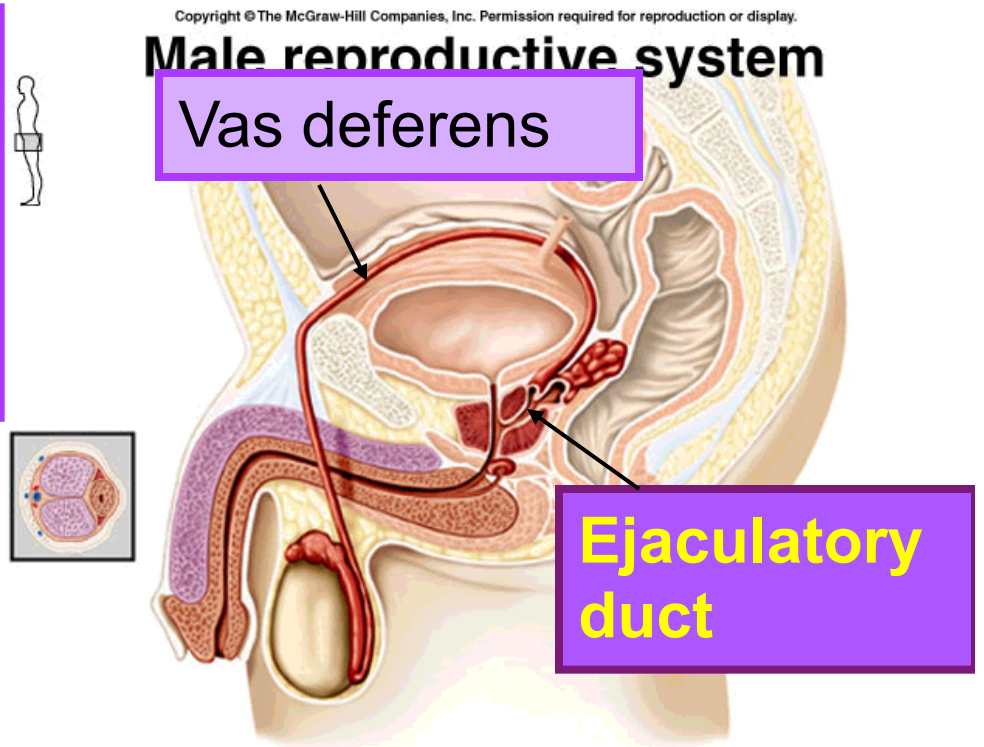


Epididymis

- **storage and maturation** of sperm
- the immune system destroys the "bad" sperm
- further develop a flagellum to swim.

Vas Deferens and Ejaculatory Duct

Ductus (Vas) Deferens – **carries sperm** from epididimus to ejaculatory duct



Ejaculatory Duct

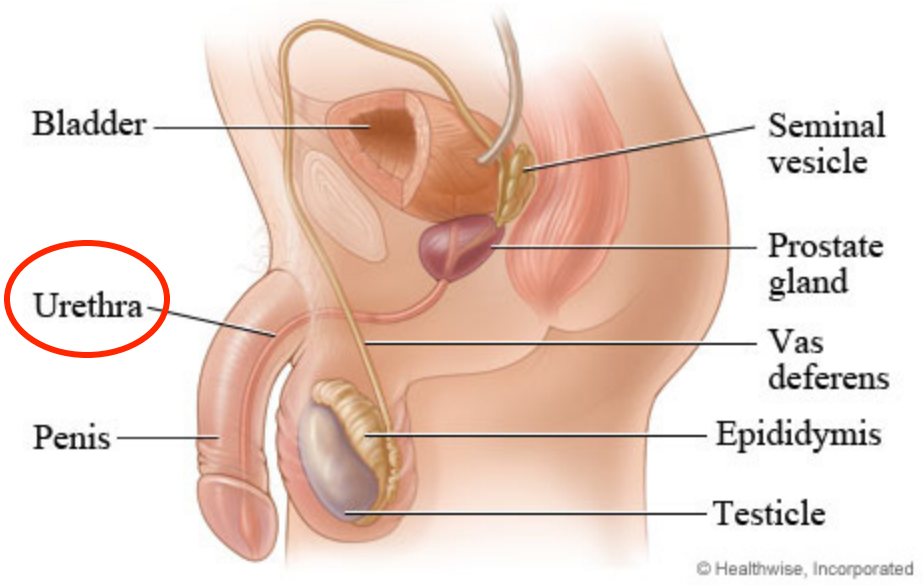
-regulates the movement of **semen into the urethra.**

(A sphincter regulates the removal of urine from the bladder.)

Penis and Urethra

Urethra

- carries **semen** (reproductive system) and **urine** (excretory system).



Penis

How does an erection happen?

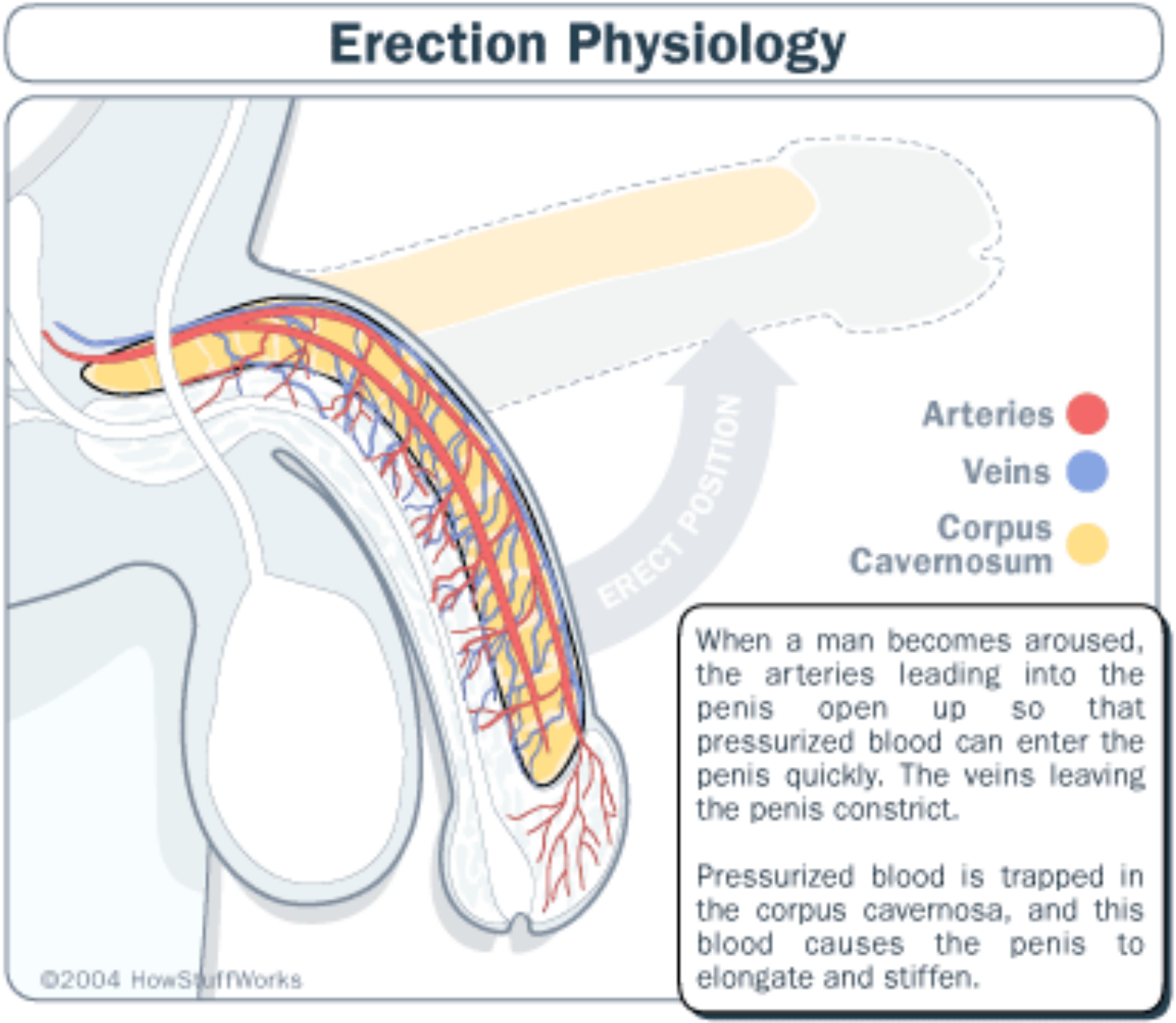
Delivers semen to female vagina

Arterioles dilate → increase blood flow→ fills with blood

while…

Compressing veins that carry blood away from penis → pressure builds → erection

Dilation of the arteries (**erection**) of the penis is under the influence of the **parasympathetic nervous system.**



How Does Viagra work?

How is a penis like a camera?

Because for both you just
Point and Shoot...

Point = **P**arasympathetic…
controls erections

Shoot = **S**ympathetic
controls ejaculations

The Great Sperm Race

Ejaculation: the release of semen through the **urethra**

Ejaculation is accomplished by the contraction of the vas deferens, the prostate and the muscles at the base of the penis, under the influence of the **sympathetic nervous system.**

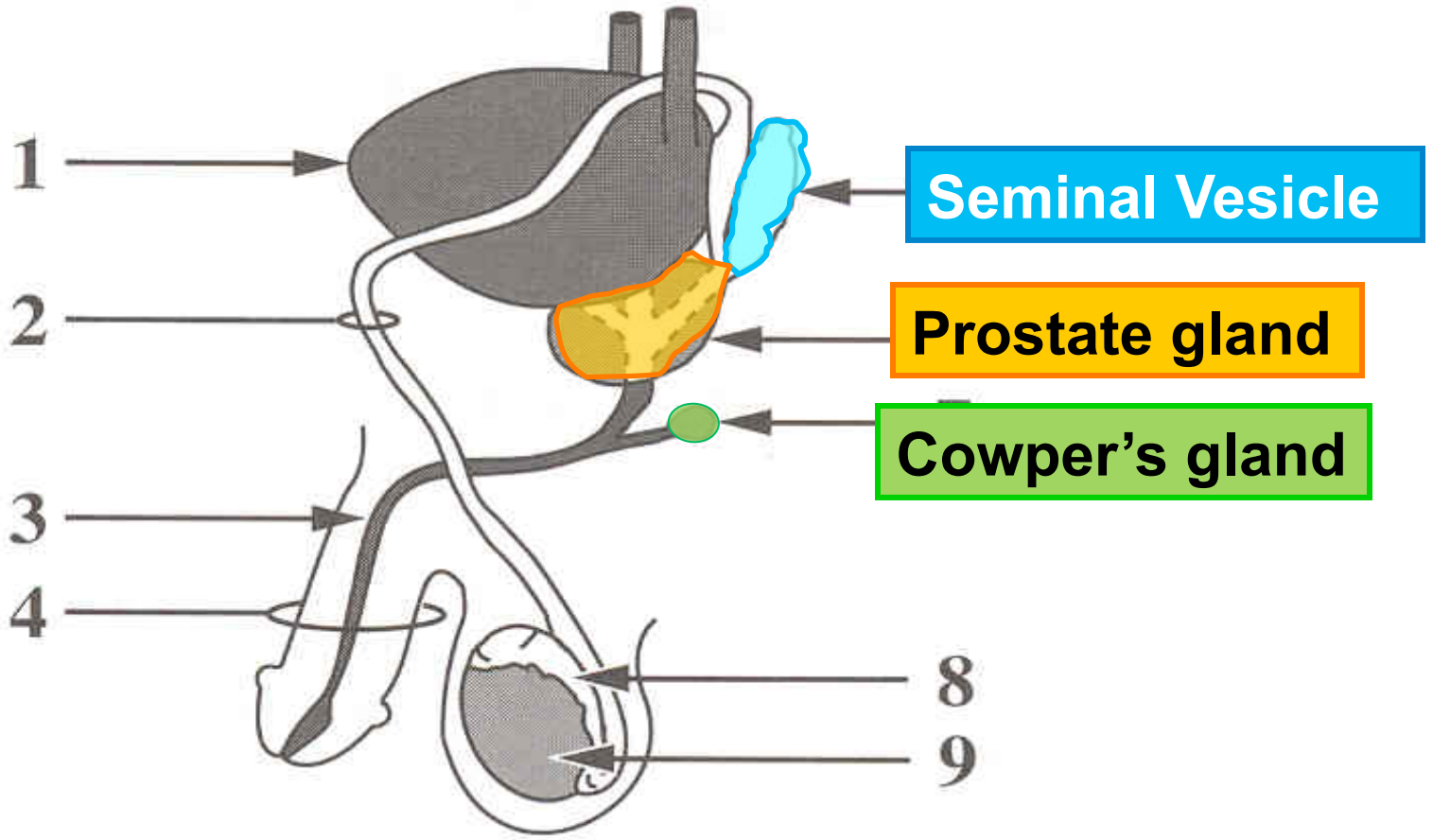
Refractory period: period of time that must pass prior to a **second erection.**

Seminal Fluid(semen)

Student Price Card

an acronym to remember the order

Secreted by Accessory Glands:

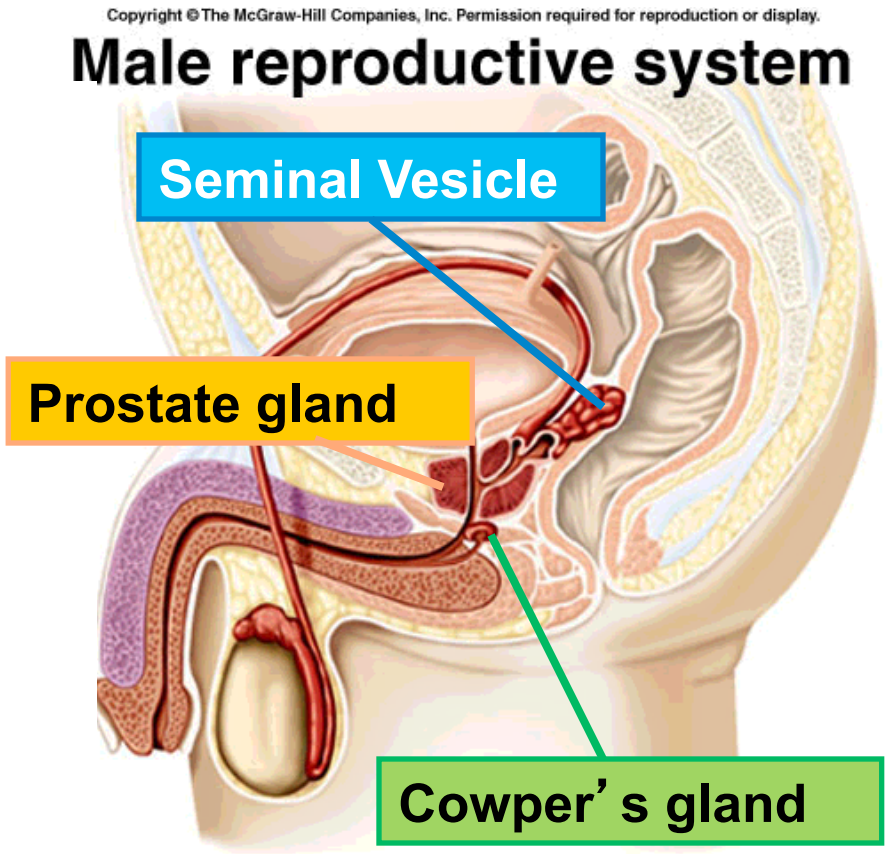


Seminal Fluid (Semen)

1) **Seminal vesicles** - 60% of total fluid

Contains fructose for energy

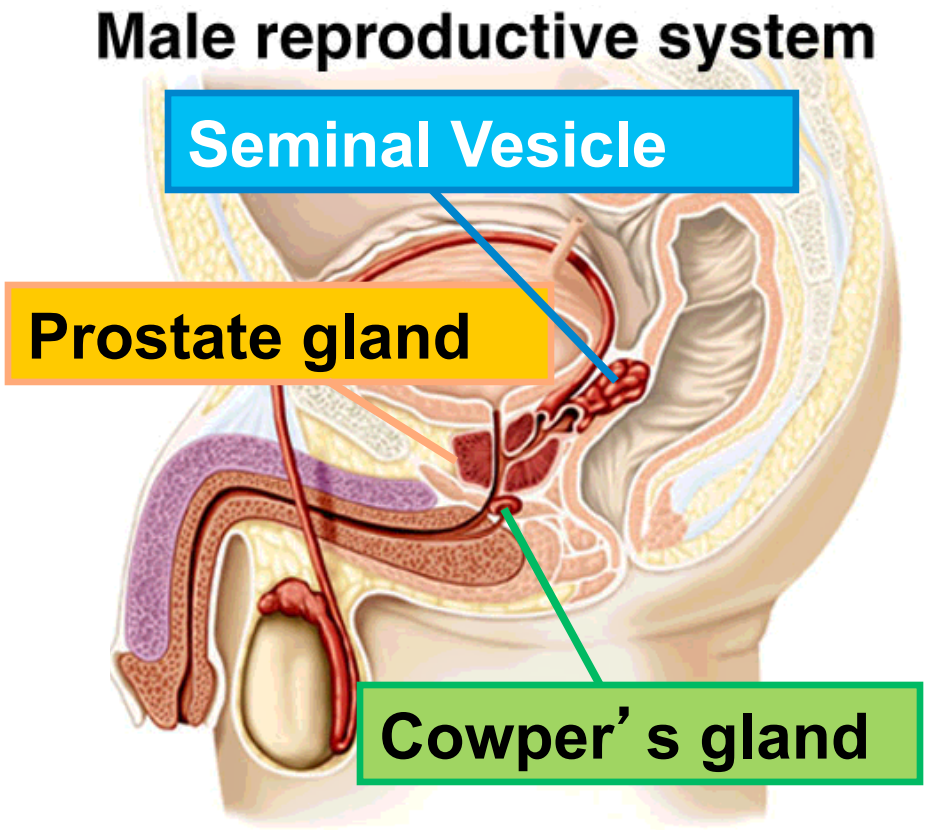
and **Prostaglandins** which cause rhythmic contractions of the smooth muscles in female, which help **sperm move up the uterus.**



Seminal Fluid (Semen)

2) **Prostate gland**:

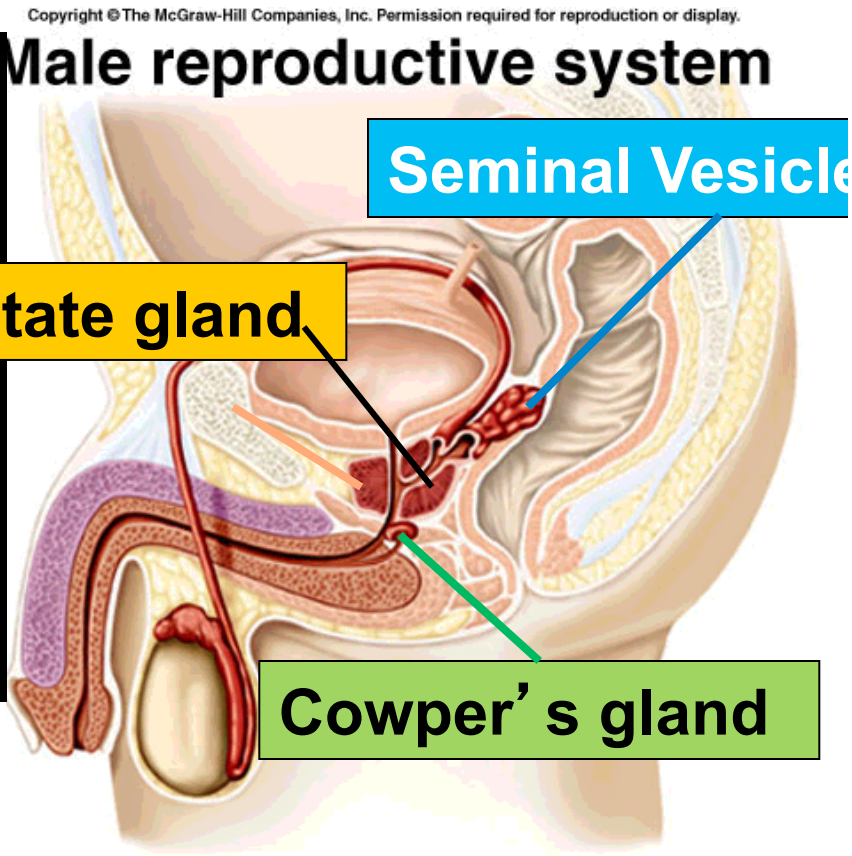
- **alkaline buffer and mucus that protects sperm** against acidic environments in the urethra and the vagina.
- Increases mobility of sperm



Seminal Fluid (Semen)

3) **Cowper's gland**:

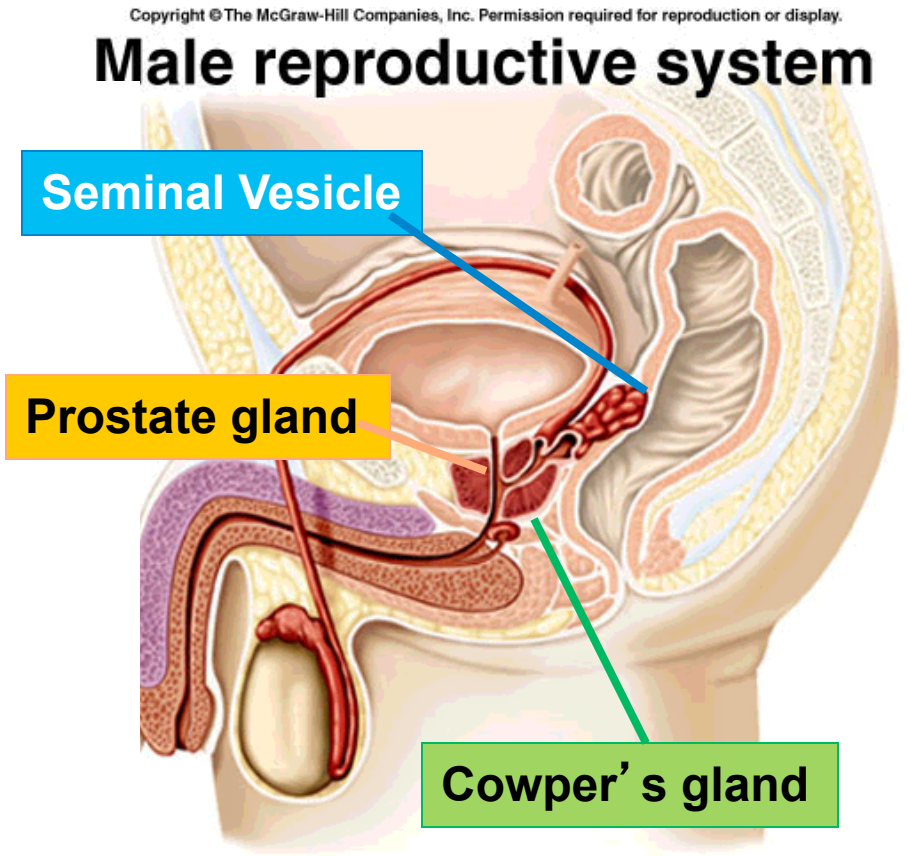
- Secretes a **mucus and alkaline buffer** prior to ejaculation to **protect against acid in urine** and increases mobility.



Sperm + seminal fluids = semen

Semen

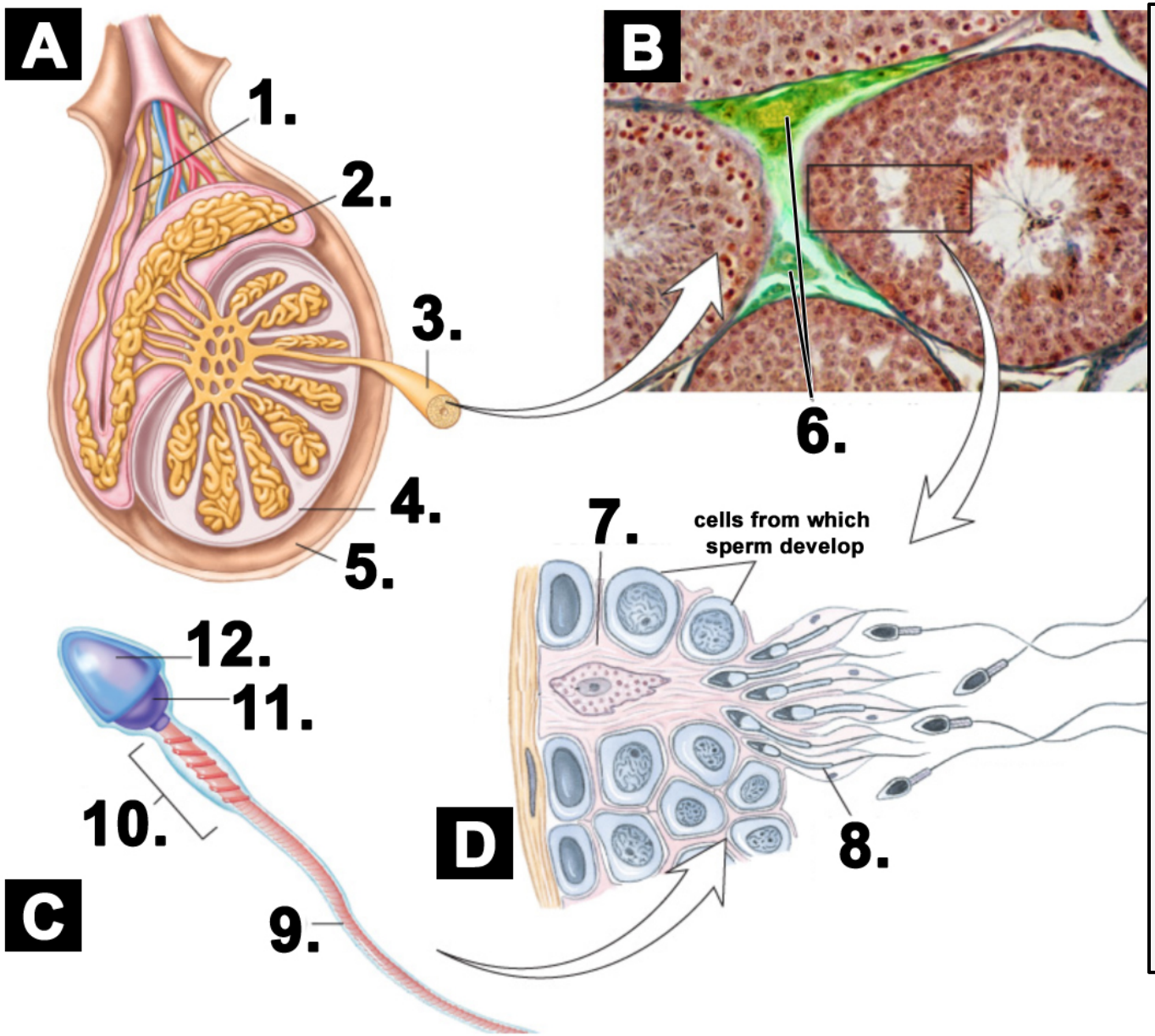
In one ejaculate there is about 3 – 4 mL of fluid and about 40 – 100 million sperm cells per mL



(Note: at least a few dozen must reach the egg to ensure fertilization!)

Where are SPERM made?

Testes- sperm formation



1. Ductus deferens
2. Epididymis
3. Seminiferous tubule
4. Testis
5. Scrotum
6. Interstitial cells
7. Sertoli cells
8. Developing sperm cells
9. Tail(flagellum)
10. Middle section
11. Head
12. Acrosome

Testes

Contain:

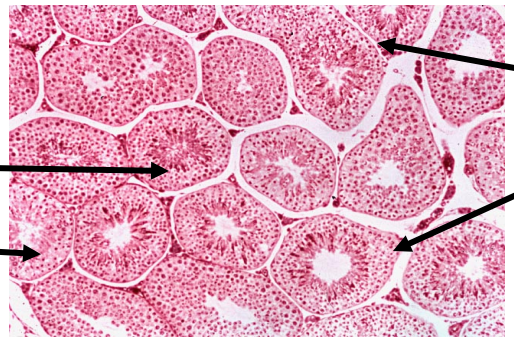
1. **Sertoli Cells** (**IN** seminiferous tubules)

- Secrete chemicals required for the **nourishment** and development of sperm cells
- Facilitate **spermatogenesis**.
- Protection from man's immune system
- Influenced by **FSH** (follicle stimulating hormone) from pituitary **and by testosterone from interstitial cells.**

2. **Interstitial Cells** **(BETWEEN** seminiferous tubules)

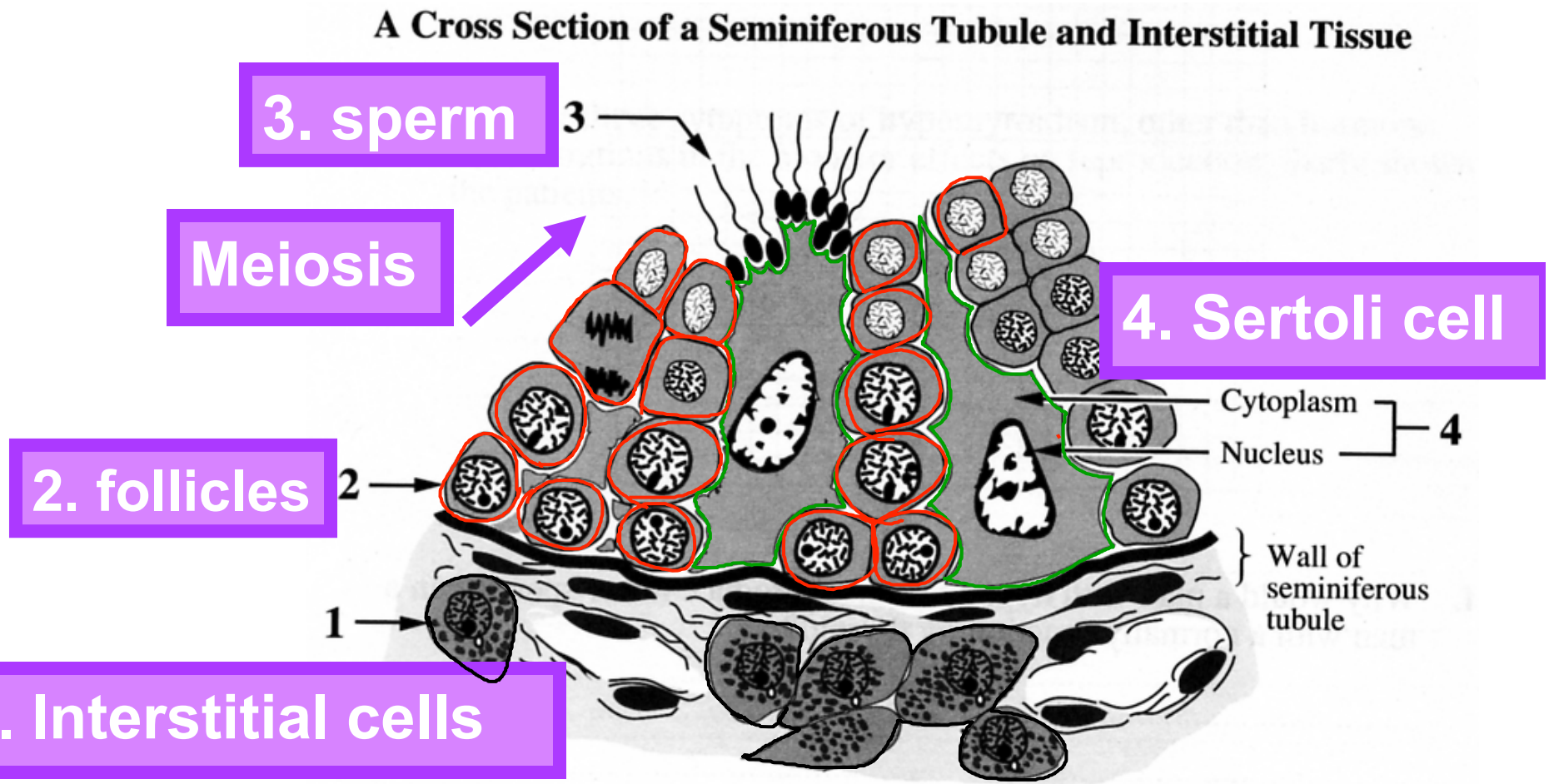
- Produce **testosterone**
- Influenced by **LH** **(leutinizing hormone)** from the pituitary

Sertoli cells in Seminiferous tubules

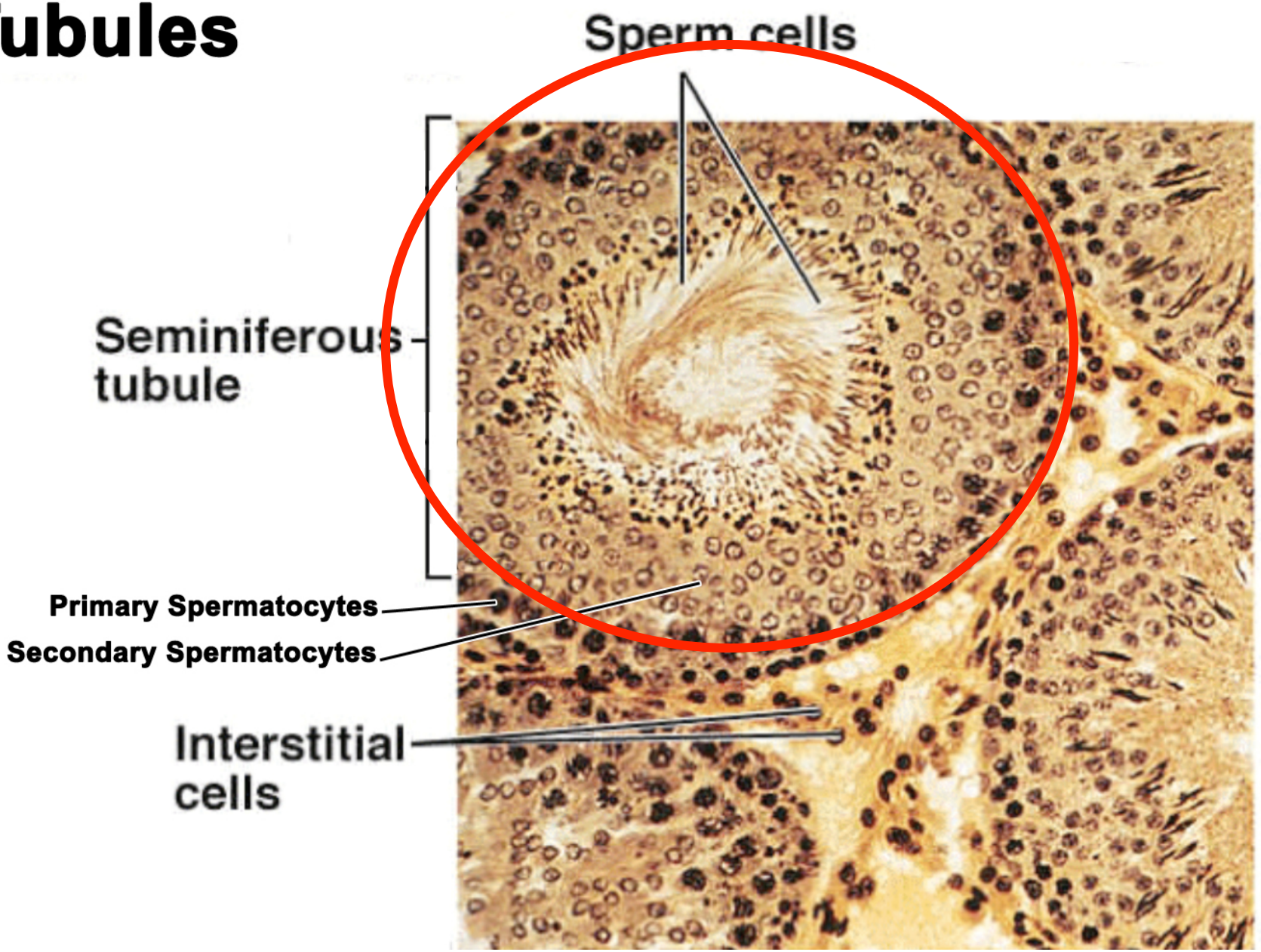


Interstitial cells

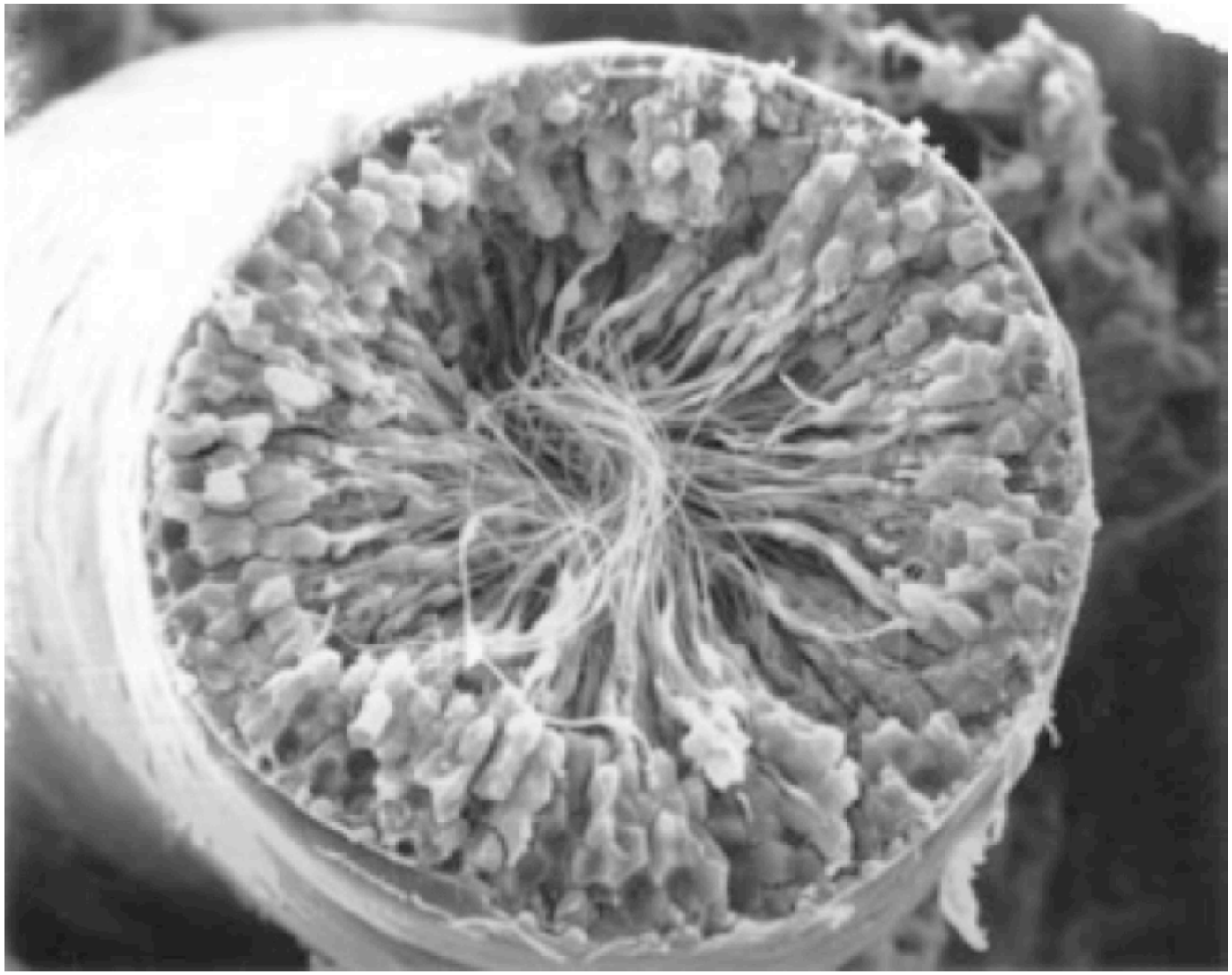
Diagram from Diploma Exam



Seminiferous Tubules

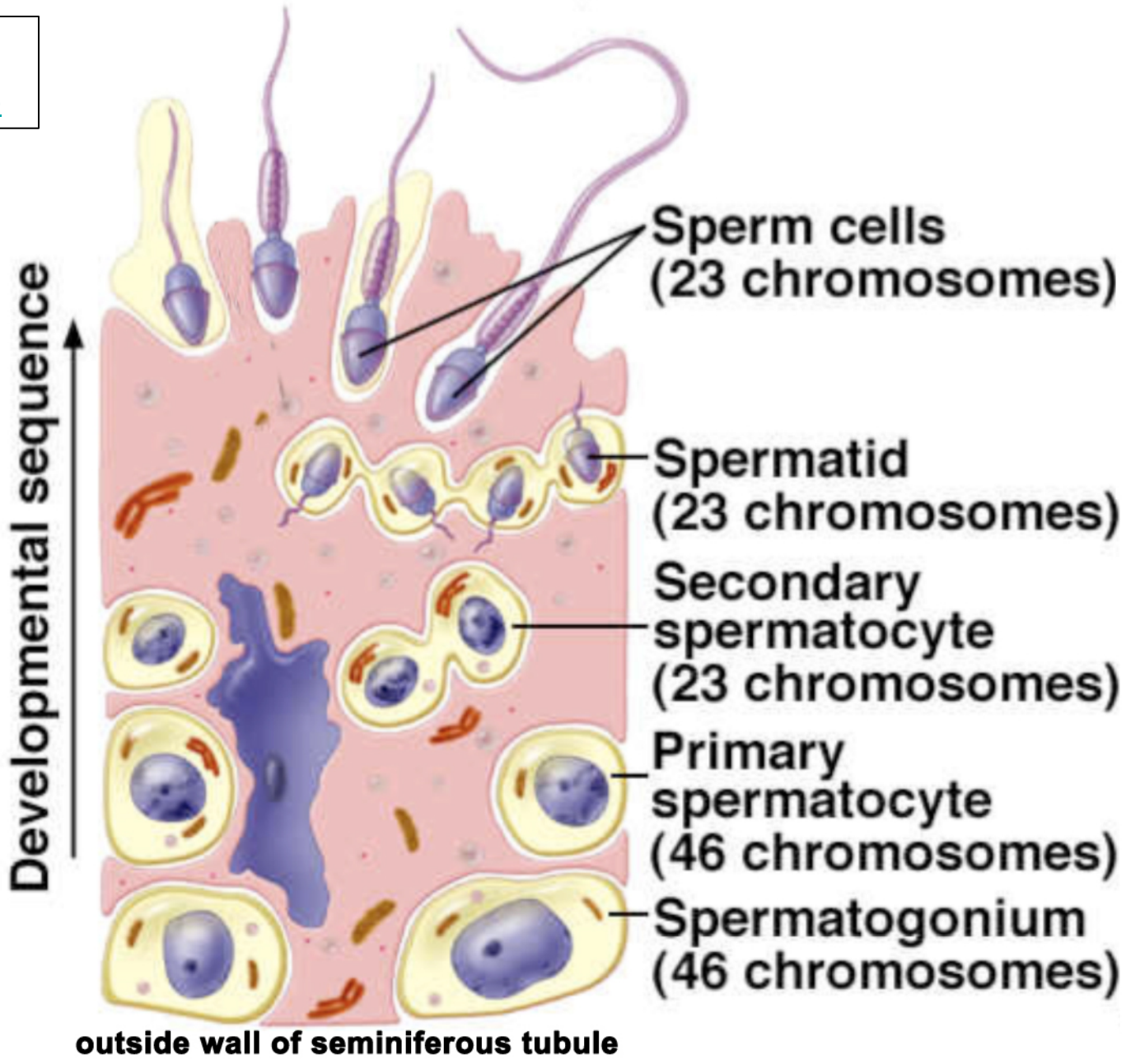


Seminiferous Tubule Cross-section

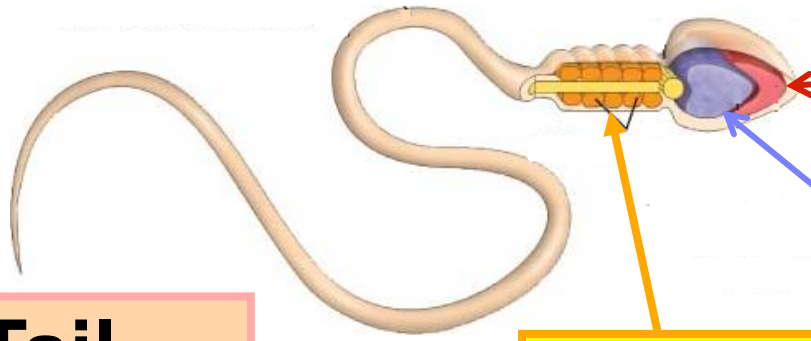


Spermatogenesis

Animation of Spermatogenesis



Sperm



Head

Acrosome
Contains an enzyme to penetrate layers surrounding the ovum

Tail
Flagellum for swimming

Midpiece
Mitochondria for energy

Nucleus
23 chromosomes

Life span of a sperm cell:

- In the epididymis - **many years**
- In semen – at body temperature, **1-5 days**
- Stored at -100°C - **many years**

Watch sperm swim

The GREAT Sperm Race **Prt I**

Fertility Clinics Check for…

-mobility (propel forward)

-morphology(size & shape)

-semen volume

-pH

-fructose content

-sperm count: less than 20 million / mL is too low

Pathway of Sperm The Great Sperm Race

Seminiferous Tubules

⇩

Epididymis

⇩

Vas deferens

⇩

Ejaculatory Duct

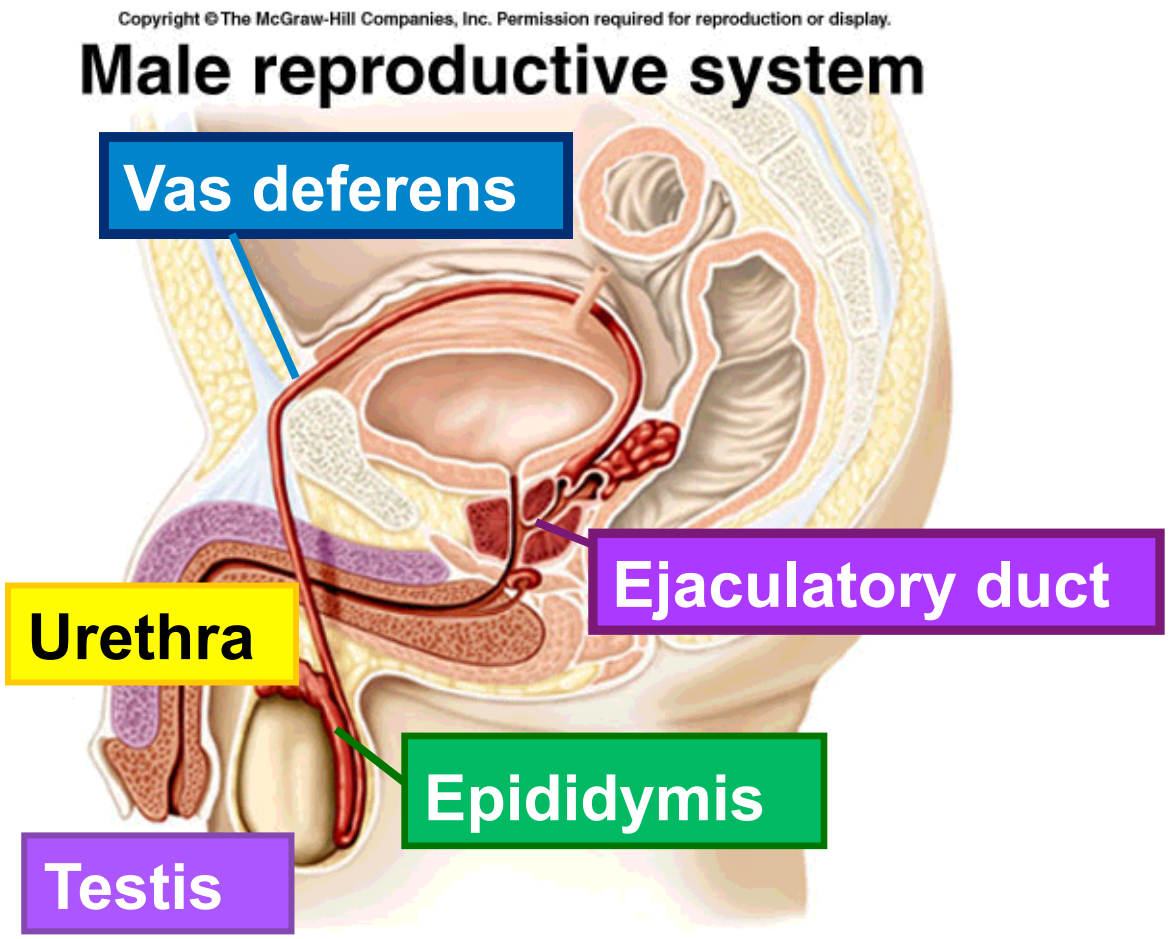
⇩

Urethra

⇩

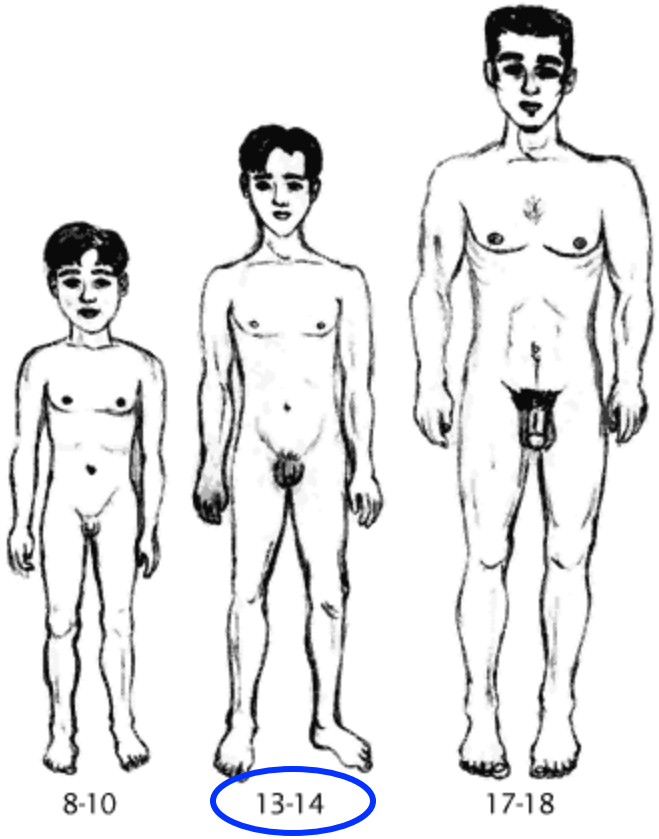
Penis

SEVEn UP



Puberty in boys

- Puberty is **when the reproductive system completes its development and becomes fully functional**
- Puberty begins when the **hypothalamus** begins releasing gonadotropin releasing hormone **(GnRH)**
- GnRH acts on the **anterior pituitary** to produce **FSH** and **LH**



Hormonal Control

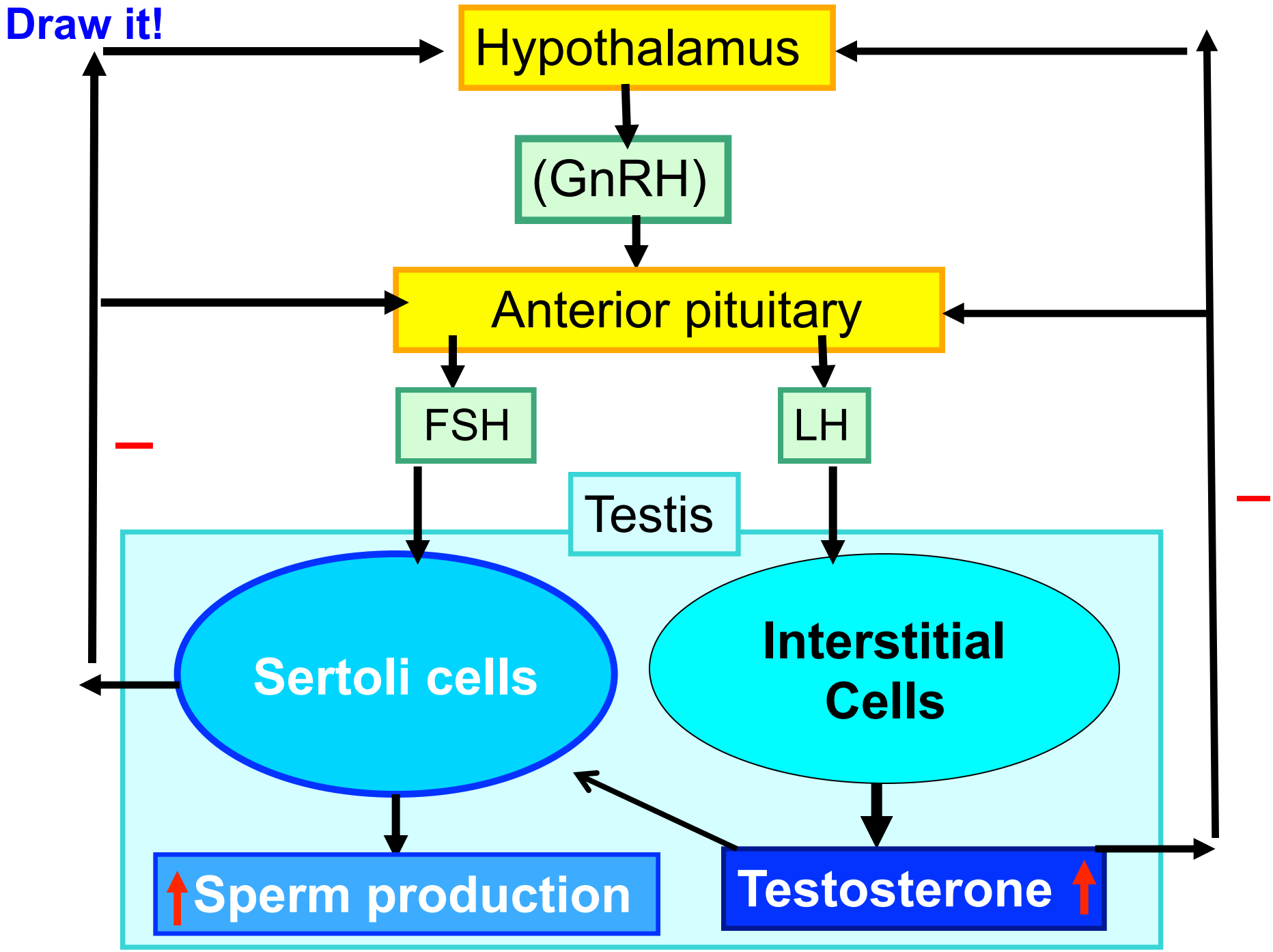
- **Testosterone**- stimulates: **spermatogenesis**

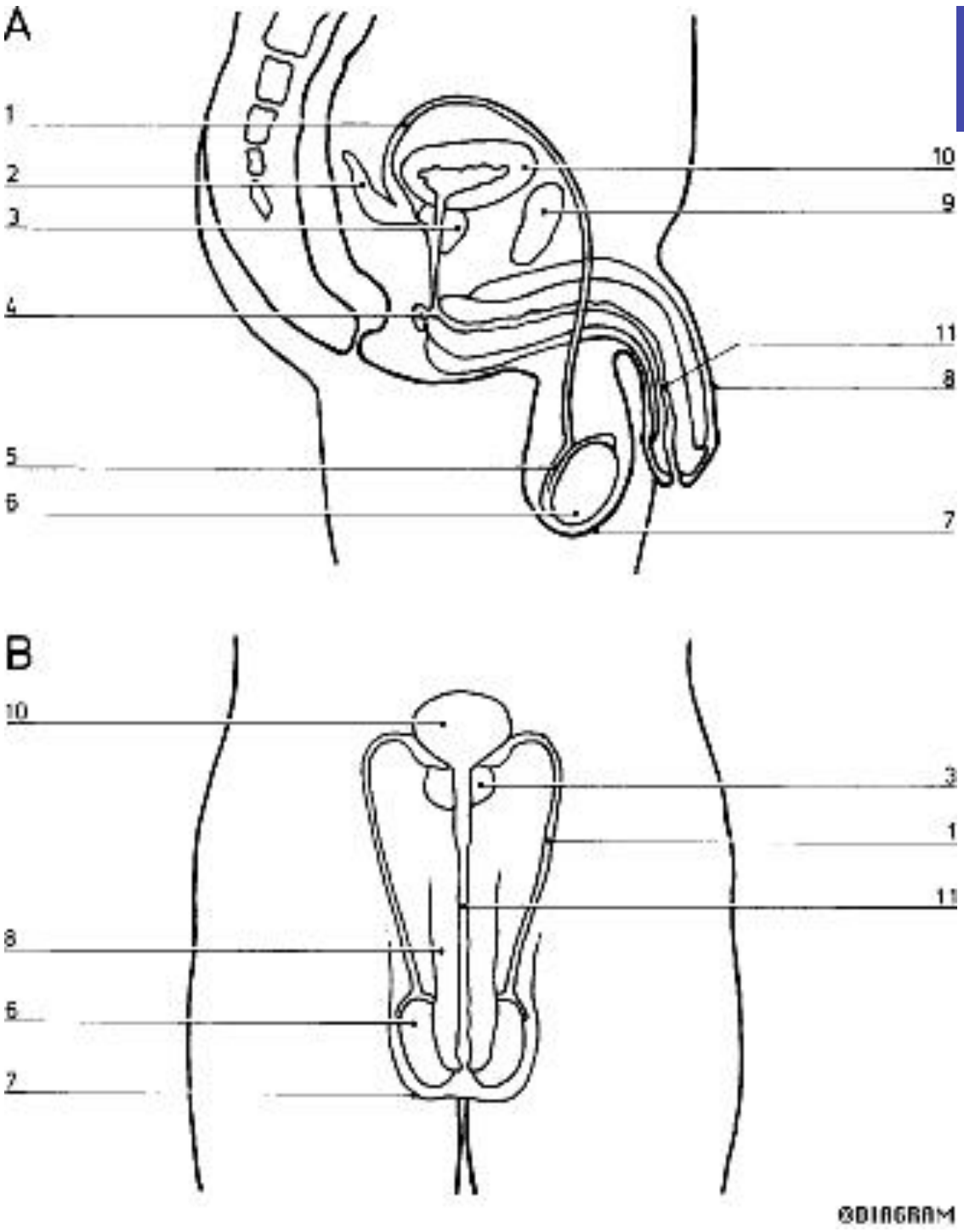
- **Primary characteristics (reproductive organs)**
- **Secondary characteristics (deepening of voice, facial and pubic hair, muscle growth)**

REMEMBER:

Follicle-stimulating hormone (FSH) stimulates production of sperm cells in seminiferous tubules

Luteinizing Hormone (LH) stimulates production of testosterone in interstitial cells


Draw it!
Hypothalamus
(GnRH)
Anterior pituitary
FSH
LH
Testis
Sertoli cells
Interstitial Cells
Sperm production
Testosterone



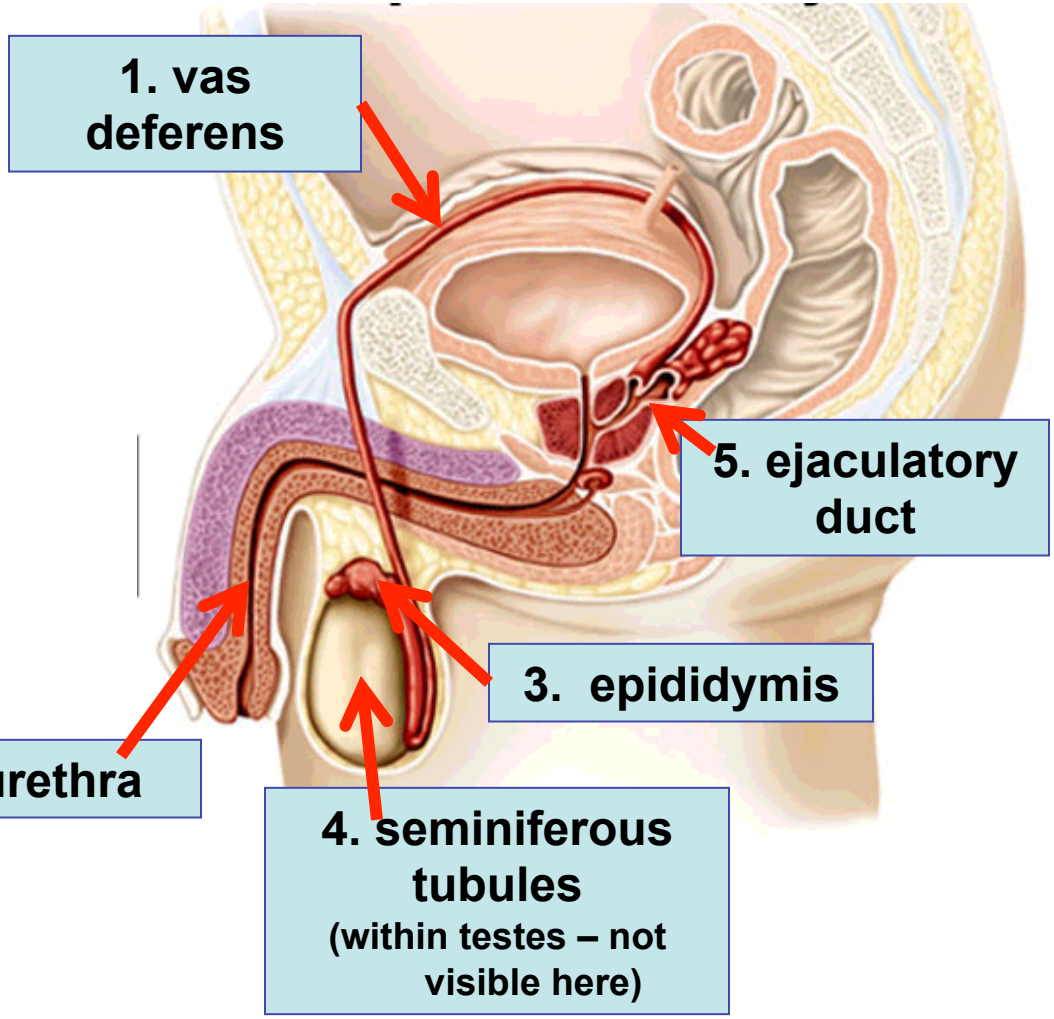
Test Yourself

1. Vas Deferens
2. Seminal Vesicles
3. Prostate gland
4. Cowper's gland
5. Epididymis
6. Testis
7. Scrotum
8. Penis
9. Pubic Bone
10. Bladder
11. Urethra

Male Reproductive System Mini-Review

1. Arrange the following structures in the order that sperm passes through them:

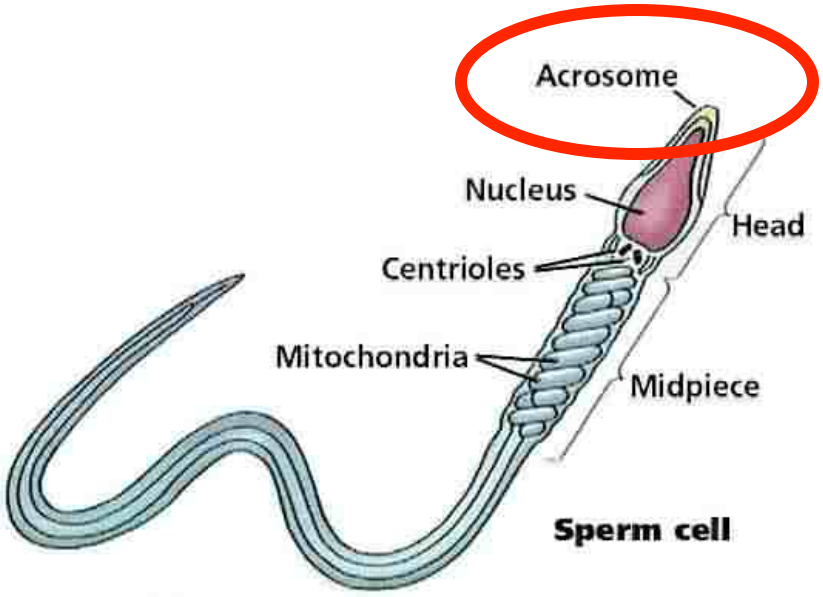
1. vas deferens
2. urethra
3. epididymis
4. seminiferous tubules
5. ejaculatory duct



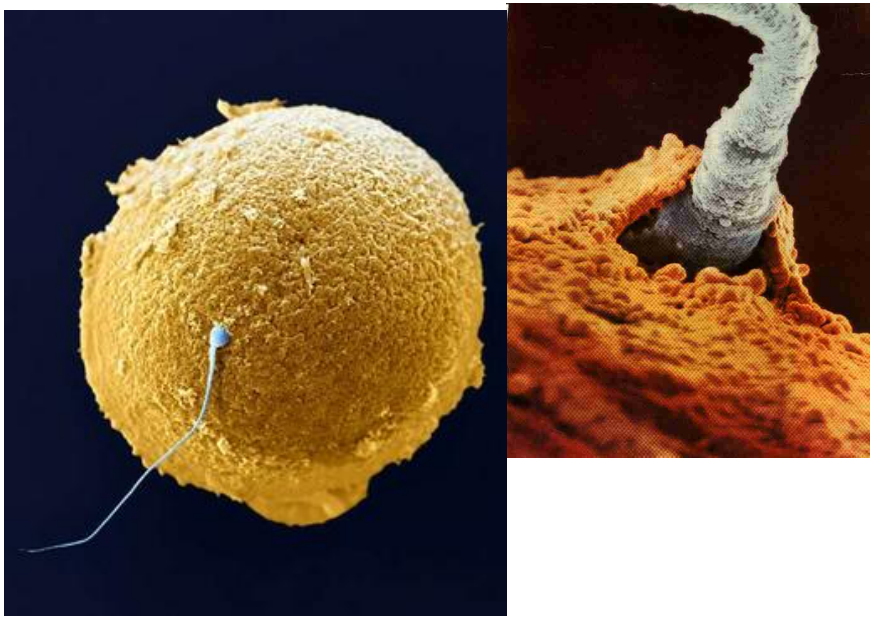
4, 3, 1, 5, 2

Male Reproductive System Mini-Review

2. What is the significance of the acrosome of the sperm?



A: The acrosome contains enzymes needed to help the sperm penetrate through the protective layer surrounding a female egg



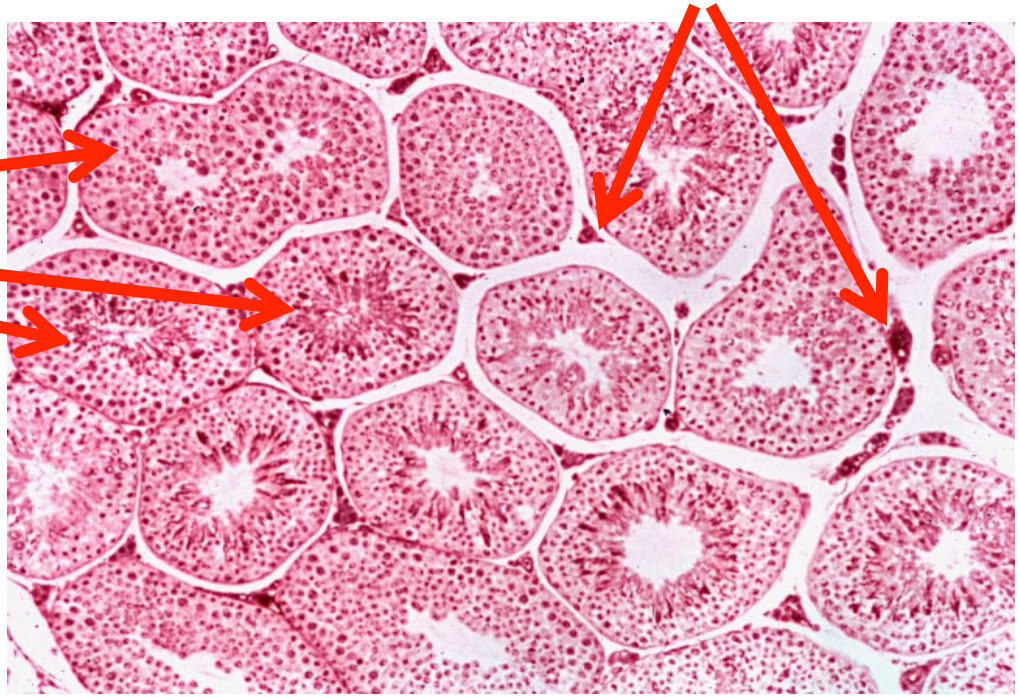
Bozeman: Repro system
0:00 – 3:08

http://www.youtube.com/watch?v=QSN5gfbzgwc

Male Reproductive System
Mini-Review

3. What is the difference between interstitial cells and Sertoli cells?

Interstitial cells:
- **Located between seminiferous tubules**
- **Secrete testosterone**



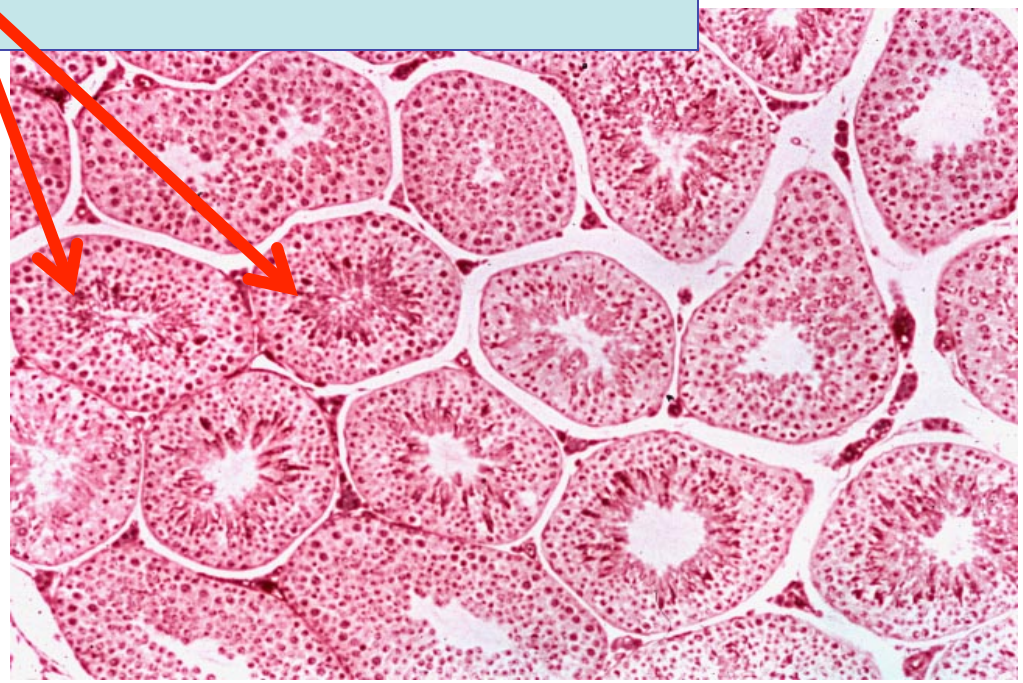
Sertoli cells:
- **Located inside seminiferous tubules**
- **Nourish and support developing sperm**
- **Responsible for spermatogenesis**
- **Release Inhibin (inhibits secretion of FSH)**

Male Reproductive System Mini-Review

4. Where are sperm made?

Seminiferous Tubules

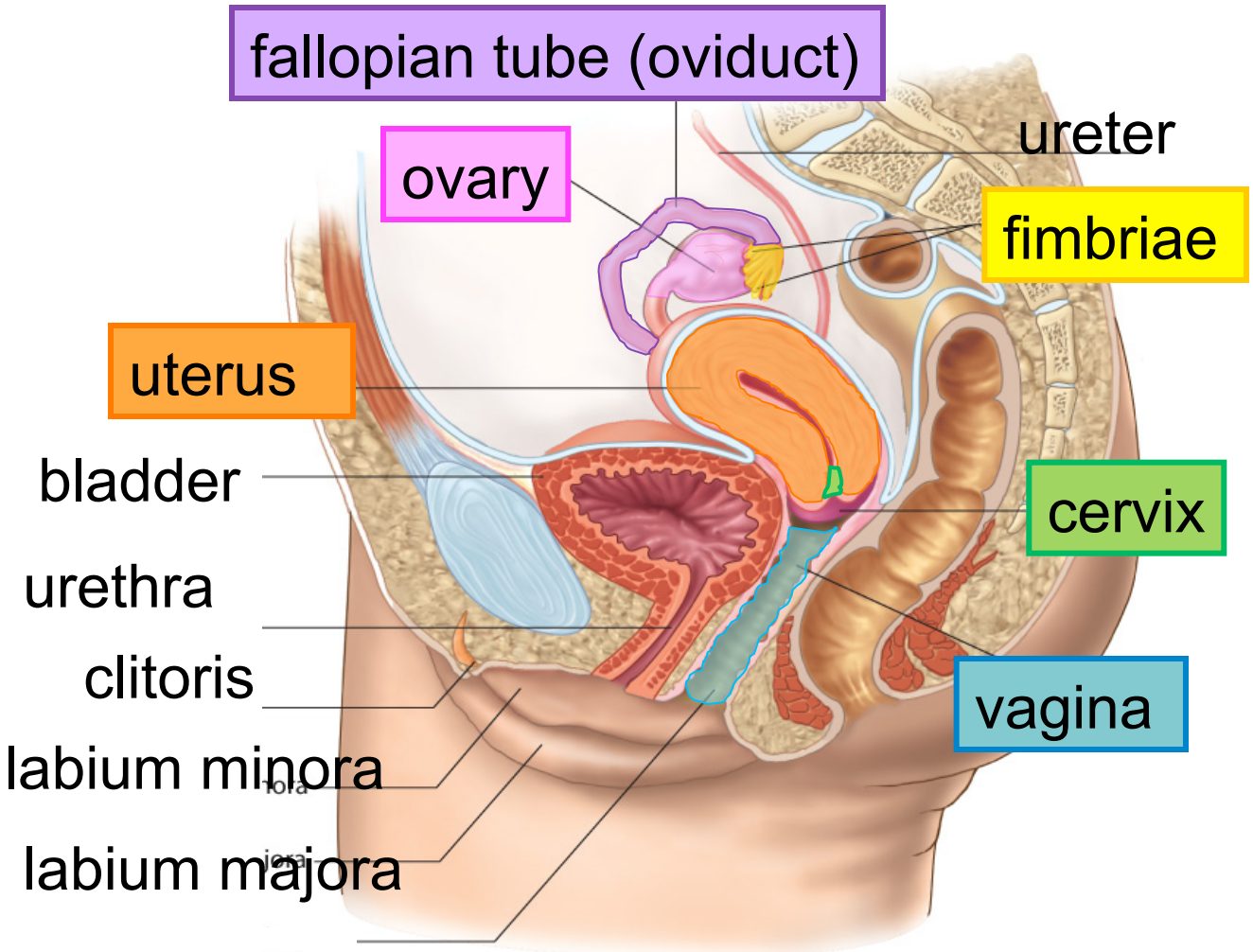
- **Follicle cells(immature sperm cells) are stimulated by the sertoli cells to undergo meiosis.**



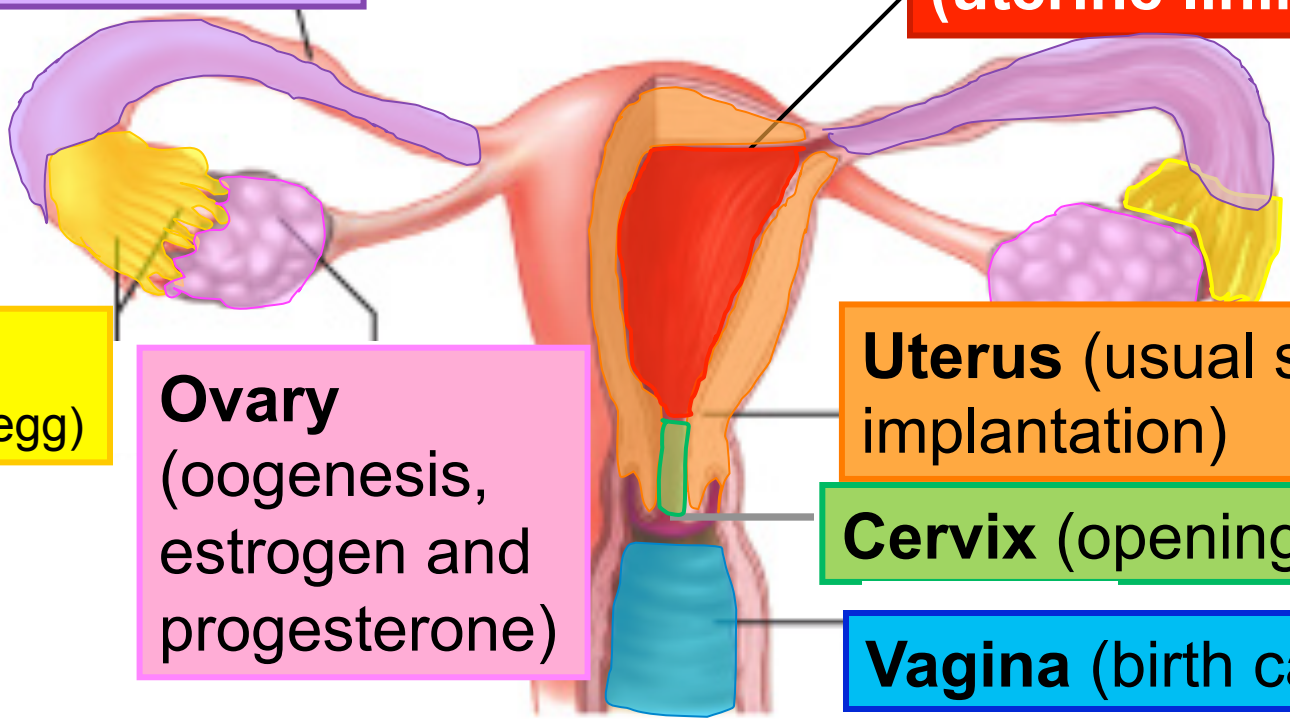
Check your Understanding…

1. What is the order of structures that semen goes through upon ejaculation?
   Semineferous tubules / testes / epididymis / vas deferns / ejaulatory duct / urethra
2. What is semen composed of?
   Sperm + seminal fluids (fructose, alkaline buffers, prostaglandins)
3. What is the difference between the epididymis and vas deferens? Epididymis matures sperm(on testes) while vas deferens is tube leading out of testes
4. What is the difference between interstitial cells and sertoli cells? Interstitial cells are IN BETWEEN seminiferous tubules and prod. testosterone while sertoli cells nourish and develop sperm
5. Describe what seminiferous tubules do. Produce sperm
6. What tube would be the easiest to sever in order to prevent sperm from leaving the testes and thus preventing pregnancy?
   Vas deferens
7. How would #6 affect testosterone in the body? No effect as is released into the blood

Label the following diagram



Label the following diagram



fallopian tube (usual site of fertilization)

Endometrium (uterine lining)

Fimbriae (catches the egg)

Ovary (oogenesis, estrogen and progesterone)

Uterus (usual site of implantation)

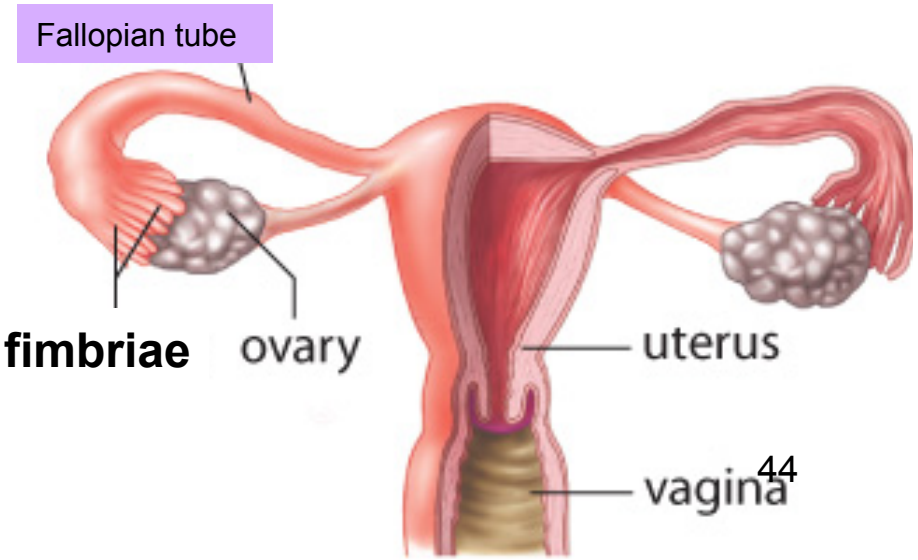
Cervix (opening of uterus)

Vagina (birth canal)

Ovaries – site of oogenesis

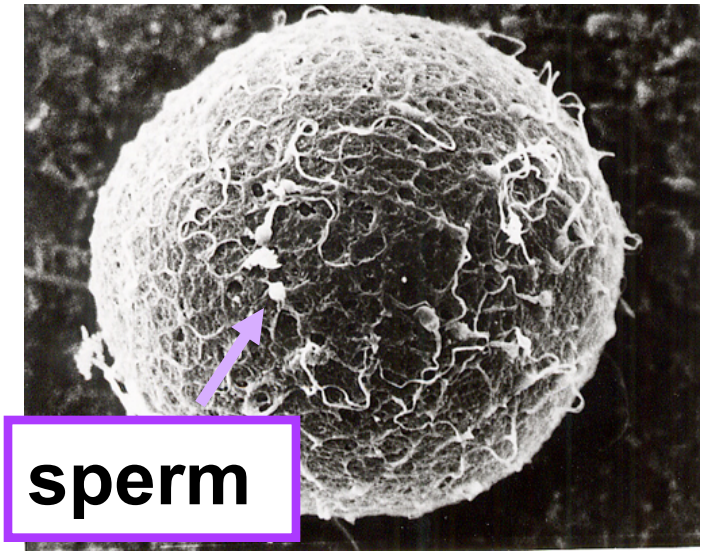
Females have 2 **ovaries**, which alternate each month to produce an **egg/ovum** **(oogenesis).**

1. **Ova** are produced from immature f**ollicle**s in ovary
2. One ova is released per month = **ovulation**
3. The ova is released into the abdominal cavity and is swept into the oviduct(fallopian tube) by **Fimbriae**
4. Cilia in the oviduct move the ovum toward the uterus
5. Sperm swim up past the **cervix**, through the uterus and usually meet up with ovum in the oviduct



Ovum (egg)

The egg is **larger** than sperm because the cytoplasm in the egg has to provide enough nutrients for **5** days if the egg is fertilized.



The ovum lives for **24 hours** after ovulation.

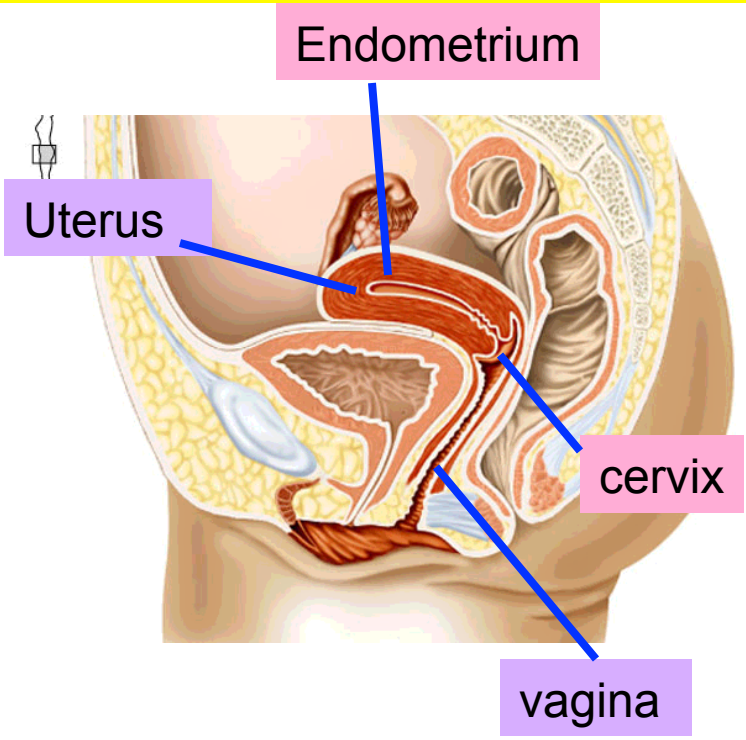
Uterus

Uterus – site of **embryo development**, two layers:

- **endometrium – nourishes** embryo; shed during menstruation; blood vessel rich
- **Myometrium – muscular layer**

Cervix – muscular opening to uterus

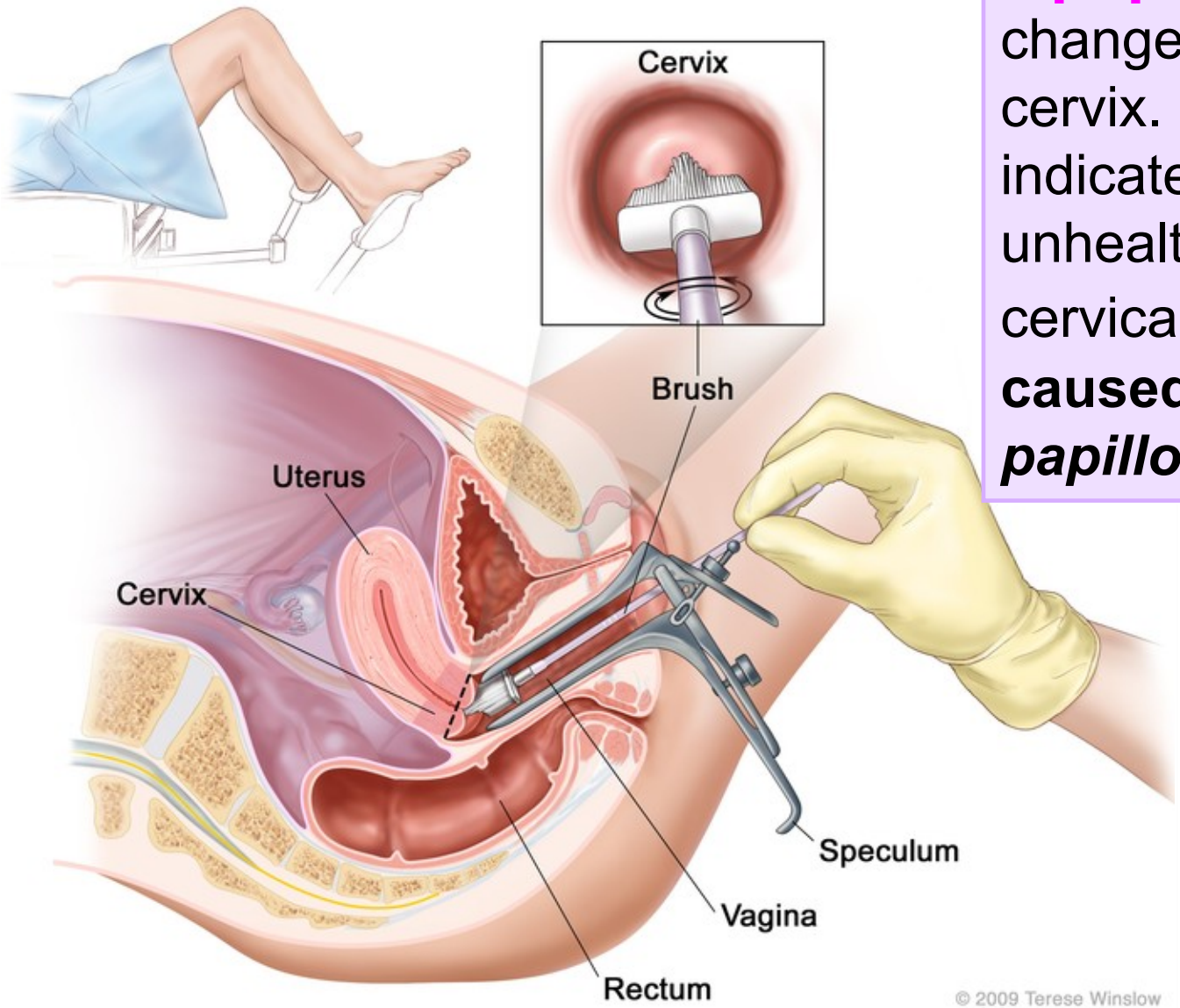
- cells constantly shed and replaced

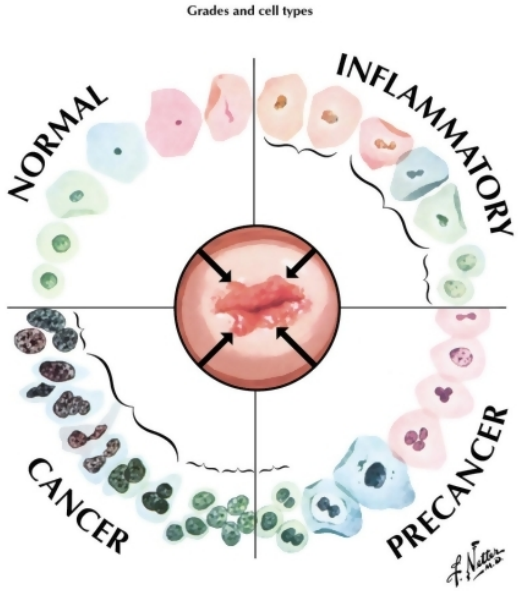


Pap Smear

Cervical cancer is the 3rd leading cancer in Women

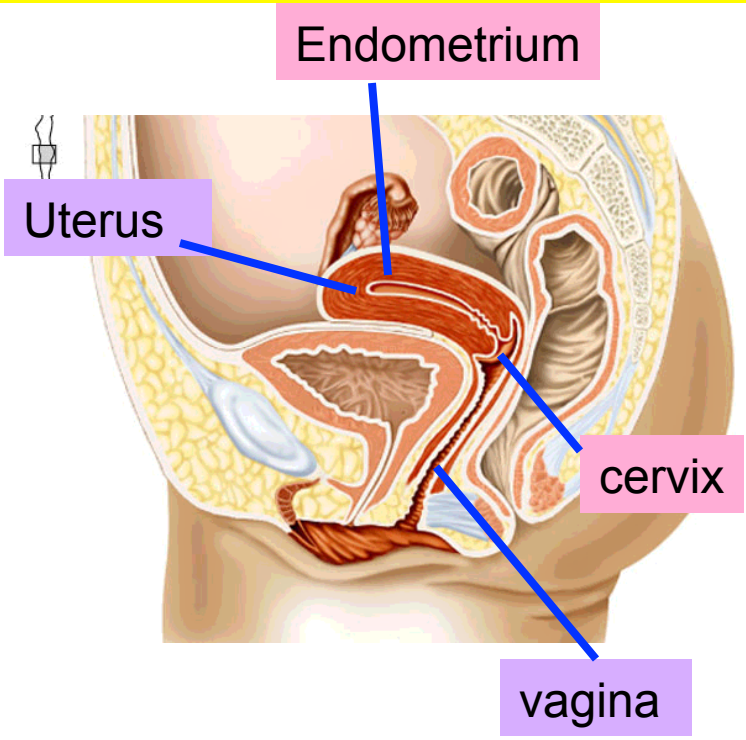
A **pap smear** checks for changes in the cells of the cervix. Changes may indicate infection, unhealthy cervical cells, or cervical **cancer** **(can be caused by *Human papillomavirus(HPV)***





Vagina

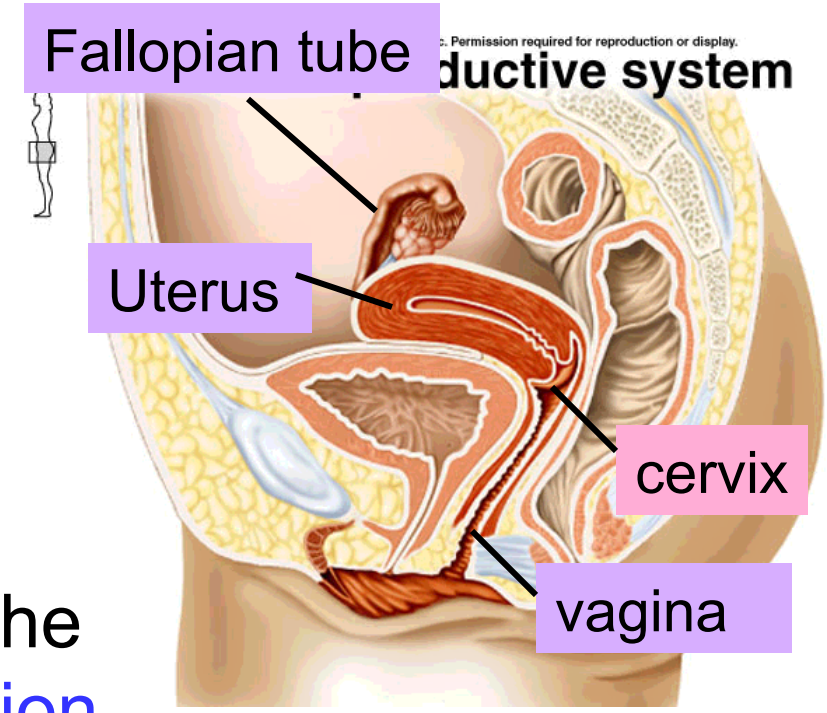
- **Vagina** – entrance for the penis as well as **birth canal**



Fertilization and Implantation

Pathway for sperm:

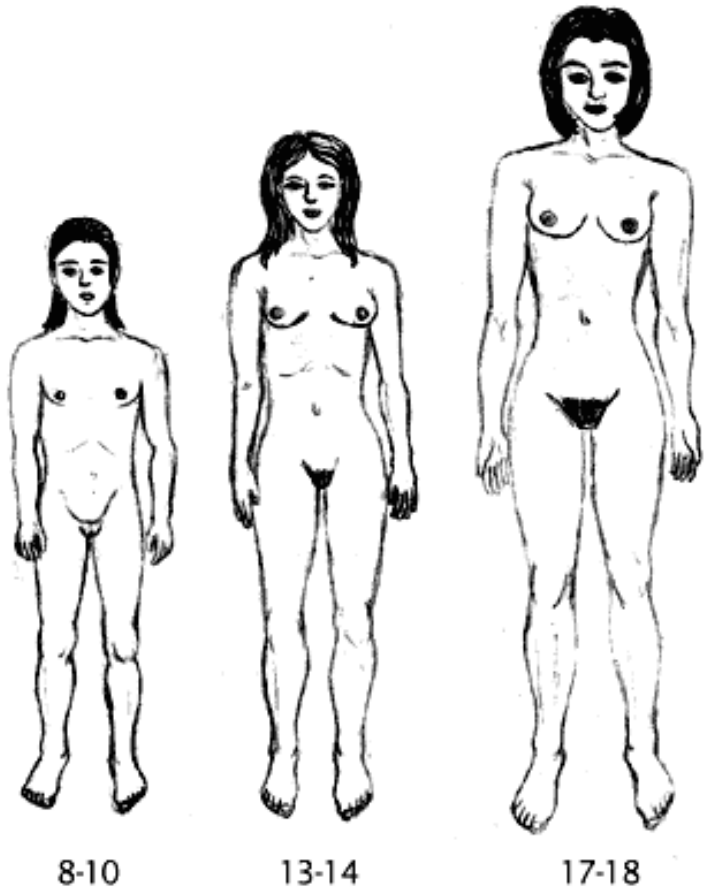
1. **vagina**
2. **cervix**
3. **uterus**
4. **Fallopian tube**



Fertilization usually occurs in the **fallopian tubes** and implantation occurs in the **uterus.**

Puberty in Girls

- At puberty, the hypothalamus releases gonadotropin releasing hormone (GnRH)
- **GnRH** activates the **anterior pituitary** to release **FSH** and **LH**
- FSH secretions are carried by the blood to the **ovary** where follicle development is stimulated.



The follicles within the ovary secrete **estrogen** into the blood which stimulates the development of the secondary female characteristics: **breasts, hair, wider hips.**

Female Reproductive Goals

1. Develop follicle (egg)
2. Develop Endometrium
3. Ovulate
4. Fertilize and Implant
5. Maintain Corpus Luteum and Endometrium
   - (or shed to reset for next month)

- This is all accomplished via **hormonal control!!!!!!!!**

Oogenesis… the formation of an ova

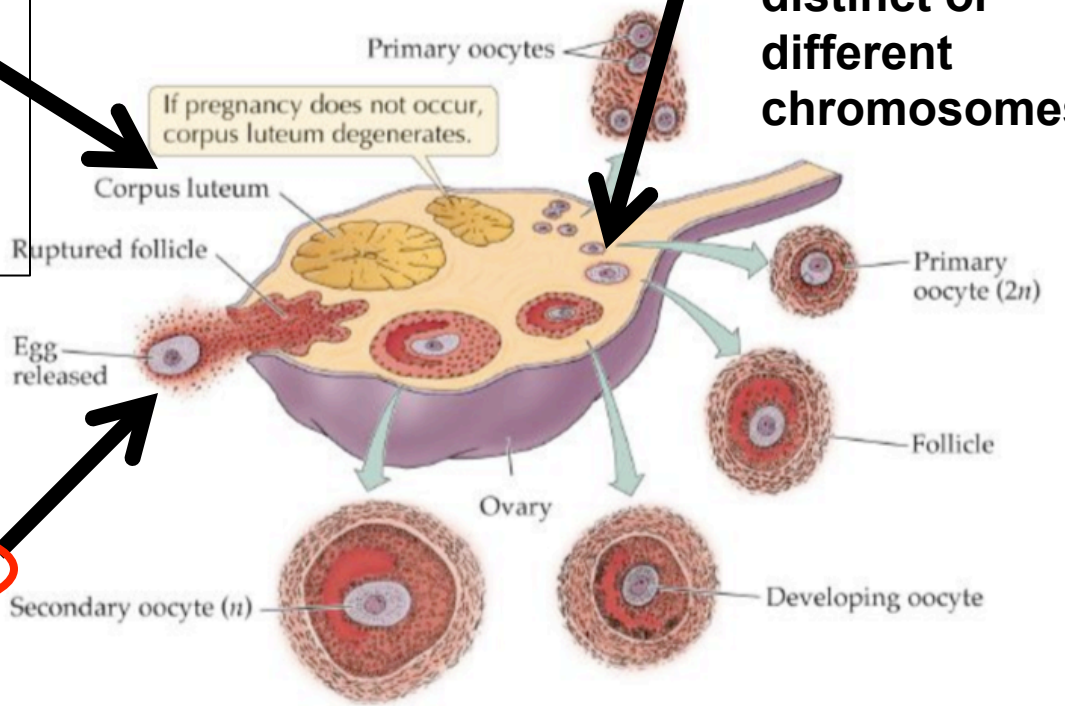
F	**FSH**
E	**Estrogen from follicles**
L	**LH**
P	**Progesterone & estrogen**

1. -**FSH** from the pituitary stimulates the maturation of ova from immature **follicles** which are **2n** = 46 chromosomes.

-**Follicles produce estrogen**

n = number of distinct or different chromosomes

3. **LH** from the pituitary stimulates formation of the **Corpus Luteum** which secretes **PROGESTERONE & estrogen.**



2.

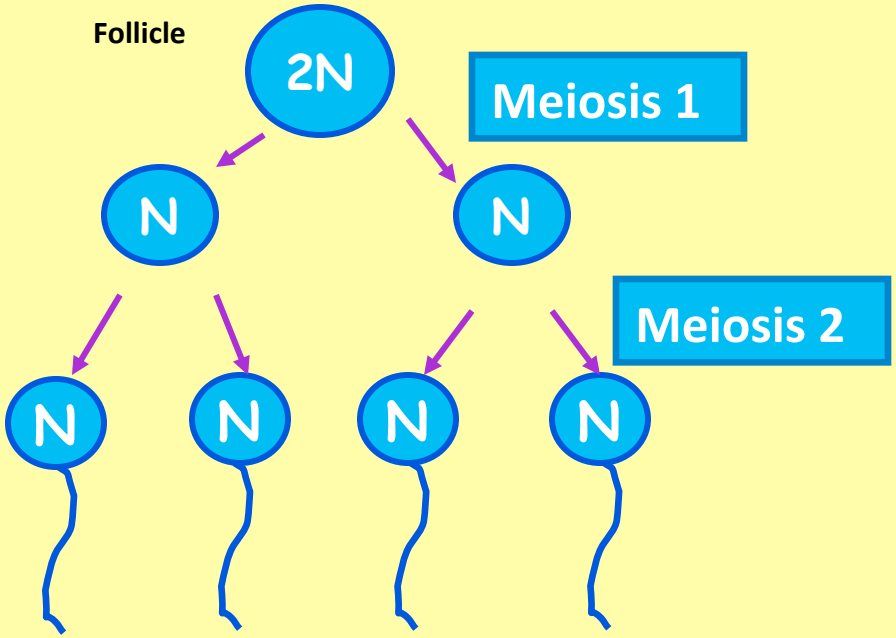
Mature ovum are released day 14 (ovulation) and are **"n"** = 23 chromosomes.

-release occurs because of **LH**

Meiosis in Males and Females

Males - Spermatogenesis

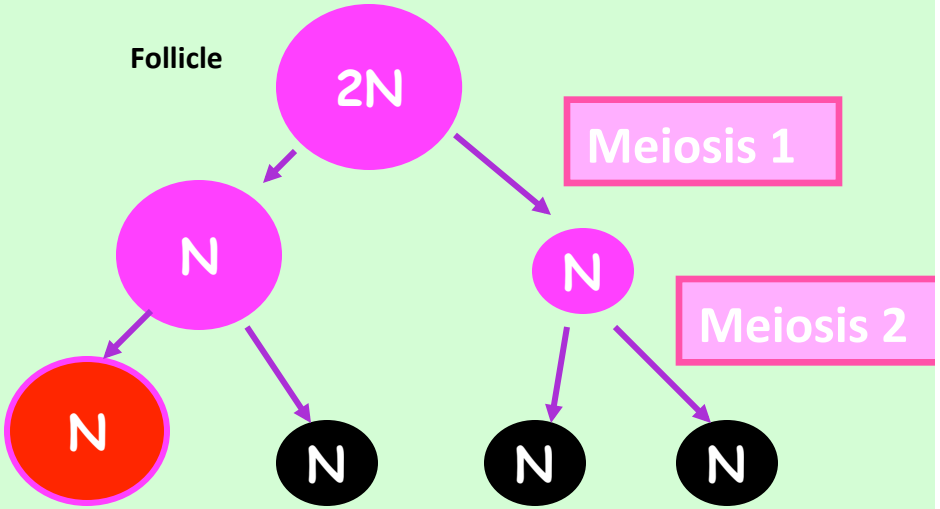
Location : **testes**



4 equal sperm

Females - Oogenesis

ovaries and fallopian tube



1 egg and 3 polar bodies

Egg (ovum) gets most of the cytoplasm. Polar bodies die and are absorbed by body.

Hormones of the Menstrual Cycle

Gonadotropins (Gn) are FSH and LH

GnRH: -causes FSH/LH release

-inhibited (halted) if estrogen and progesterone levels are high

FSH: promotes follicle growth

LH: promotes ovulation & corpus luteum formation and maintenance

Hormones of the Menstrual Cycle

- Progesterone **- increased amount**

  - stimulates the endometrium (uterus lining) to prepare for for an embryo

  -inhibits menstruation by…

  inhibiting GnRH → inhibits FSH/LH→ inhibits follicle growth & ovulation

  -firms the cervix

- Estrogen – **increased amount**

- -thickening of endometrium

Decrease of E & P triggers menstruation

If E & P remain high
then body is likely pregnant

Hormones of the Menstrual Cycle

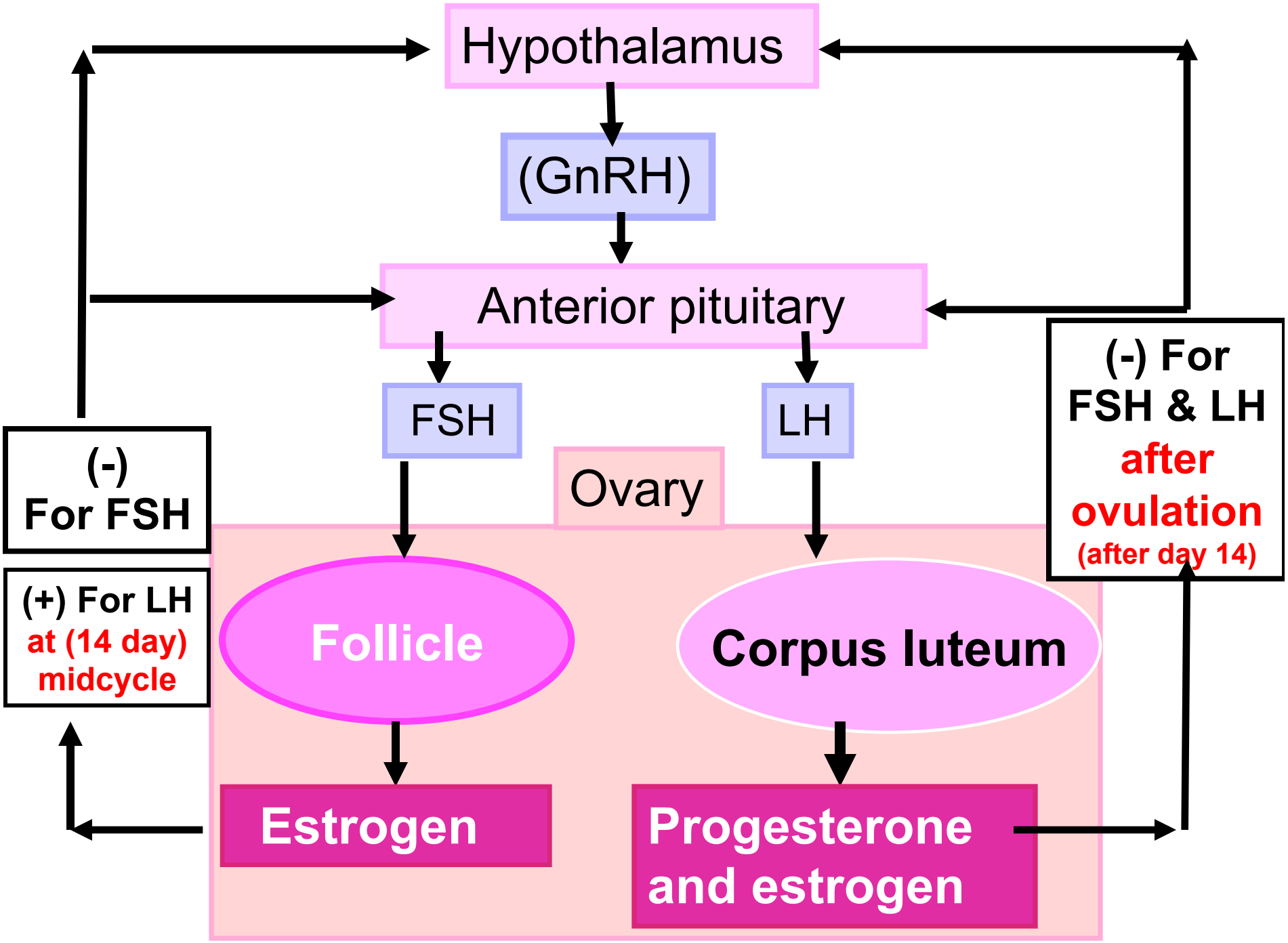
IF FERILIZATION OCCURS…

hCG - "human chorionic gonadotropin hormone" is secreted

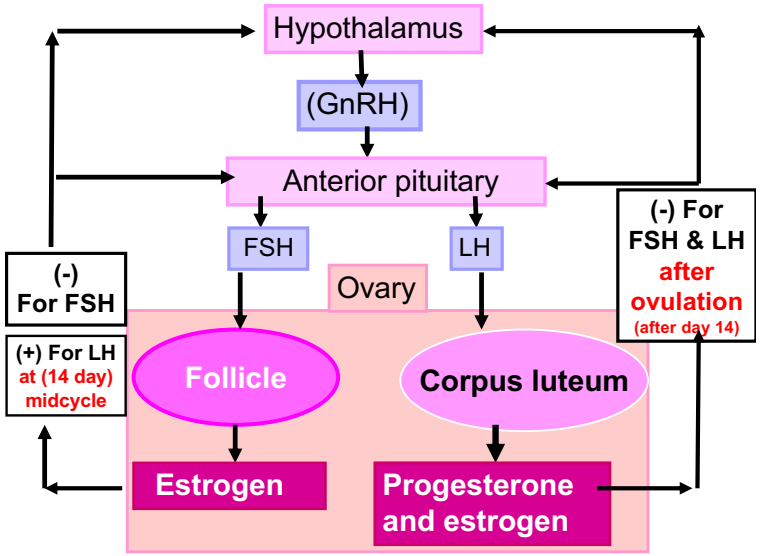
-produced by **<u>cells around the EMBRYO</u>**

-prevents corpus luteum breakdown so it can continue to produce progesterone until the placenta (organ that nourishes embryo) takes over

- **pregnancy test: checks hCG in urine**


Hypothalamus
(GnRH)
Anterior pituitary
FSH
LH
Ovary
(-)
For FSH
(+) For LH
at (14 day)
midcycle
(-) For
FSH & LH
after
ovulation
(after day 14)
Follicle
Corpus luteum
Estrogen
Progesterone
and estrogen

Menstrual Cycle Hormones



1) Where is FSH and LH produced? **Anterior Pituitary**

2) Where is the Follicle and Corpus Luteum located?
In ovary…Follicle appears first then C.L.

3) What stimulates the Corpus Luteum to be created?
FSH

4) Does LH stimulate the Corpus Luteum first or is the Follicle Stimulated first by FSH? **FSH stimulates follicle first**

5) Why does Estrogen increase after FSH is released? **Follicle secretes it the more it matures**

6) Why does LH eventually get released (what is the trigger)? **High Estrogen triggers LH To be released**

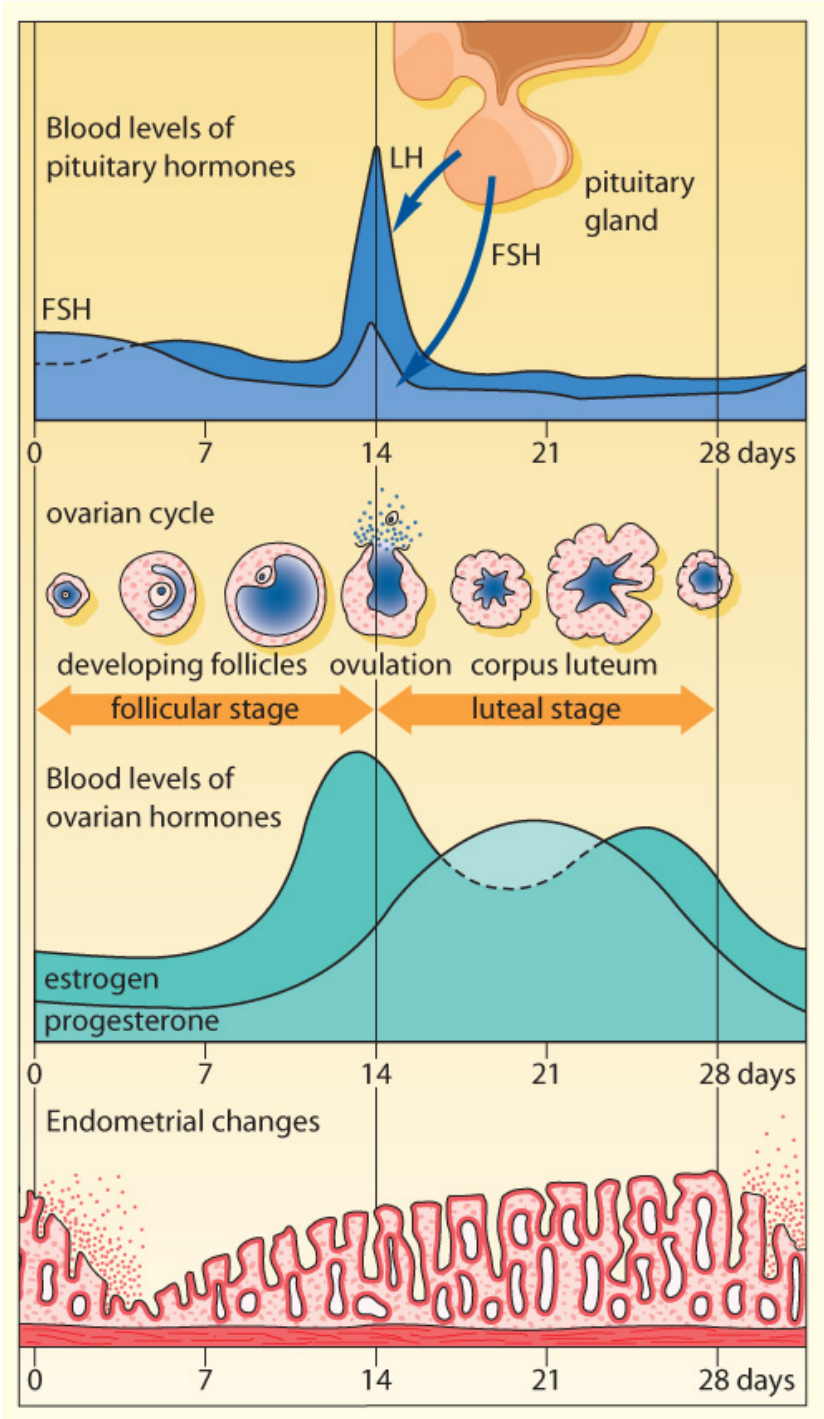
7) What prevents FSH from being continually released? **High estrogen from matue follicle then high estrogen from C.L.**

8) What prevents LH from being continually released? **High progesterone and estrogen from mature C.L.**

9) When and why does the corpus luteum become active? **After ovum is released and LH secreted (after day 14)**

THE MENSTRUAL CYCLE

Before we begin what's happening here…



Levels of FSH and LH throughout month

Follicle releasing egg and turning into corpus luteum

Levels of Estrogen & Progesterone throughout month

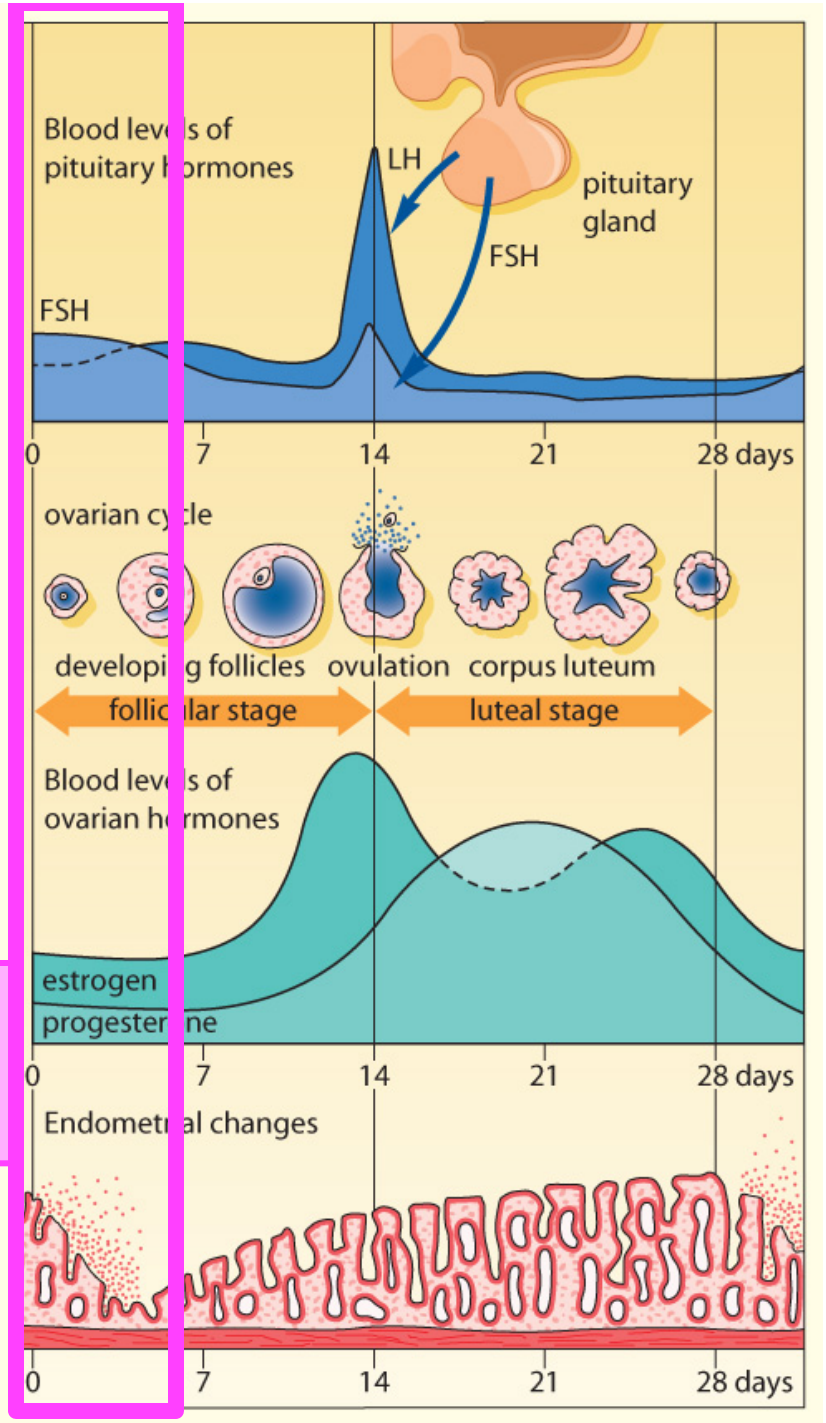
Thickness of endometrium throughout month

Menstrual Cycle: ~28 days

1. Flow phase (Day 1-5)

- endometrium is shed; follicle growth in ovary
- **Estrogen and progesterone levels are low**

Flow Phase



First moon party

https://www.youtube.com/watch?v=NEcZmT0fiNM

Menstrual Cycle: ~28 days

2. Follicular phase (Days 6-13):

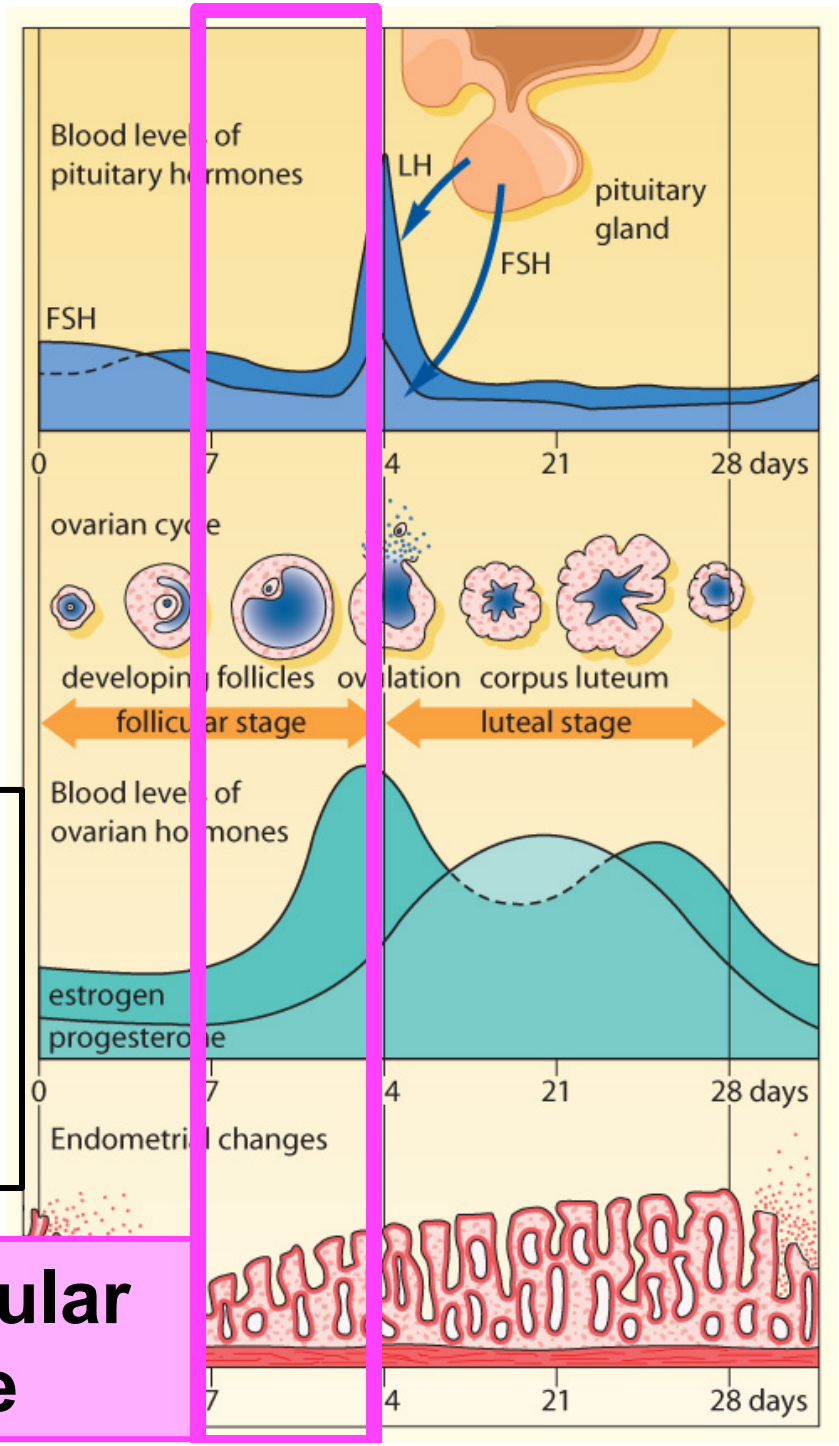
<u>follicles grow and mature</u>

→ secrete Estrogen

endometrium thickens

Stimulates GnRH → LH

(via <u>positive</u>-feedback from estrogen prod.)

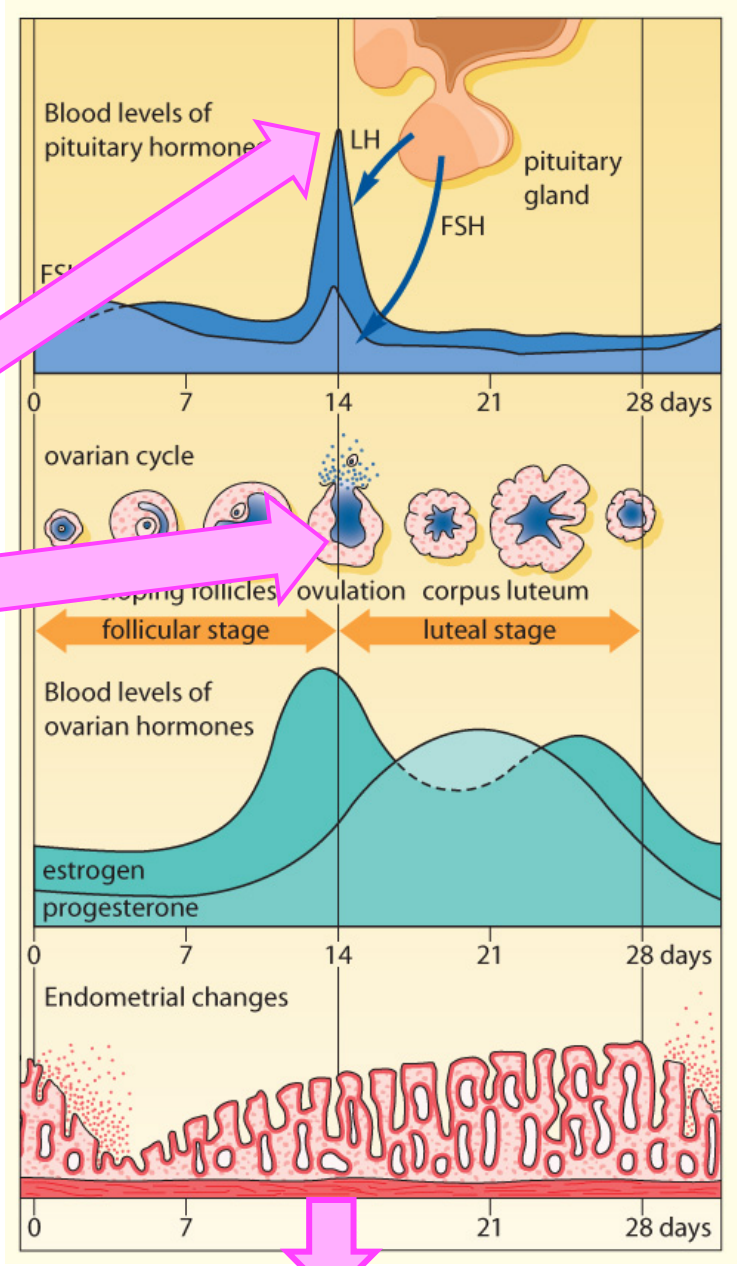


Follicular Phase

Menstrual Cycle: ~28 days

3. Ovulation (Day 14):

LH peaks causing ovum to burst from the follicle in the ovary into oviduct



Ovulation

Menstrual Cycle

4. Luteal Phase (Day 15-28)

LH causes corpus luteum to develop from follicle

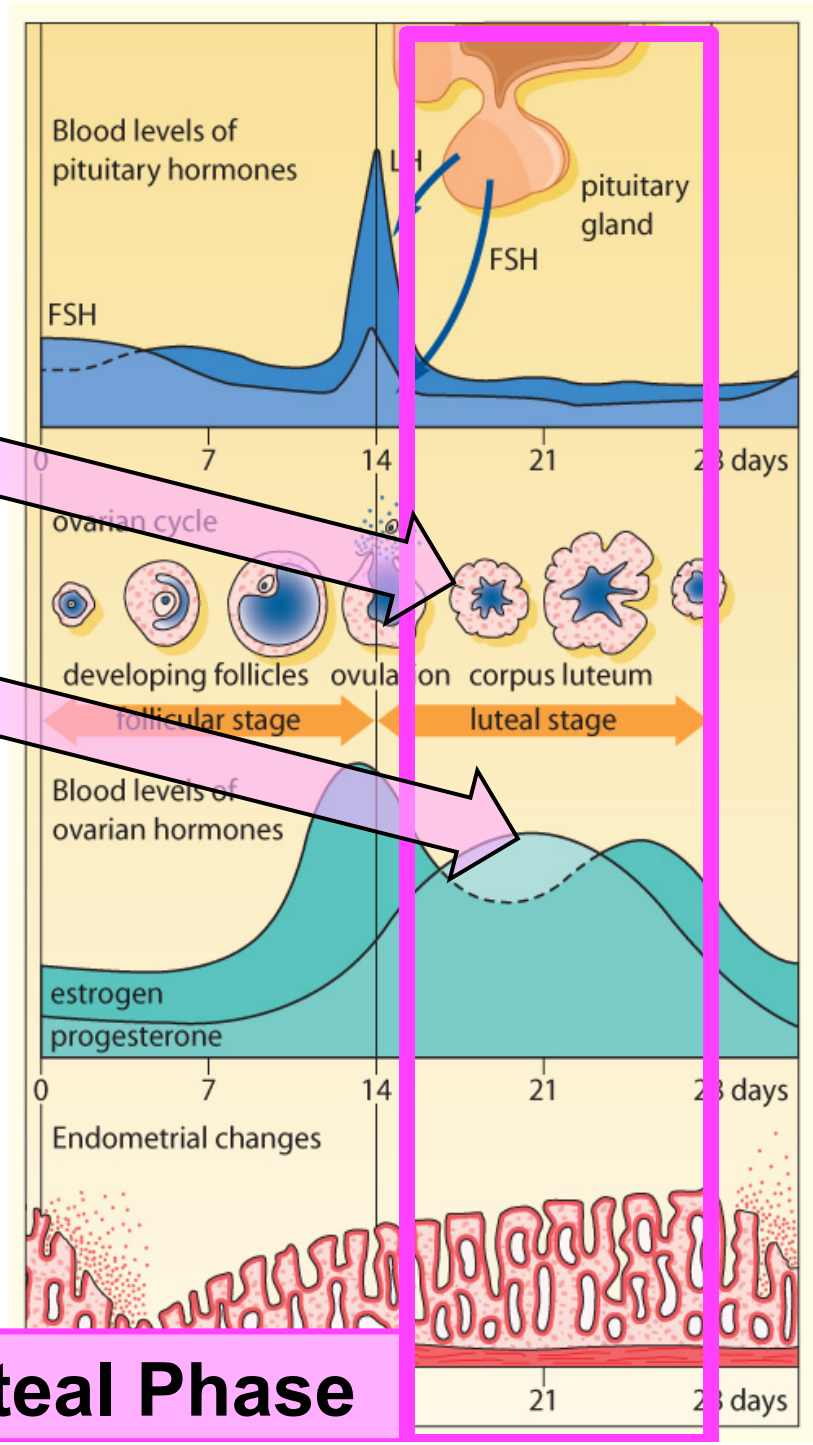
→ corpus luteum secretes

Progesterone & estrogen

Endometrium thickens and is maintained (progesterone prevents **contractions**)

Inhibits **GnRH →LH & FSH**

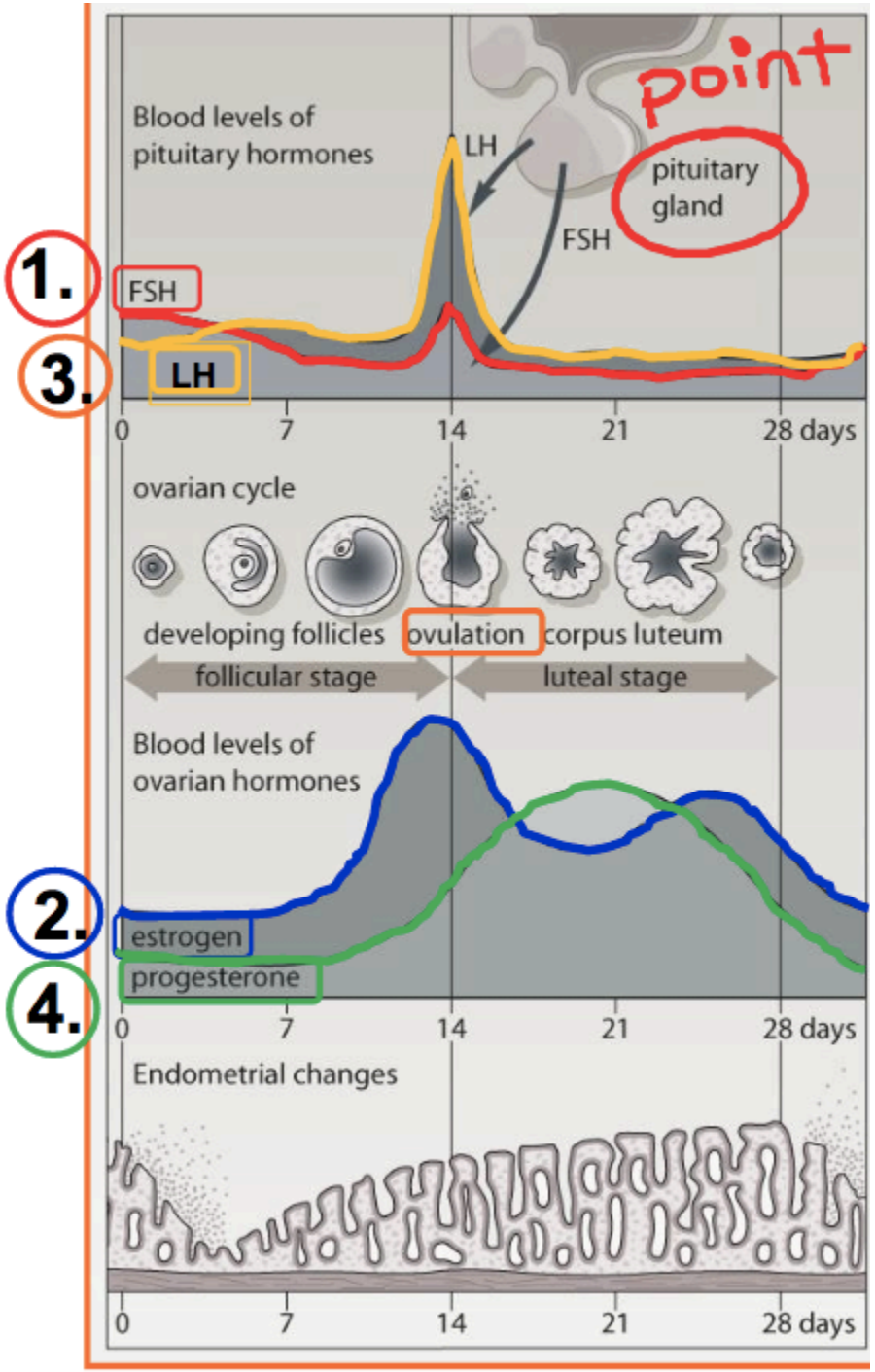
(via negative-feedback)



Menstrual Cycle: ~28 days

Label the hormones:

FELP



Bozeman: Repro system
3:08 – 6:50

http://www.youtube.com/watch?v=QSN5gfbzgwc

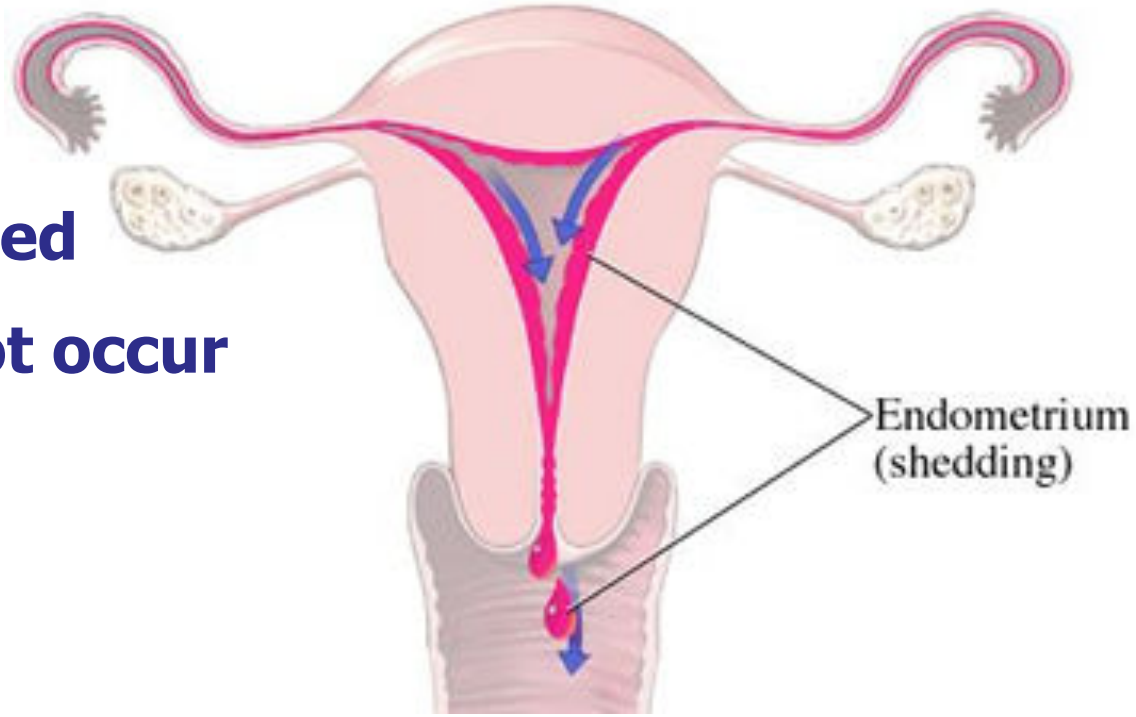
Menstrual Cycle

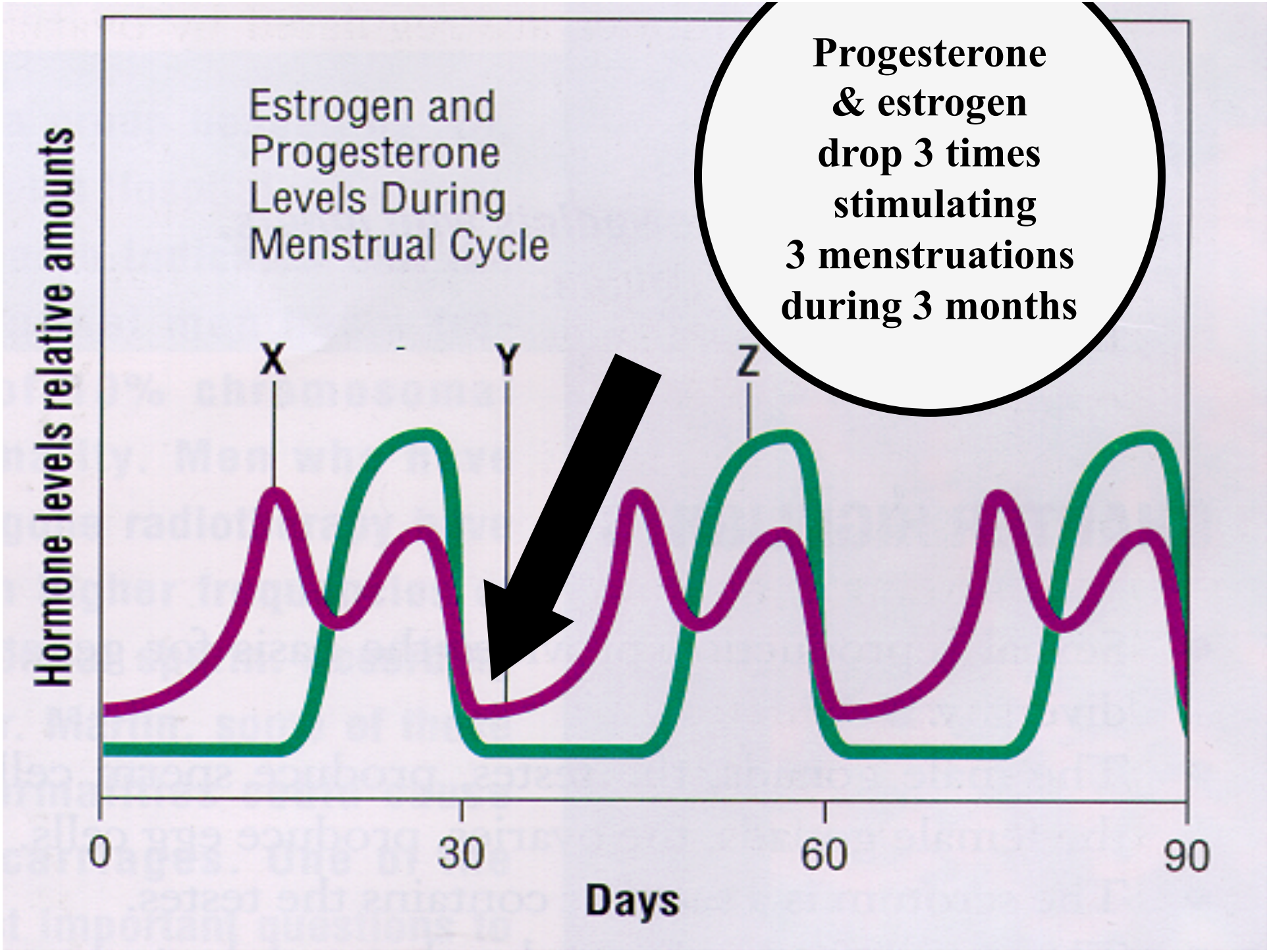
1. The loss of the endometrium (a monthly occurrence during the reproductive phase of a female's life) is termed menstruation and occurs over approximately 4-5 days.

2. The endometrium is shed on a monthly basis but the immediate reason is because of :

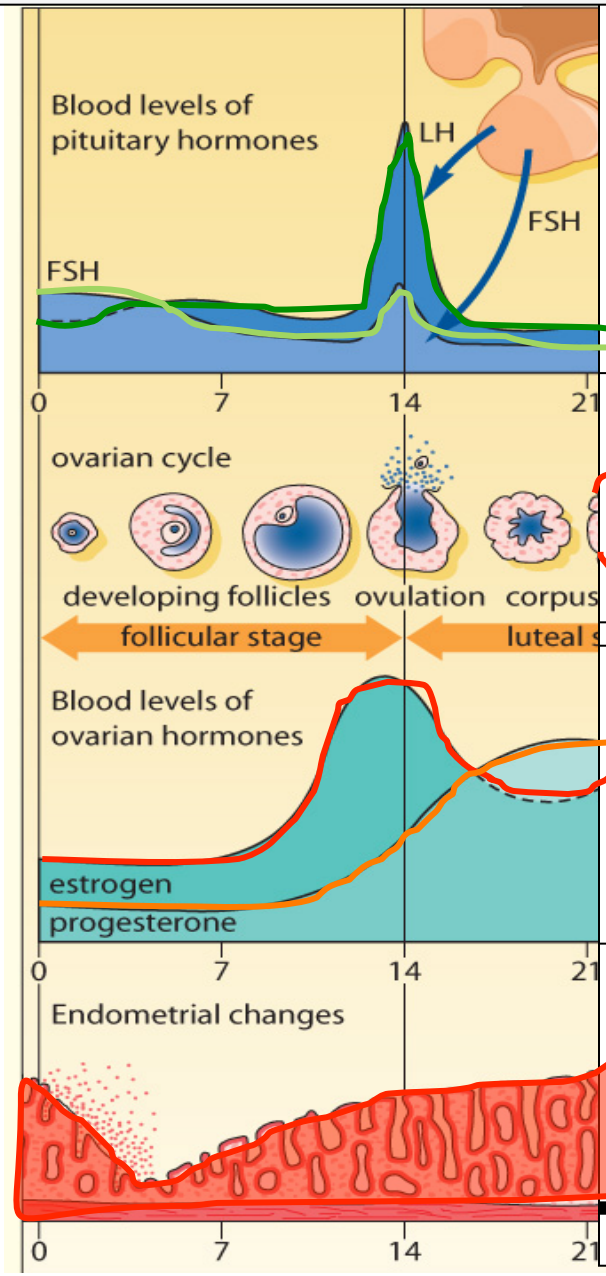
Low estrogen & progesterone.

3. If the egg is fertilized menstruation does not occur




Estrogen and
Progesterone
Levels During
Menstrual Cycle
Progesterone
& estrogen
drop 3 times
stimulating
3 menstruations
during 3 months
X
Y
Z
Hormone levels relative amounts
0
30
60
90
Days

But what if the egg gets fertilized?…
What will happen to the hormone levels?



1. Predict, with a sketch, what each diagram/graph should look like if a woman were to become pregnant at around day 21.

Day 45

For the first 3 months stimulated by hCG

Estrogen and Prog. cause growth of the endometrium

Progesterone prevents contractions

Endometrium forms part of placenta

QUESTIONS?

Where is the high estrogen amount produced from at day 14?

Estrogen is being produced by the stimulated follicle cells

Why does the amount of progesterone increase from about day 7 to 21?

The corpus luteum has begun to produce progesterone

Why do the amounts of FSH and LH decline and stay low after day 14?

The high amounts of progesterone and estrogen produce a inhibit the amount of FSH and LH released by pituitary.

Why does the "second spike" in estrogen amount occur?

The corpus luteum has begun to produce estrogen

When is the endometrium at its thickest? Why?
Between days 14 and 21 right when the egg is released….so the uterus is ready for a potential embryo implantation

MORE QUESTIONS:

Which phase is dominated by estrogen? follicular

Which phase is dominated by progesterone? luteal

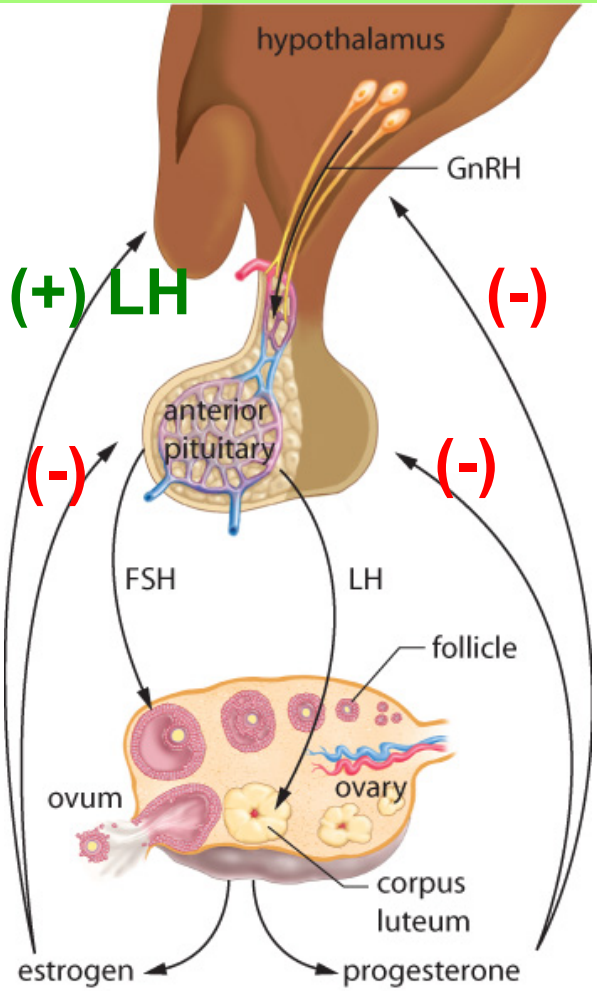
The sharp rise in temperature signals what event? ovulation

Menstrual Cycle Animations

1)
http://wps.prenhall.com/wps/media/objects/1115/1142409/36_1_7a_plain.html

2)
http://wps.prenhall.com/wps/media/objects/1115/1142409/36_2_1a_plain.html

Hormone Review



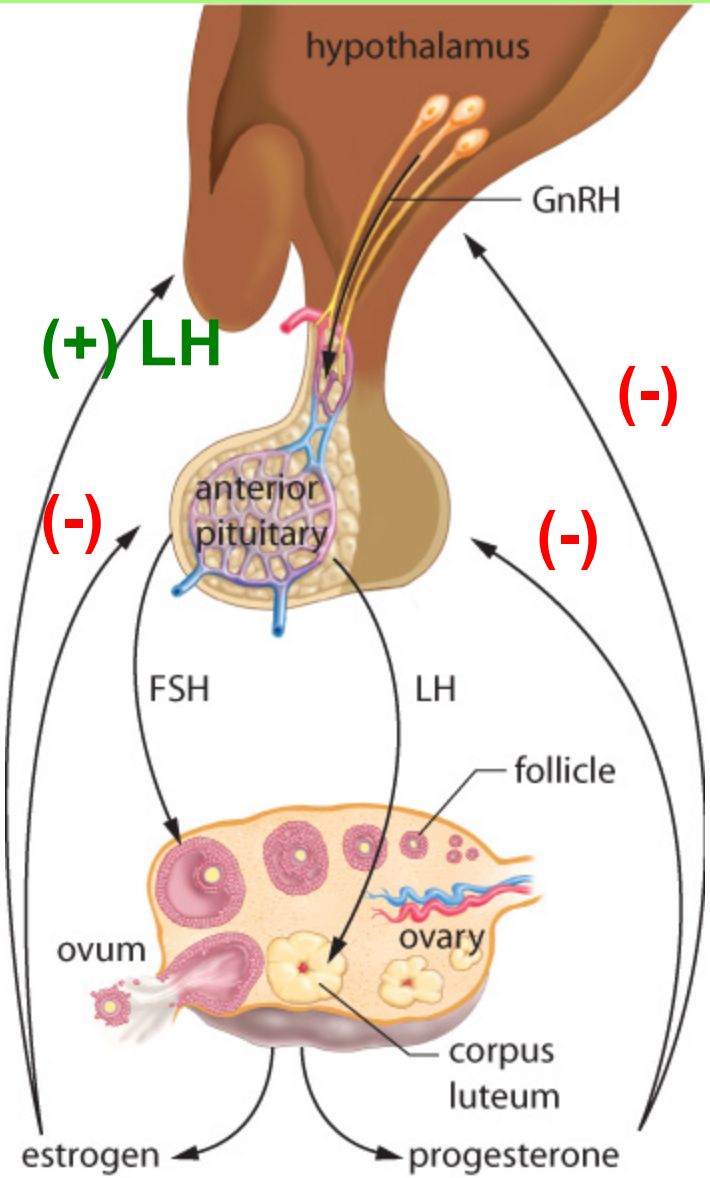
1. FSH

- **Target:** follicles in the ovary
- **Effect:** Ova and estrogen

2. Estrogen

- **Target:** -various cells
  -endometrium,
  -hypothalamus(feedback loop)
- **Effect:** development 2º sexual characteristics (breasts, larger hips);
- neg. feedback to decrease **FSH**;
- positive feedback to increase **LH** production;
- growth of **endometrium**

Hormone Review



3. LH

- **Target**: follicle (ovulation) corpus luteum
- **Effect**: ovulation & progesterone and estrogen production

4. Progesterone

- **Target**: -endometrium & -hypothalamus(feedback loop)
- **Effect:** thicken and maintain **endometrium** (inhibit contractions); negative feedback to **stop FSH and LH**

Hormone Review (chart format)

Hormones and Their Effect on Menstrual Cycle

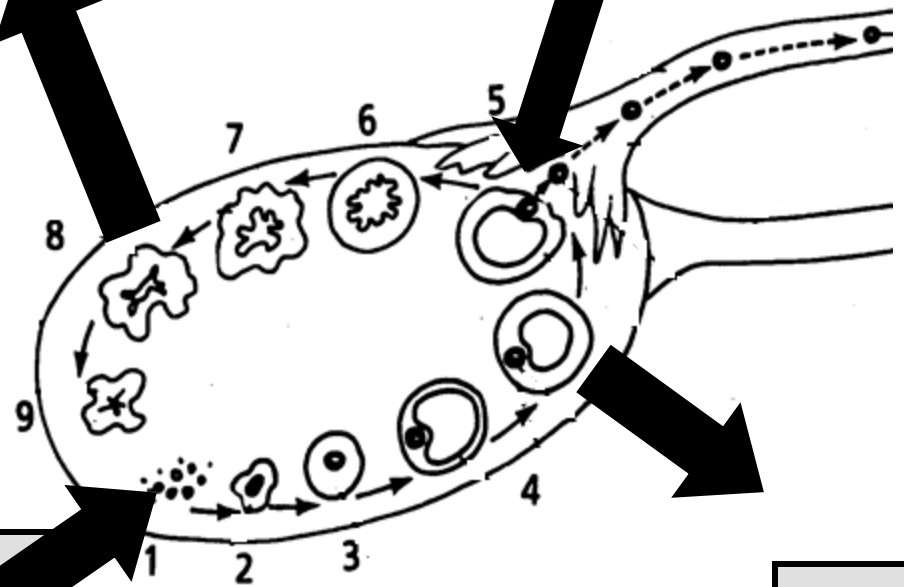
Hormone	Target	Effect
1. FSH	Follicles in Ovary	-Ova maturation -Estrogen production
2. Estrogen	-various body cells -endometrium	-2^0(secondary) sex characteristics
3. LH	-mature follicle -corpus luteum development	-release of ova(egg) -progesterone & estrogen production (made by corpus luteum)
4. Progesterone	-endometrium	-thickens and maintains endometrium -inhibit contractions -stops FSH and LH release (though negative feedback to hypo. and pit.)

Ovary hormone review

Which hormones are involved?

4 **Progesterone** & estrogen from corpus luteum

3 **LH** from pituitary stimulates ovulation



1 **FSH** from pituitary

2 **Estrogen** from follicle

Comparing LH and FSH in men and women

IN MEN:

FSH: stimulates **Sertoli cell**s to facilitate spermatogenesis

LH: stimulates the production of testosterone in **Interstitial cells** (cells between seminiferous tubules)

Sertoli Cell facilitating sperm production is influenced by **FSH and Testosterone**

REMEMBER:
-sperm are produced inside seminiferous tubules
-Sertoli Cells are **INSIDE** seminiferous tubules and between germ cells (immature sperm)
-Interstitial Cells are **BETWEEN** seminiferous tubules

IN WOMEN:

FSH: stimulates **a** follicle in ovary to mature an egg into a viable, mature egg, which will soon be released
(women have about 400,000 follicles that could potentially produce an egg)

LH: stimulates the release of an egg about day 14
-develops corpus luteum

REMEMBER…
-Follicles produce **estrogen**
-The Corpus Luteum, which is formed from the follicle that released the egg, starts to **produce progesterone and some estrogen** for the first 3 months if the egg is fertilized
-progesterone and estrogen prevent menstruation during pregnancy
-if P and E levels go down, menstruation occurs

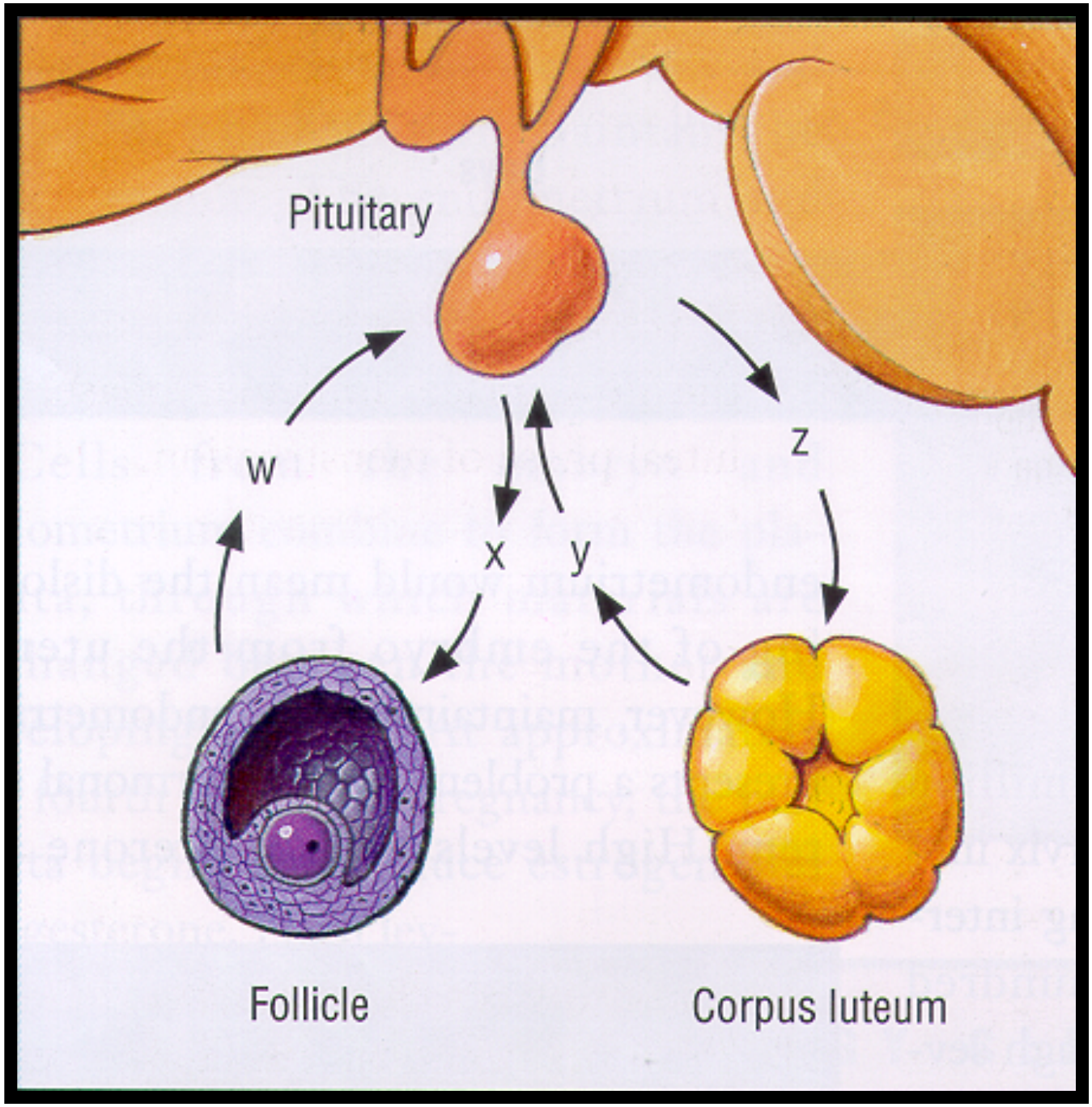
Hormones Controlling Menstruation

X = FSH

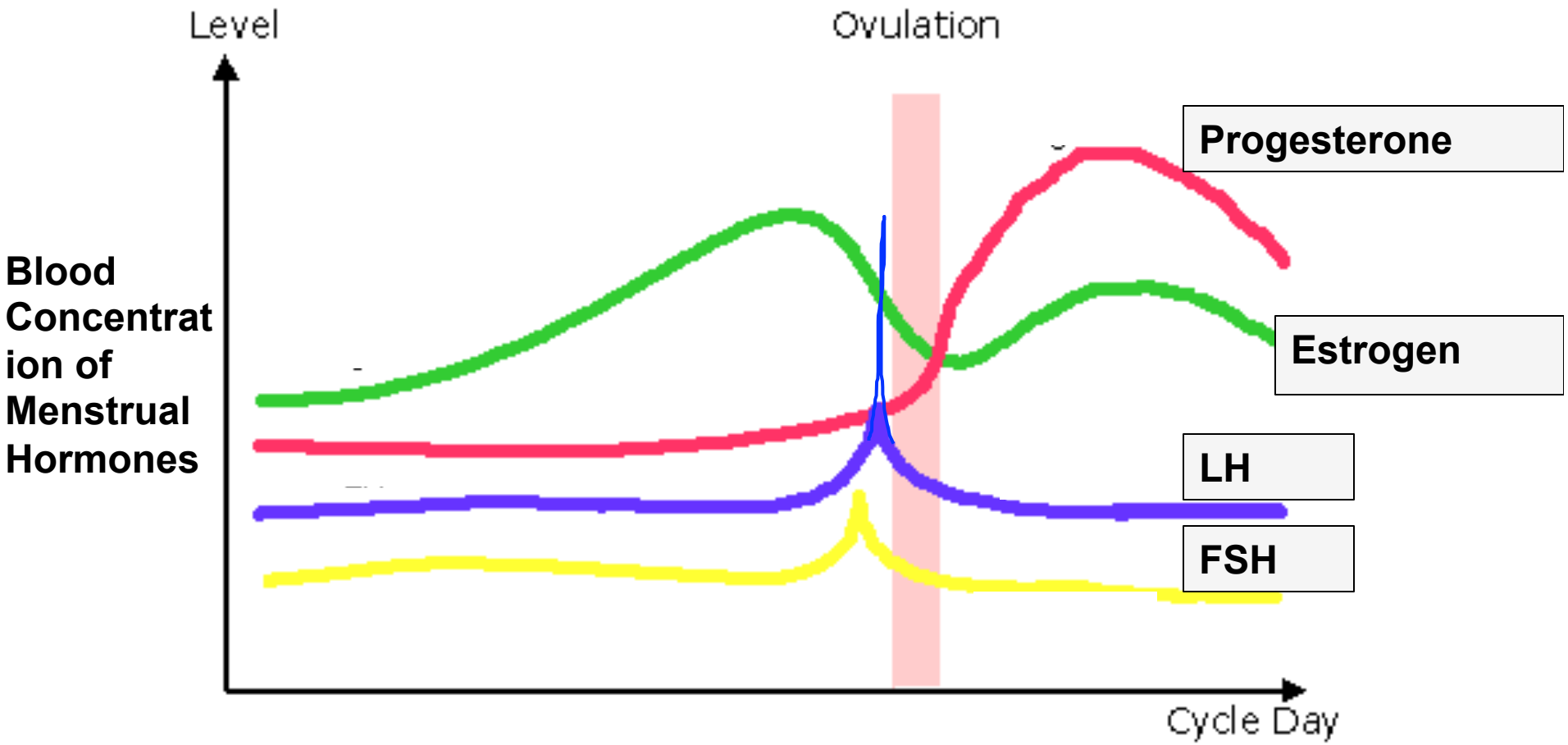
W = Estrogen

Z = LH

Y = Progesterone

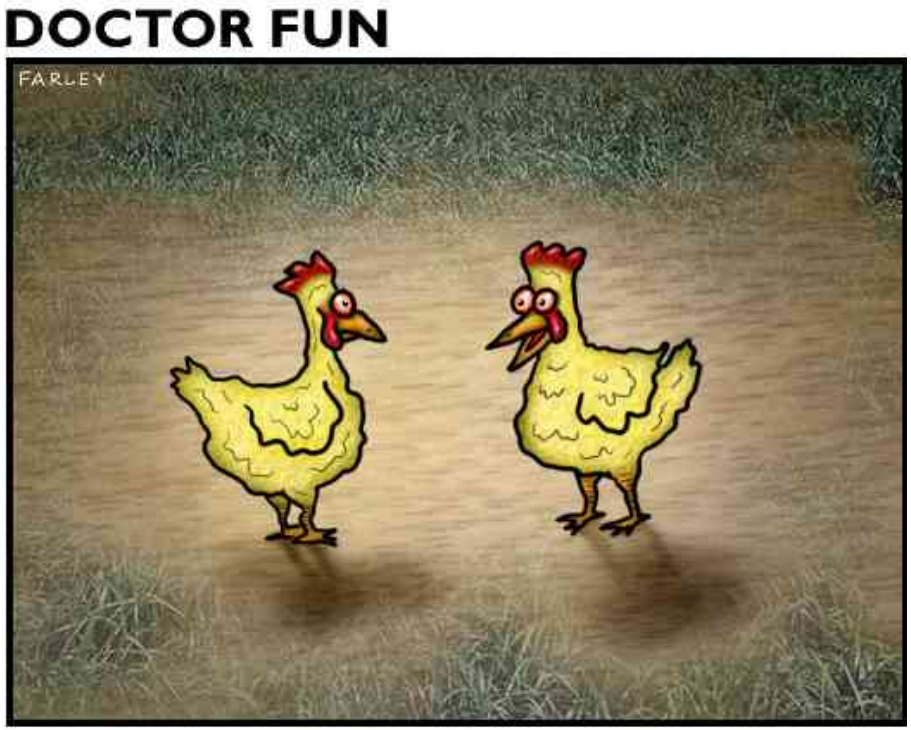


Which color represents which hormones?



Menopause

- Occurs at around ~50
- **Ova stop being produced**
- Ovaries and follicles **don't produce estrogen and progesterone**
- **Symptoms**: hot flashes, joint pain and decreasing bone mass(osteoporosis)
- **Hormone replacement therapy** – women are given low doses of estrogen (some progesterone)
  - But this has many possible side effects:
    - Possible cancer
    - Appetite and weight changes
    - Cramps or bloating etc,etc, etc..



"Menopause is easy - after you stop laying eggs, they eat you."