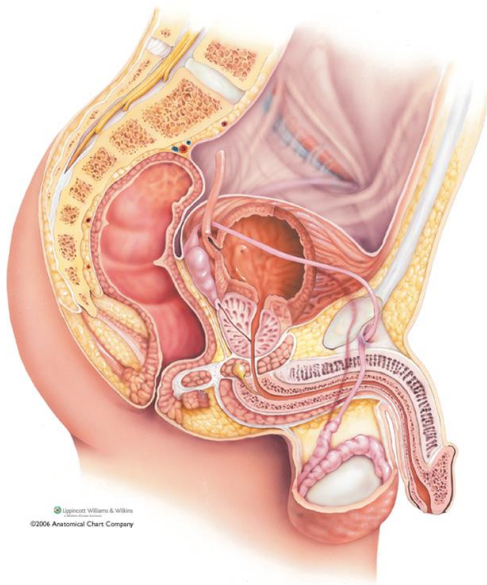
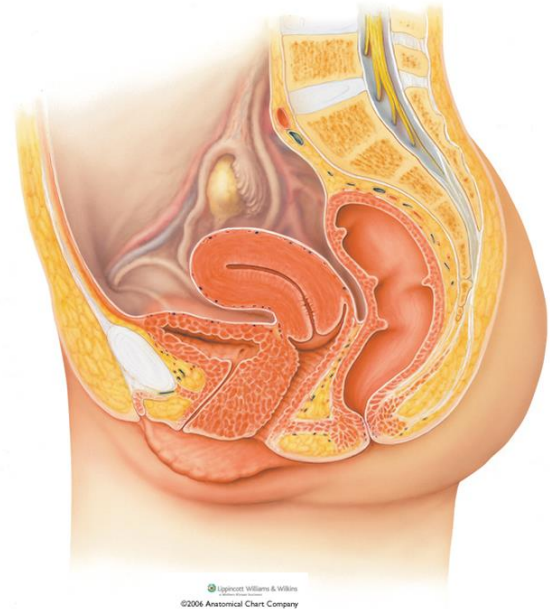


Human Reproductive System



Lippincott Williams & Wilkins
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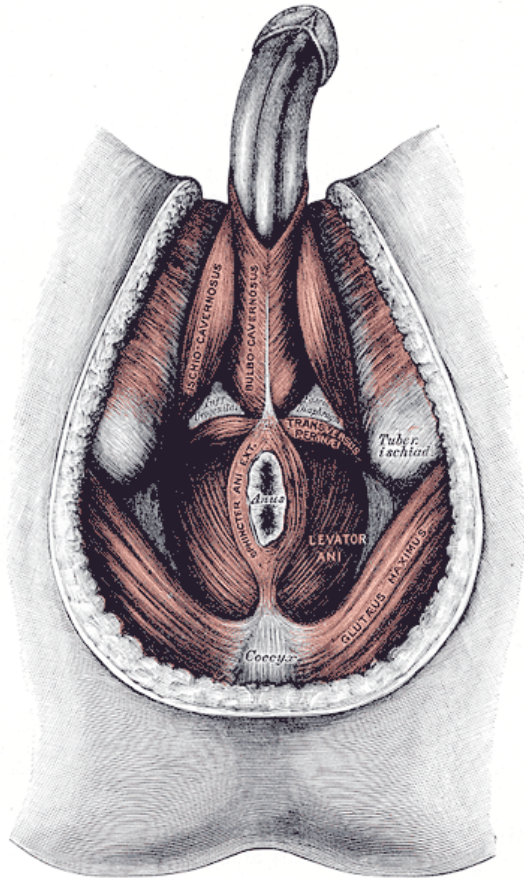


DISCLAIMER!

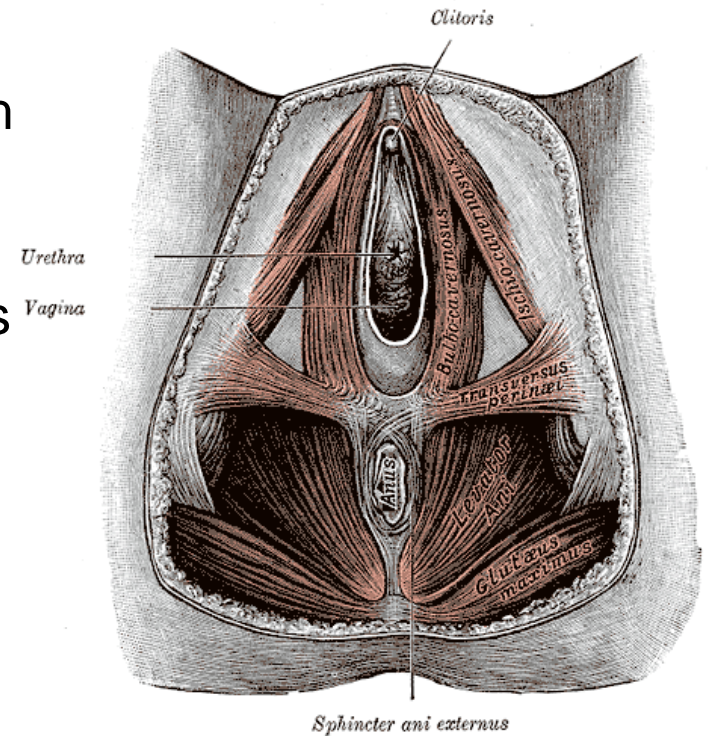
- This lecture is a clinically and scientifically frank **ADULT** discussion about the human reproductive system with **ADULT** students who are studying to go into fields of health care and need a fundamental knowledge of:
 - The anatomy and physiology of the human reproductive system,
 - Elementary concepts of anatomy, physiology and biochemistry of sexual intercourse, and
 - Embryogenesis, fetal development, gestation and delivery of the human fetus.
- If you feel uncomfortable with and/or about this[these] topic[s], it is quite likely that you're probably not going into an appropriate field of study for your future and may wish to reconsider your career path.

You've been forewarned.

Perineal Musculature – Compare and Contrast – Male and Female



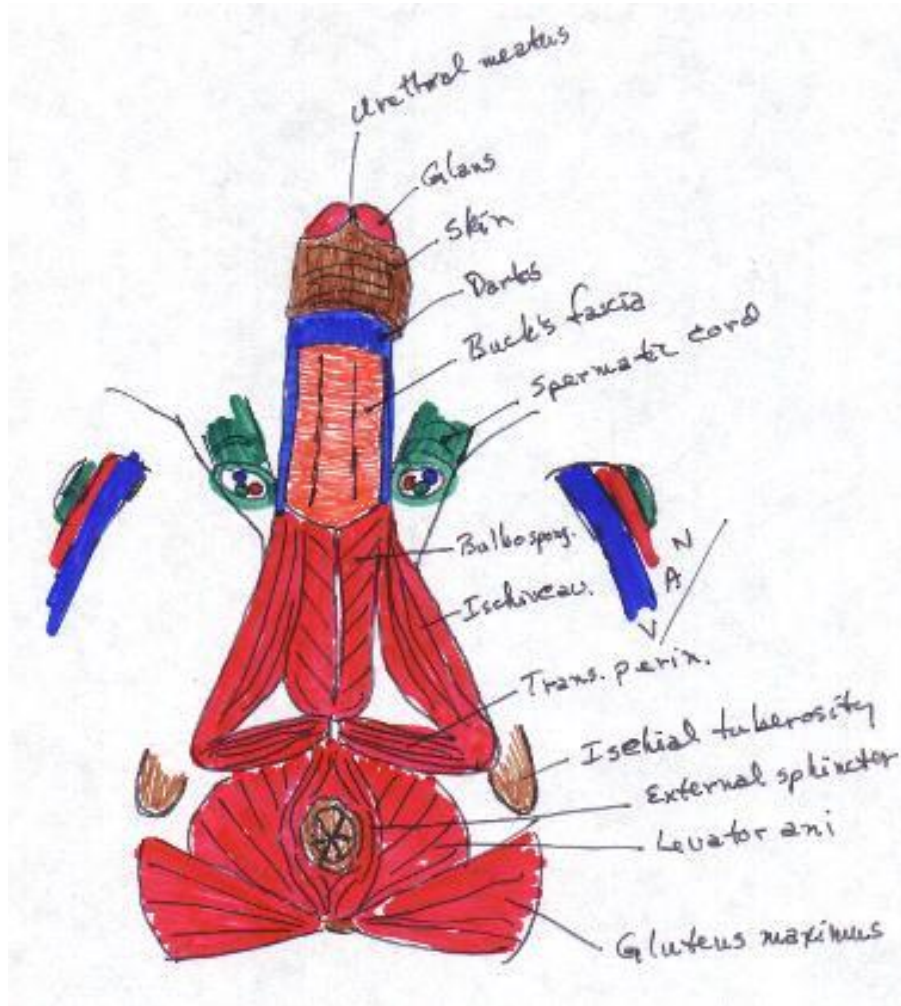
- This graphic simply reinforces that which you learned in the chapter on muscles and illustrates some orientation of organs with vessels and other anatomical landmarks.



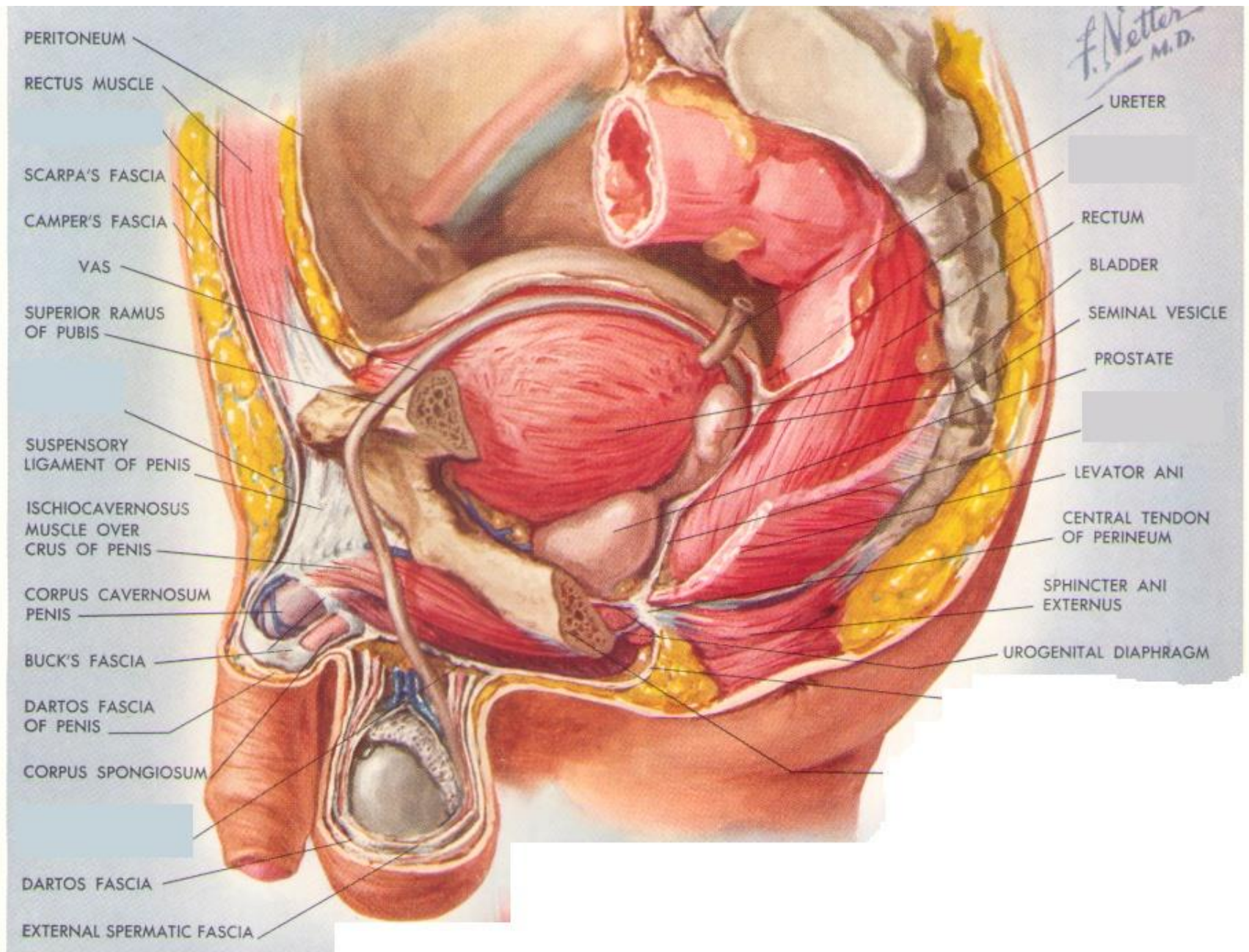
Male Reproductive System

- The penis is the organ of copulation and is an accessory organ.
- The reproductive organs in the male are the testes.
- The dartos is involuntary muscle that puts the wrinkles in the scrotum; remember the cremaster is the muscle that lifts the testes towards the body or lowers them from the body.
- The epididymis is 4-6 meters in length and is where spermiogenesis (sperm maturation) occurs.
- It takes sperm about 12 days to traverse the epididymis.
- Spermatogenesis (production of sperm) takes place, specifically, in the seminiferous tubules.
- The testes produce the sperm and secrete testosterone.

Male Reproductive System

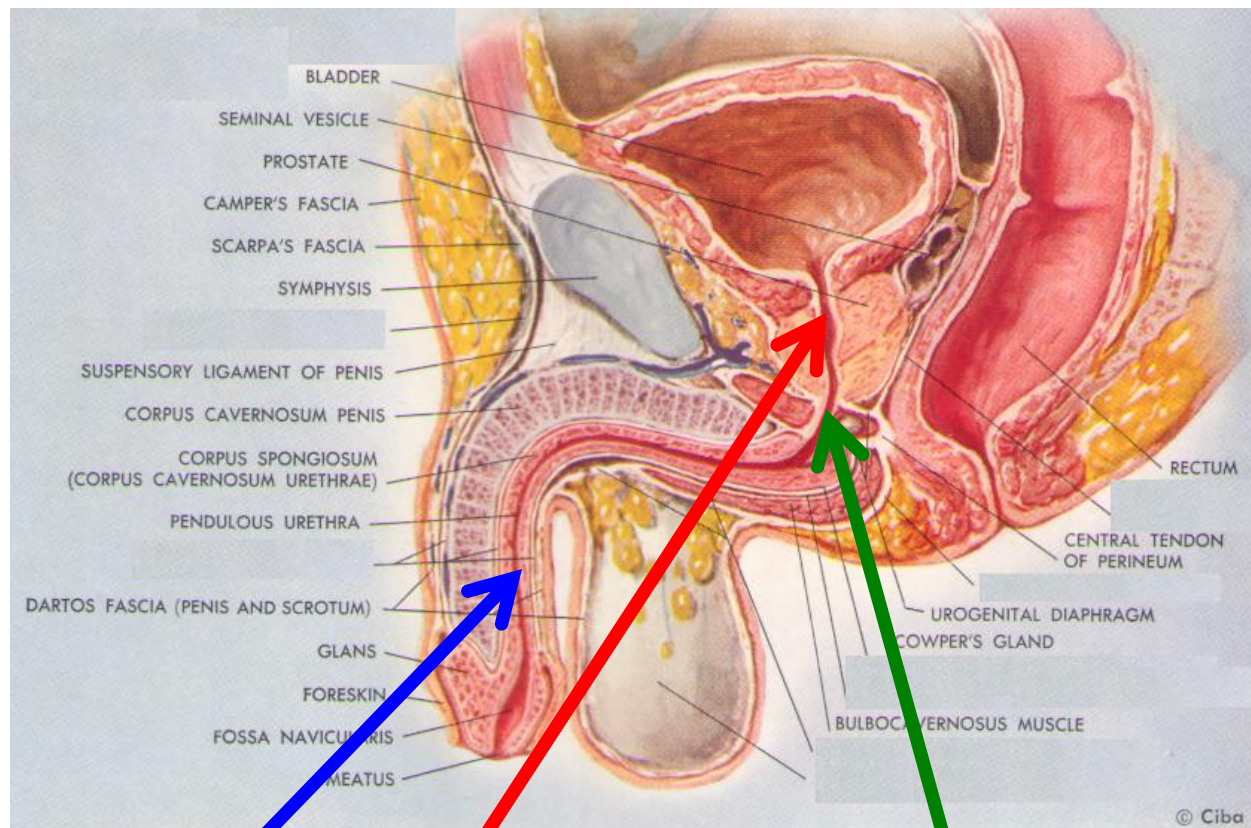


- Note that the spermatic cord contains blood vessels and nerves to provide a source of nourishment, sensation and waste removal for the testes.



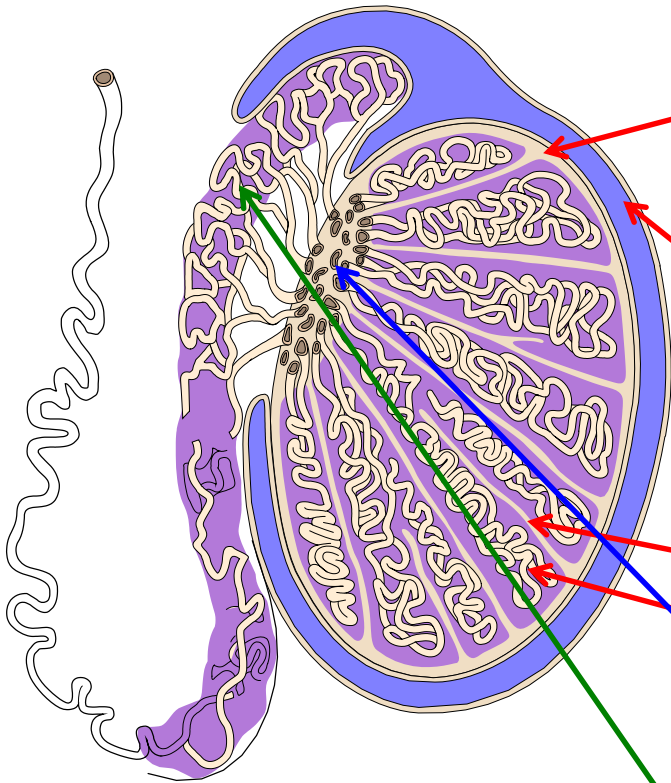
Male Reproductive System

- The **seminal vesical** secretes fructose, vitamin C, prostaglandins, amino acids and the bulk of the semen.
- It also contains clotting precursors (fibrinogen) and is a yellowish, alkaline fluid.
- The **prostate gland** is about the size of a chestnut, contains two lobes and is a firm organ.
- It secretes "plasmin".
- The fluid released from the prostate is thin, milky, alkaline and makes up about a third of the semen.
- **Cowper's glands** are utilized to flush the urethra of residual urine or other substances that will damage the sperm when they are ejaculated through the urethra.
- These secretions are alkaline and mucous-like; they provide only about 2-3 drops of lubricant, so these glands aren't of great significance in terms of lubrication for intercourse.
- In general, the volume of semen runs around 3-6 mL and contains in the neighborhood of 300 to 400 million sperm.
- Succeeding ejaculates in a short period of time contain a smaller volume of semen.



- Spongy urethra, Prostatic urethra, Membranous urethra .
- The spongy urethra is approximately 15 cm in length.

Testis



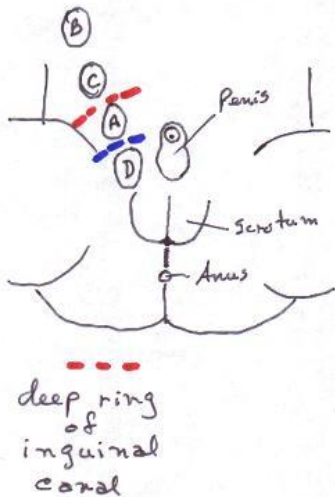
- At 7 months of gestation, the testes descend towards the inguinal canal from the abdominal cavity.
- By 8 months, they are generally through the inguinal canal.
- The outer coating of the testis (the tunica albuginea) is eventually surrounded by the tunica vaginalis (this is from "vaginal" growth during embryological differentiation).
- At 7 months, the tunica vaginalis "drops" into the scrotum; at 8 months, it is in the scrotum anterior to the testis.
- By one month of post-natal age, it is called the tunica vaginalis.
- The tunica albuginea give rise to the septa in the testes, which separate the tissue into lobules.
- The lobules consist of the seminiferous tubules (where the sperm are synthesized).
- ALL seminiferous tubules converge on the rete testis and the epididymis.

What Can Go Wrong, Testes-wise

Cryptorchidism

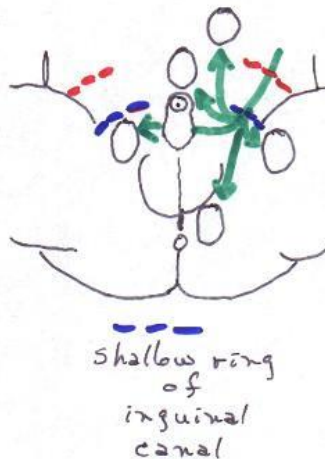
$A > f$

$D < f$



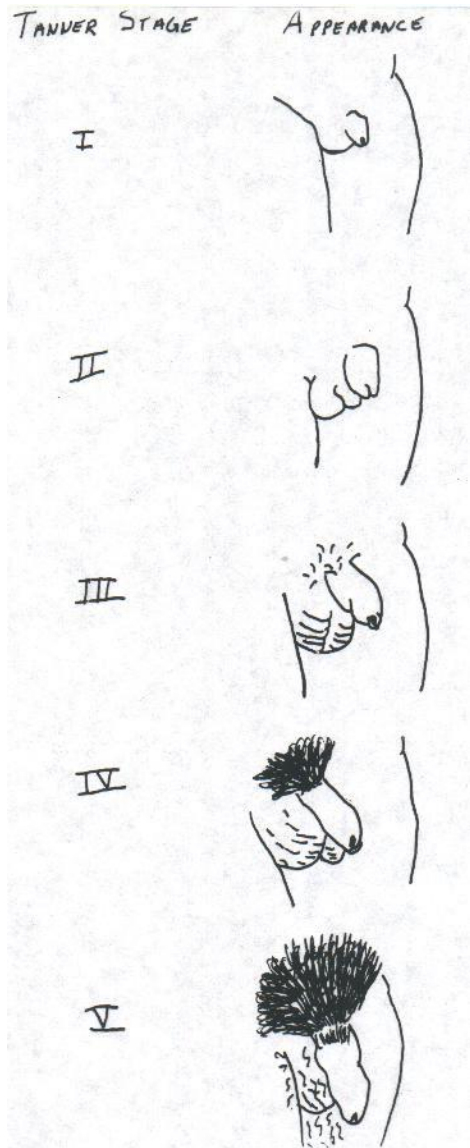
Ectopic Testes

$\sim 5\%$ of undescended testes are ectopic



- **Cryptorchidism** occurs when testes do not descend into the scrotum.
- The left graphic illustrates various sites where these testes may be found. "A" is the site of greatest frequency and "D" is the site of least frequency.
- Note that "A" is the site between the inguinal canals (deep ring and shallow ring).
- **Ectopic testes** occur when the testes descend through the two inguinal canals, but get "side-tracked".
- Note the different sites of ectopism illustrated with the oval shapes.
- Approximately 5% of undescended testes are ectopic.

Male Sexual Development



Tanner Stages of Sexual Development

Stage I: Pre-adolescent; no pubic hair

Stage II: Scrotum/testes enlarge; texture of scrotum changes; scrotum begins to redden; rugae appear

Stage III: Growth of the penis primarily in length, but a little in width; Further growth of testes/ scrotum; first pubic hair

Stage IV: Penis increases in length AND width; development of the glans; further darkening of scrotal skin

Stage V: Genitalia adult in size and shape and color; no further enlargement occurs after this stage

Female Reproductive System



- Skene's ducts are generally not talked about much unless a woman is being examined for gonorrhea, in which case these glands/ducts may become infected.
- The lower graphic illustrates 4 different types of hymens.
- An imperforate hymen is not shown, however, still occurs periodically. It does not allow for any flow of menstrual fluid. Many times a woman will present with complaints of abdominal pain and not having had a period, although she's in her late 20's and has obviously been through puberty. This is dealt with by the physician making a nick in her hymen with a scalpel and giving her sounds to use to maintain the patency of the "nick" until such a time as she decides to become sexually active (which will maintain the patency of the "nick", as well).
- The last introitus is a rough rendition of the appearance of the external genitalia following normal vaginal births.
- The middle two are variations on the same theme and the first is simply a hymen that has a single opening. The ONLY graphic that is indicative of being a "vaginal" virgin, sexually, is the imperforate hymen. The lack of a hymen is NOT an indication of being a sexual virgin as this membrane is easily damaged by horse-back riding, bicycle riding, inserting tampons, etc.

Female Reproductive System

- The primary organs of reproduction in the female are the ovaries.
- The vagina is the organ for copulation and, with the remainder of the reproductive system, is an accessory organ.
- When the vagina is damaged by trauma, it is repaired by taking epithelial tissue from the lining of the cheek and grafting it in place.
- This tissue differentiates readily into the epithelial tissue required by the vagina for lubrication purposes and to withstand the trauma of intercourse.

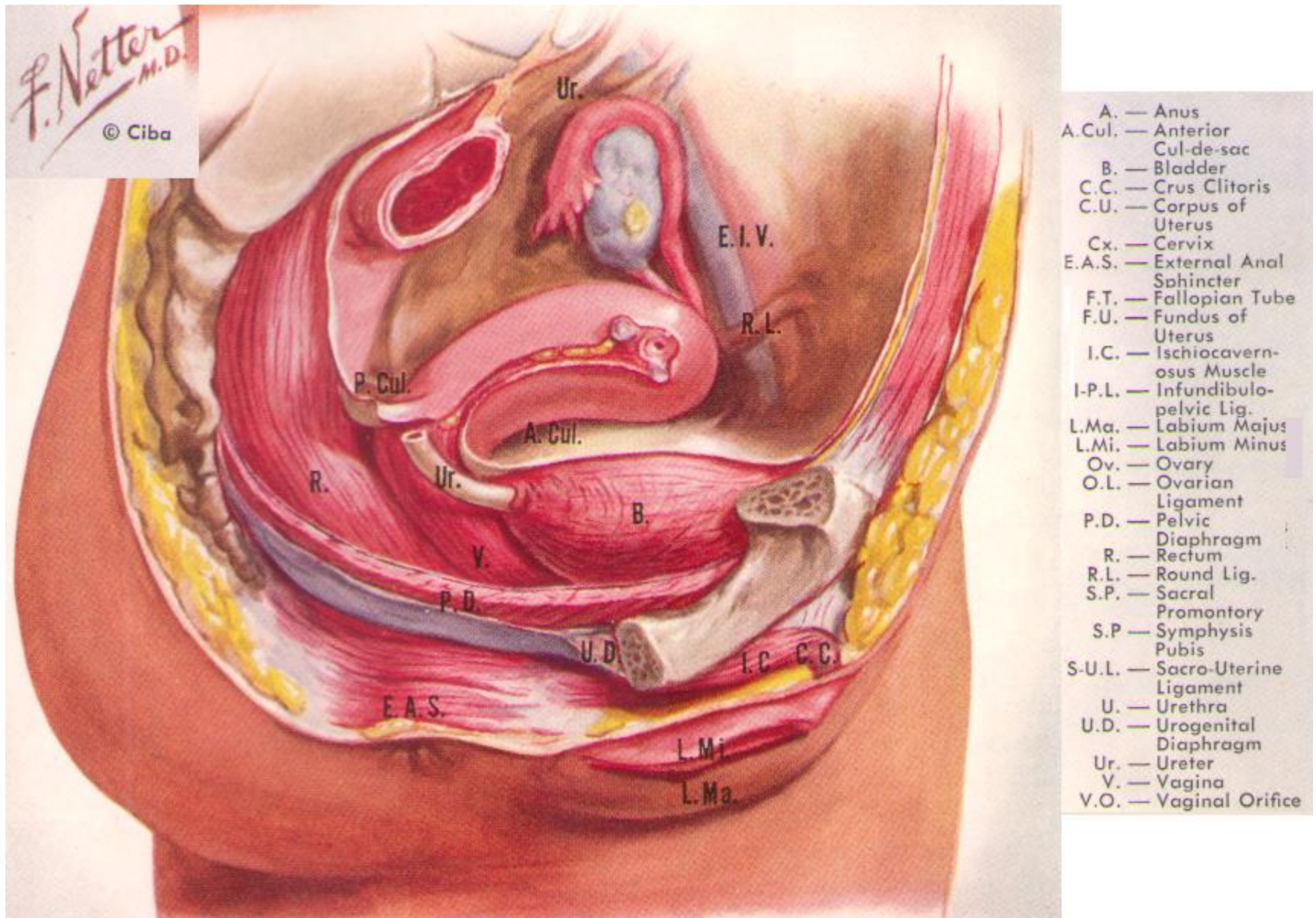
Common Vaginitis Etiologies

Infection	Atrophy	Allergy	Dermatosis
Trichomonas vaginalis; Candida albicans; Bacterial vaginoses; Condyloma acuminatum	Menopause	Feminine Hygiene Products	Psoriasis
Normal Vaginal Secretions	UTI and incontinence	Miscellaneous Anal Diseases	
Peri-ovulatory mucous secretion	Provides medium for bacteria to grow	Enterobius vermicularis (pin worm); pruritis; Bartholinitis; Skeneitis	

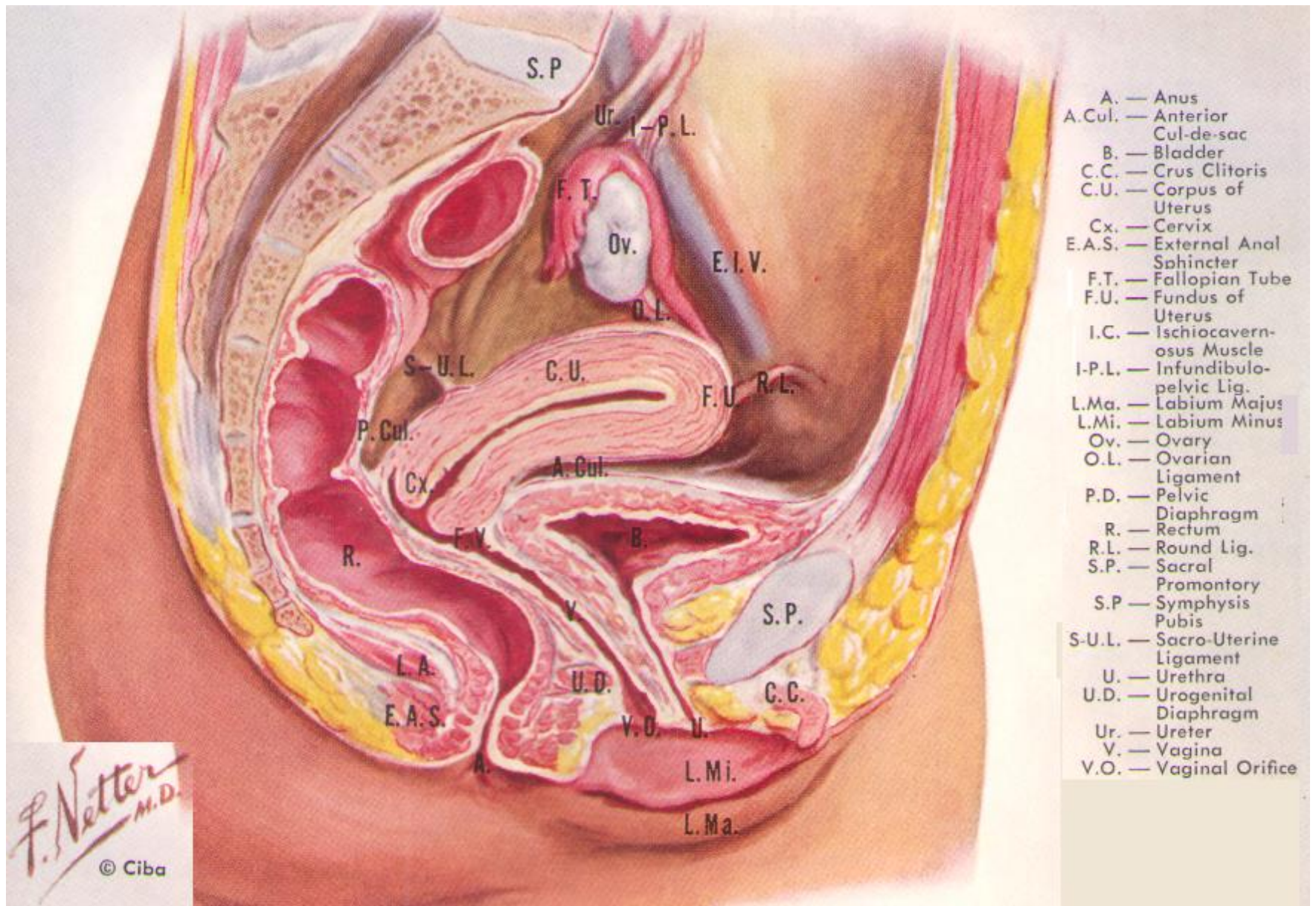
3 Common Etiologies/Disease with Diagnostic Tips

Bacterial vaginosis	Trichomonas vaginalis	Candida albicans ("yeast" infection)
Smell exudate for putrid ammonia odor; clue cells on microscopic exam.	Add 10% KOH to the exudate and smell for a fishy odor; vaginal exam reveals a "strawberries and cream" appearing cervix.	Add 10% KOH to a sample on a microscope slide and look for buds and hyphae under the microscope.

Clitoris contains corpora cavernosa.



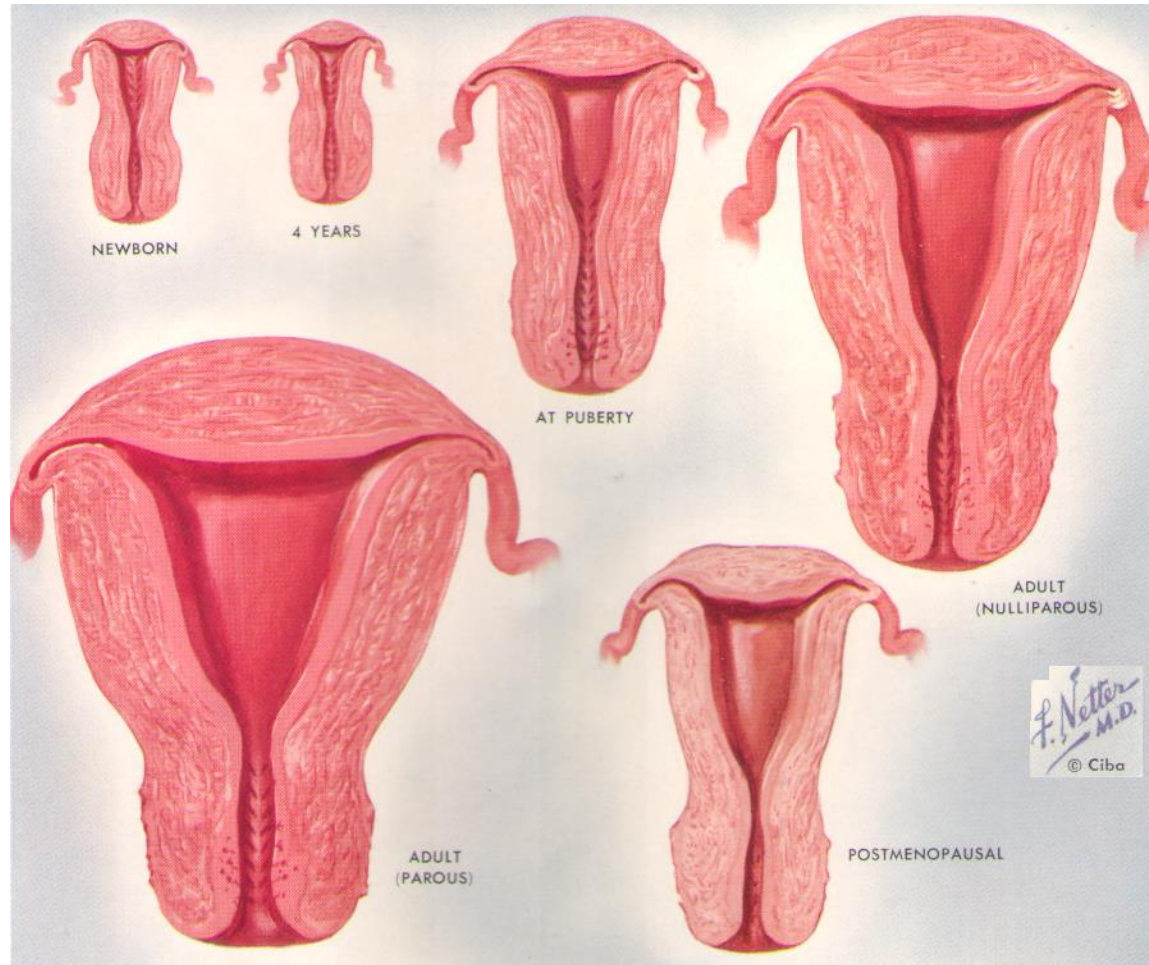
Vagina contains corpus spongiosum in outer third or so of the vaginal barrel.



Female Reproductive System

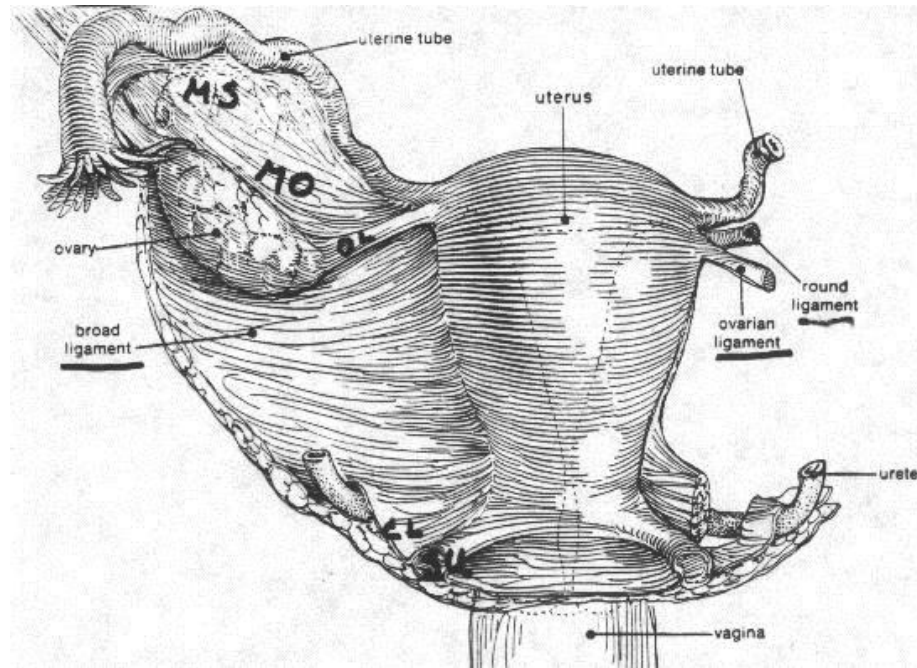
- The labia minora contain no hair, whereas the external layer of the labia majora do.
- The ovaries contain roughly one million follicles at birth between both ovaries -- only about 400 of them ever reach maturity throughout the woman's reproductive life.
- It is ovarian tissue that is responsible for secreting estrogens and progesterone (more later).
- The female urethra is only about 4 cm in length.
- The uterus is anteflexed.

A Relative Idea of The Size of The Uterus in A Woman Throughout Her Life



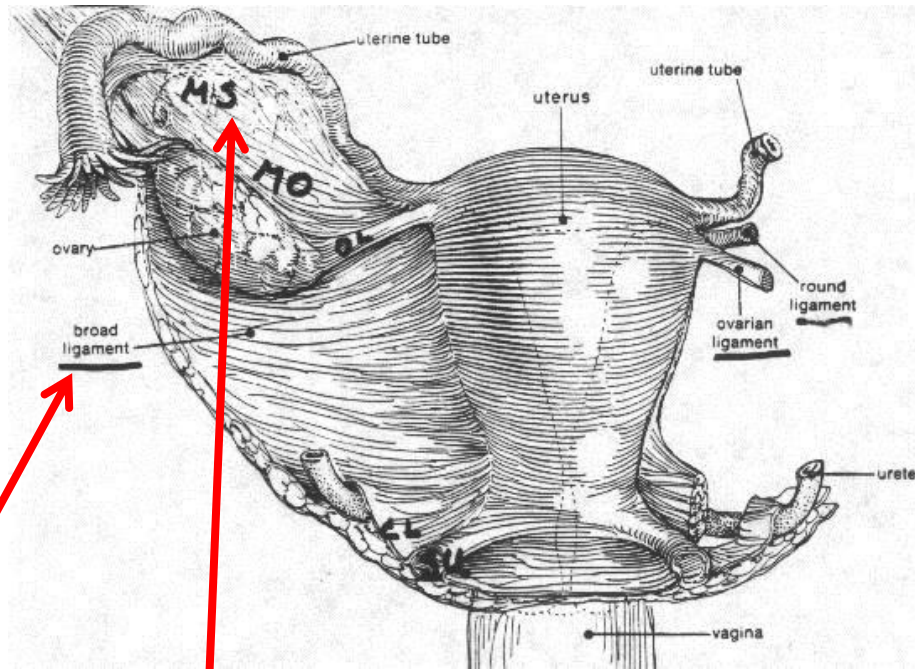
- A general rule, albeit much less than perfect, is that the size of the uterus during a woman's reproductive years is about the size of a fist.
- As previously stated it's not perfect, but it does give a bit of an idea of how much the uterus changes in size and volume throughout a female's life.
- Note that the uteri at puberty, then post-menopausally, are roughly the same size; this₁₉ indicates the "power" of hormones on the growth and development of this organ.

Uterine Ligaments



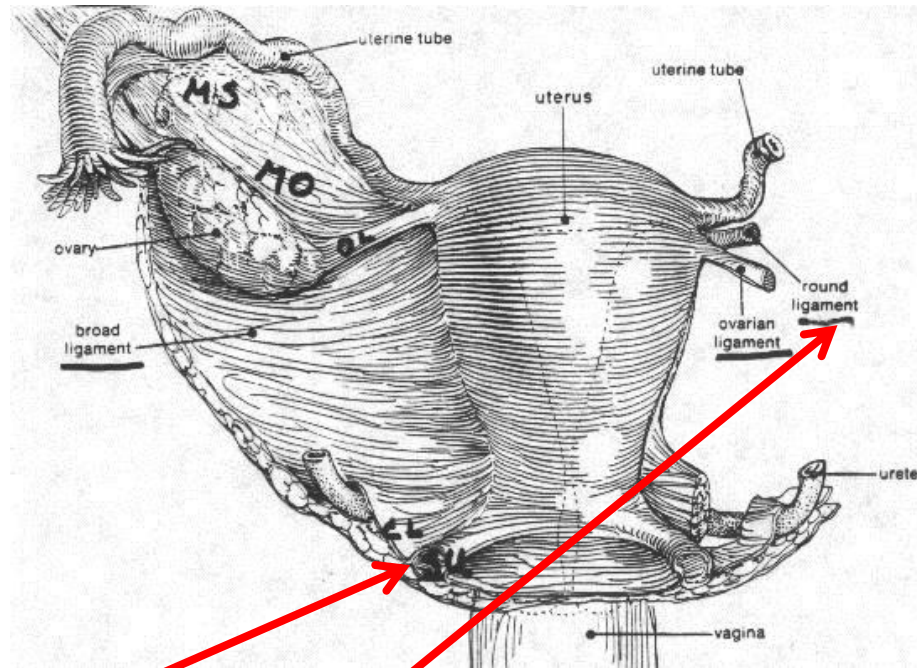
- Contrary to popular opinion, the uterus doesn't "just float" in the abdominal cavity. It is anchored in place by a series of ligaments.
- The anterior (or vesico-uterine) ligament is formed of peritoneum and reflects onto the bladder from the anterior junction of the cervix and the uterine body. It is not illustrated, above.
- The posterior (or recto-uterine) ligament is formed of peritoneum and reflects from the posterior wall of the uterus over the proximal fourth of the vagina and then to the rectum and sacrum. It is not illustrated, above.

Uterine Ligaments



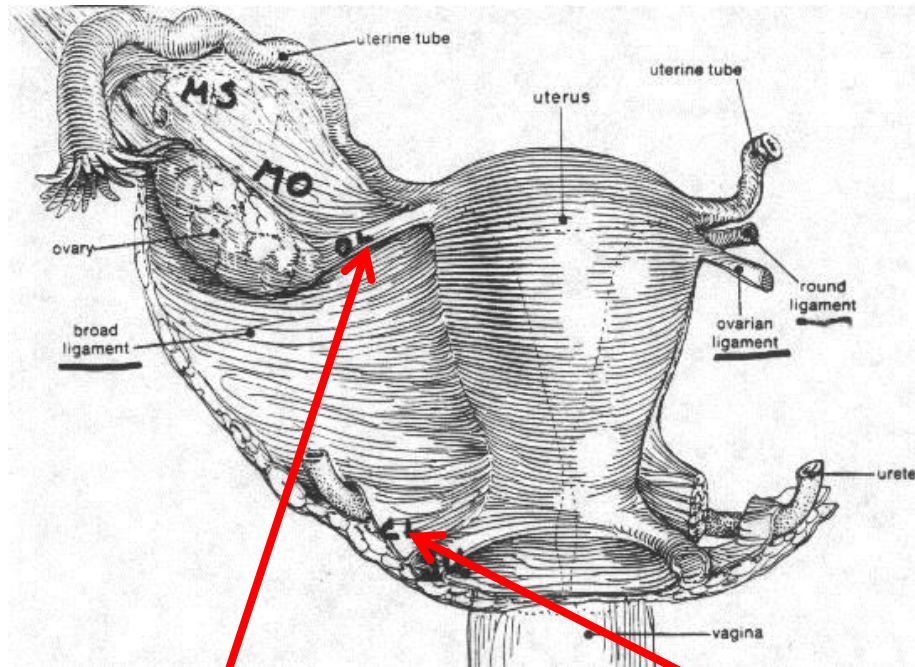
- The lateral (or broad) ligament is also formed of peritoneum.
- It runs from the sides of the uterus to the lateral walls of the pelvis.
- It is shown above.
- (The mesosalpinx [MS above] is a special fold of the broad ligament which contains the Fallopian tubules.)

Uterine Ligaments



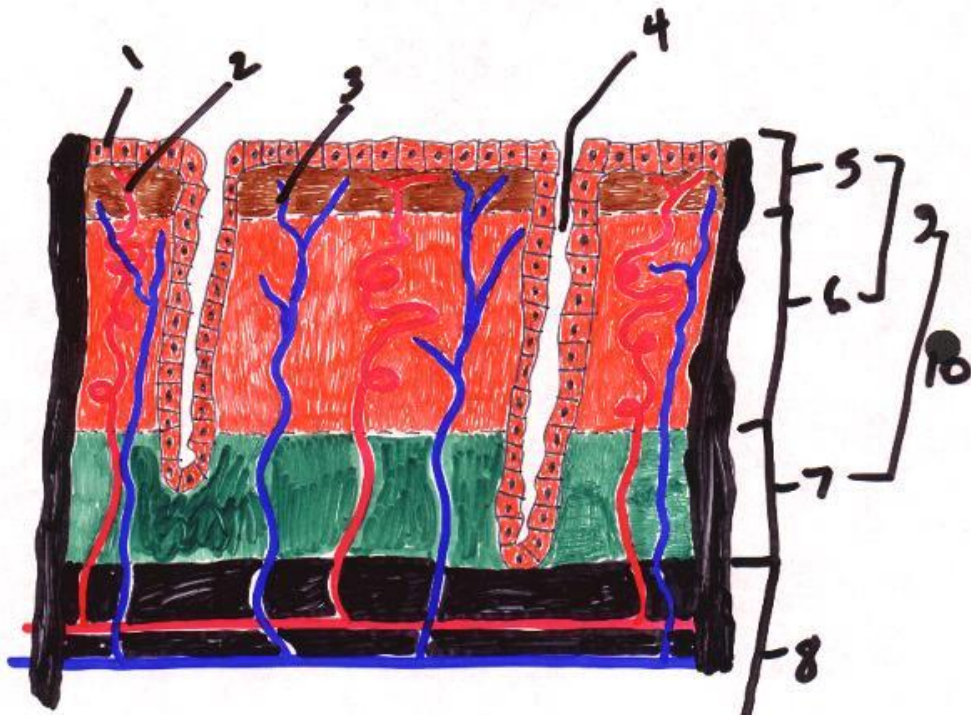
- The sacro-uterine (or uterosacral) ligaments are formed of peritoneum and run from S2 or 3 inferoanteriorly to the lateral rectum and are attached at the external portion of the internal os [SU above].
- The round ligaments are also formed of peritoneum.
- They are 4-5 inches long, cord-like and run from the superior angle of the uterus and exits through the inguinal canal, disappearing into the labia.
- They are shown, above.

Uterine Ligaments



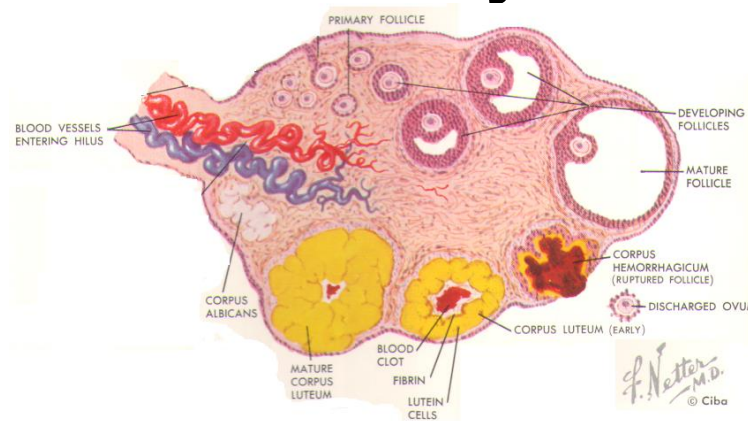
- The ovarian ligaments are formed of fibrous tissue.
- They are rounded cords (OL, above) and run from the superior angle of the uterus to the medial surface of the ovary.
- Probably the two most important ligaments are the cardinal ligaments (CL, above).
- They are formed of fibrous tissue.
- They extend below the base of the broad ligament between the pelvic wall and cervix and vagina.
- These ligaments are the CHIEF ligaments that keep the uterus from falling through the vagina.

Uterine Wall Anatomy



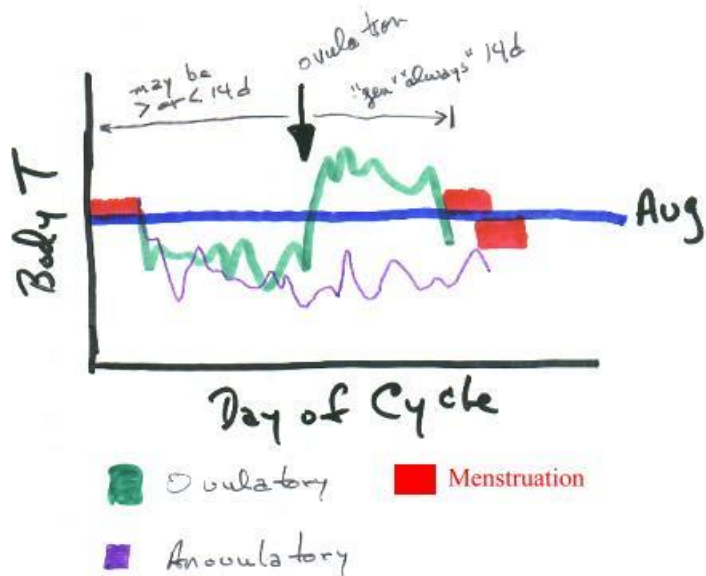
1. Endometrial endothelium
2. Spiral artery
3. Vein
4. Uterine gland
5. Compact layer
6. Spongy layer
7. Basal layer
8. Myometrium
9. Functional layer (layer sloughed off during menstruation)
10. Endometrium

Ovary



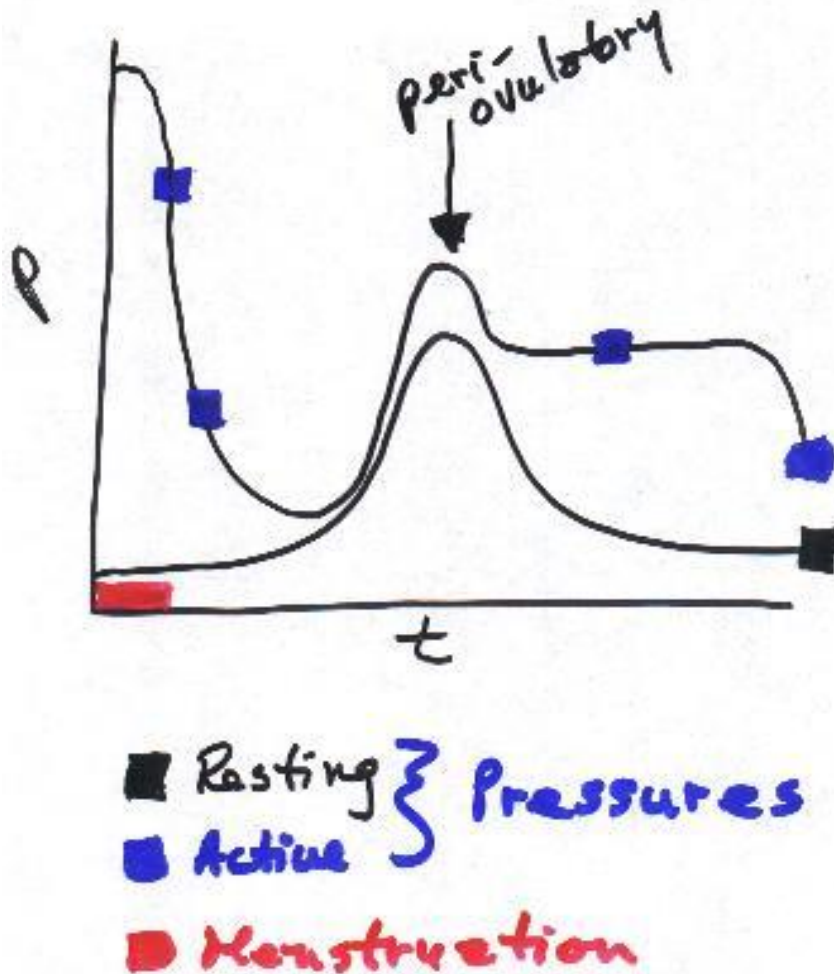
- The ovary is the site of follicular development.
- The primary follicle develops into a primary oocyte under the influence of FSH and, specifically, estradiol.
- As we discussed in endocrine, this sets up a positive feedback cycle that continues to nourish the developing "egg".
- As the primary oocyte develops into the Graafian follicle about 14 days into the cycle, the high levels of estradiol inhibit the release of FSH and stimulate the release of LH.
- When LH is secreted, the Graafian follicle ruptures much like a zit popping, releasing the secondary oocyte into the abdominal cavity.
- With this release, LH levels drop rapidly and estradiol levels drop, as well.
- The fimbria "tease" the ovum into their grasp to move the ovum into the tubule for fertilization or for excretion if fertilization doesn't occur.
- The remaining tissue from the ovulation site differentiates from the corpus hemorrhagicum (bloody body) into the corpus luteum (yellow body; CL).
- The CL secretes progesterone to prepare the inner lining of the uterine wall for implantation of the fertilized egg -- providing fertilization occurs.
- If there is no fertilization, the CL differentiates to the corpus albicans (white body), progesterone levels and estradiol levels drop to virtually zero and the woman begins her menstrual bleeding.
- If fertilization occurs, the CL continues to secrete progesterone until the placenta is sufficiently prepared to do so

Ovulatory Influence



- Two cycles are illustrated:
 - an ovulatory and
 - an anovulatory cycle.
- The former shows that following menstrual bleeding, her body temperature drops below an average (she calculates).
- If she ovulates, her body temperature rises above the average and stays that way until she has her period.
- The temperature spike corresponds with the progesterone increase and the LH drop.
- The latter shows that her body temperature never increased, implying non-ovulation.
- Note that it can be greater than or less than 14 days from bleeding to ovulation, but that it's "generally always" 14 days from ovulation to first day of bleeding.
- This is the infamous rhythm method.
- Most people who use this method are called parents.
- In general, the way it works is that the woman must take her body temperature in the morning before she gets out of bed.
- She must be consistent and she must realize that it is not perfect.

Intrauterine Pressure

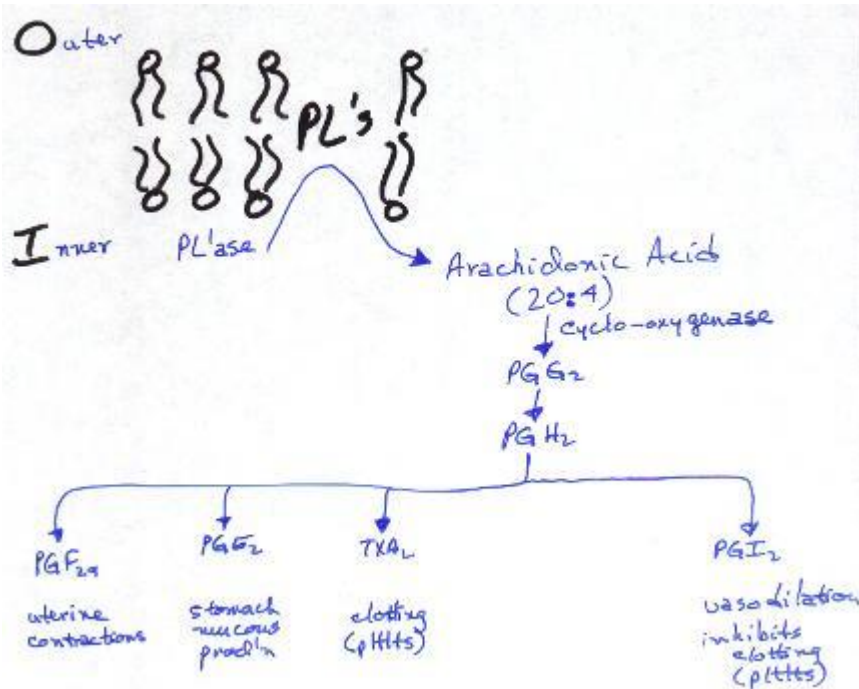


- Intrauterine pressures in an active uterus are the highest at menstruation and second highest during peri-ovulation.
- They remain elevated following ovulation.
- It seems that the latter is in order to "move" the "egg" into the uterus for implantation.

Dysmenorrhea

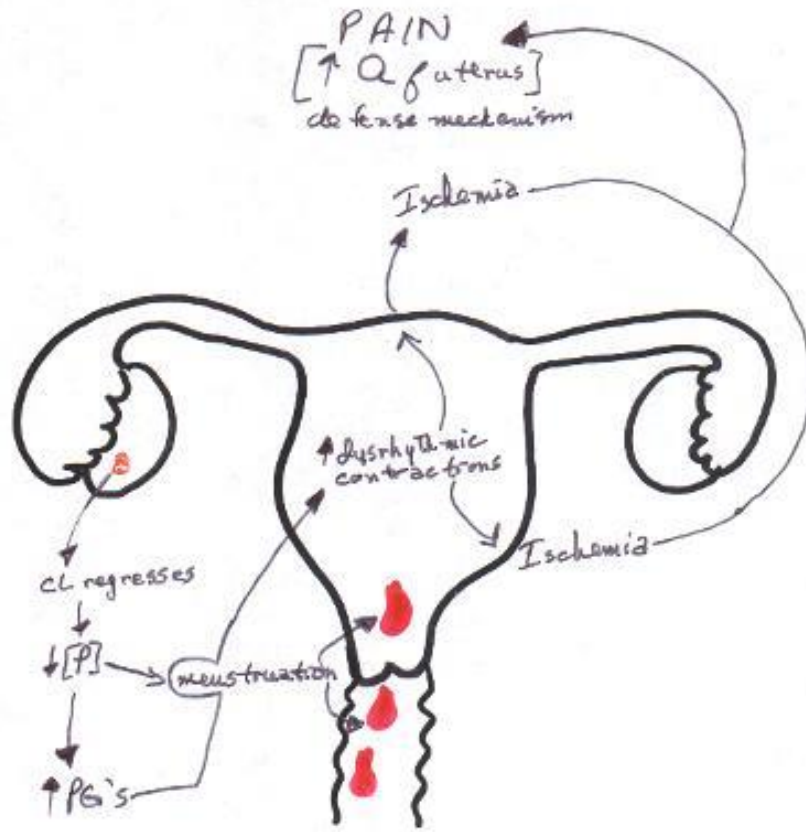
- Painful menstruation is called dysmenorrhea.
- One mechanism that has been advocated as a cause of dysmenorrhea is that of the release of excessive amounts of prostaglandins (PG's).
- When the CL regresses, progesterone levels drop off which causes menstruation AND the release of PG's.
- It's thought that these PG's act on the uterus to cause increased dysrhythmic contractions that lead to ischemia throughout the uterus.
- This ischemia is interpreted by the body as pain (due to increased uterine activity) and is thought to be a defense mechanism -- to what, though, I haven't the foggiest idea.

PG's



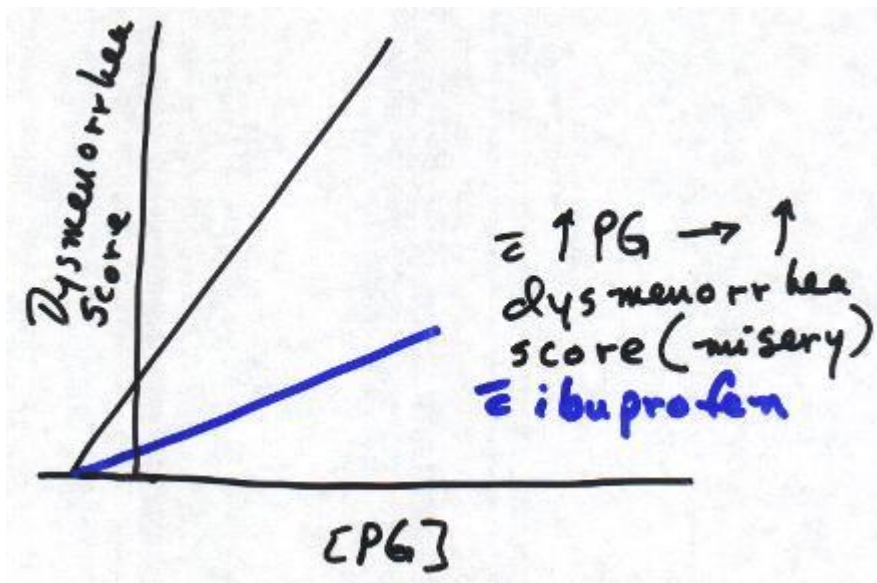
- The synthesis of prostaglandins begins at the inner cell membrane.
- Note that a "PL'ase" -- phospholipase -- hydrolyzes 20:4 (remember this nomenclature?) from phospholipids in the membrane. 20:4 is then cyclized by cyclo-oxygenase (used to be known as prostaglandin synthetase) to form prostaglandin G₂ (PGG₂).
- PGG₂ is rapidly turned over to form PGH₂. PGH₂ is the immediate precursor in the synthesis of the following prostaglandins (PG's)

PG's and Dysmenorrhea



- The putative mechanism for the misery caused during dysmenorrhea by the release of prostaglandins.
- As the CL regresses, lesser and lesser concentrations of progesterone (P) are available for the body (specifically, the uterus).
- The reduced levels of P appear to "trigger" the release of PG's.
- **Putatively $\text{PGF}_{2\alpha}$**
- With the onset of menstruation by the reduction of P, the PG's cause dysrhythmic contractions of the uterus.
- These contractions are a lot like kinking a hose that has water running through it.
- This stops the flow of blood into the myometrium, causing ischemia.
- This ischemia is interpreted by the CNS as pain due to increased activity of the uterus.
- This detection is a defense mechanism "designed" to direct the woman to find something to reduce the pain.

There is very compelling evidence that PG's play a significant role in some women's dysmenorrhea



- One way this has been followed has been to follow the amounts of PG's in menstrual fluid and compare those levels with a "Dysmenorrhea Score" (a written evaluation that scores various events during menstruation on a numerical scale; a measure of misery, so to speak).
- Once that data has been collected, then the same women were given ibuprofen (Advil; Motrin) and the same data was collected.
- With the ibuprofen, the dysmenorrhea scores dropped, although the PG levels didn't.
- This says that the ibuprofen "blocked" the effects of the released PG's.
- In addition, oral contraceptives have been shown to reduce the measurable levels of PG's by 70% to 85% for some women, as well.

Primary Dysmenorrhea

- Primary dysmenorrhea has had numerous therapies over the years.
- Therapy and reassurance all came from patronizing health care professionals who had no concept of the misery that many women go through during menstruation -- at the time most providers were male. How many of them actually went through menstruation?
- Dilatation and curettage were used for some women with mixed results.
- Oral contraceptives, as mentioned above, worked for some women -- their primary mechanism is by fooling the body into thinking it's pregnant, then getting it through a fixed period of bleeding and raising the hormone levels, again.
- Tocolysis was accomplished by giving intravenous grain alcohol. We now know that's not the best therapy.
- Non-narcotic and narcotic analgesics have been and are still used to regulate the pain caused by dysmenorrhea with mixed results.
- Newer treatments are more humane and more respectful: the use of OCP's
- which inhibit ovulation and cyclo-oxygenase inhibitors like aspirin, indomethacin and ibuprofen.
- Cyclo-oxygenase inhibitors (drugs that inhibit the synthesis of PG's), e.g., aspirin, indomethacin, ibuprofen, have been used, again, with mixed results, as not all women have the same etiology for their dysmenorrhea.
- For some women, unprotected intercourse during the most painful part of menses brings relief -- presumably from $\text{PGF}_{2\alpha}$ in semen causing the uterus to contract more and expel the menstrual contents even more rapidly, bringing relief in that manner.
- There is, unfortunately, not enough information or research into this intense, compelling subject.

PG's and Dysmenorrhea

- It is fairly well accepted that PG's cause some, but not all, dysmenorrhea.
- The evidence is remarkably reproducible and has been determined by measuring the levels of $\text{PGF}_{2\alpha}$ in menstrual fluid collected in tampons.
- The table, following, summarizes the findings from two studies along with the findings of PG levels in menstrual fluid from women taking oral contraceptives (OCP):

PG's and Dysmenorrhea

Normal PG Menstrual Fluid Levels	Dysmenorrhea PG Menstrual Levels	Dysmenorrhea + OCP PG Menstrual Levels
~0.025 mg	~0.055 mg	~0.015 mg

PG Levels without OCP	PG Levels with OCP
~0.060 mg (per ~60 mL menstrual fluid; 1 ng/mL)	~0.010 mg (per ~20 mL menstrual fluid; 0.5 ng/mL)

PG's and Dysmenorrhea

- Note that in all cases that the women who were taking OCP's had consistently lower PG levels.
- Couple this with the data from correlating the dysmenorrhea score with PG level and there is a remarkably obvious relationship between the relief from dysmenorrhea from OCP's and with the utilization of anti-inflammatory drugs like ibuprofen.
- This does not treat all cases of dysmenorrhea.
- That means that there are other mechanisms "out there" that require study.

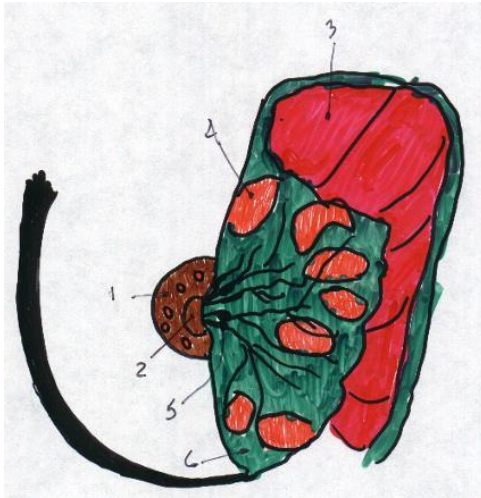
The Breasts: Normal Developmental Factors

- There are numerous factors in the normal development of the breasts during puberty.
- The central nervous system contributes via psychological factors and by releasing catecholamines -- or not.
- The hypothalamus and pituitary gland release PIF, LH, FSH, TRH, GnRH and PRL that all play roles in normal breast development.
- The thyroid gland's T_4 and T_3 are necessary for normal development of the mammary appendages as is the adrenal gland's release of corticoids.
- The ovaries provide estrogens and progesterone for their development; sensory input through the peripheral nervous system is necessary, as well.

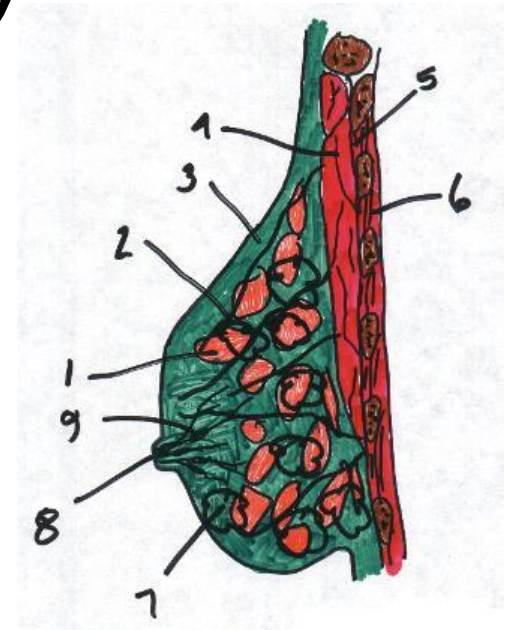
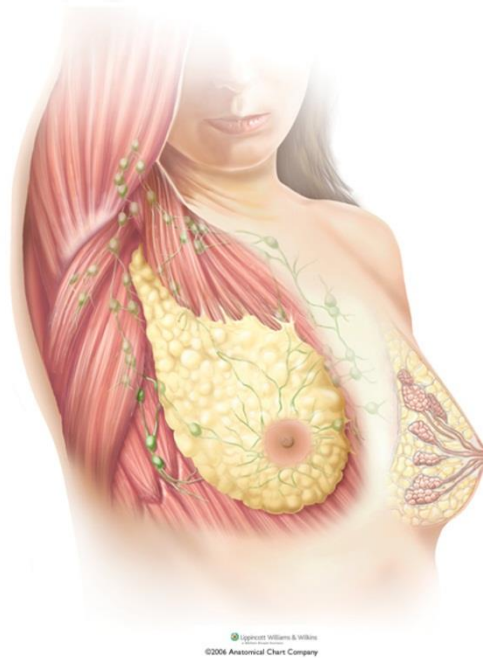
Breast Development

- Until puberty, the breasts lie dormant in little girls and little boys.
- When puberty hits, though, breast development in both sexes occurs.
- In boys, however, it's of a limited (but potentially embarrassing) nature: it's not uncommon for adolescent boys to have a slight amount of breast development that, eventually, regresses.
- Any development beyond that, though, needs to be examined by a pediatrician or pediatric endocrinologist.

Breast Anatomy

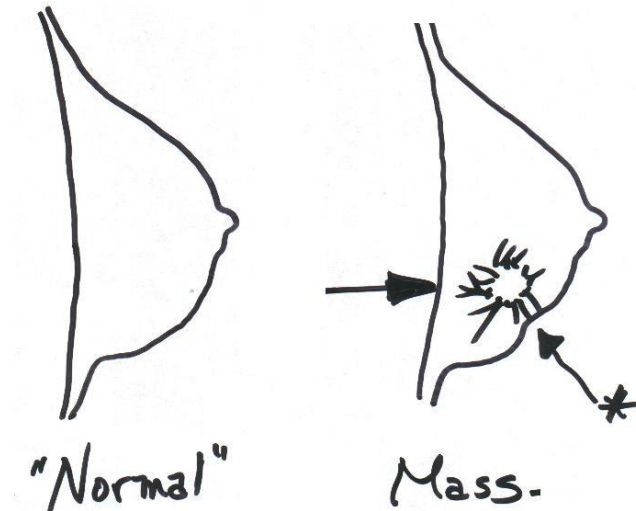


1. Aereola
2. Nipple
3. Pectoralis major
4. Fat globule
5. Milk ducts
6. Connective tissue



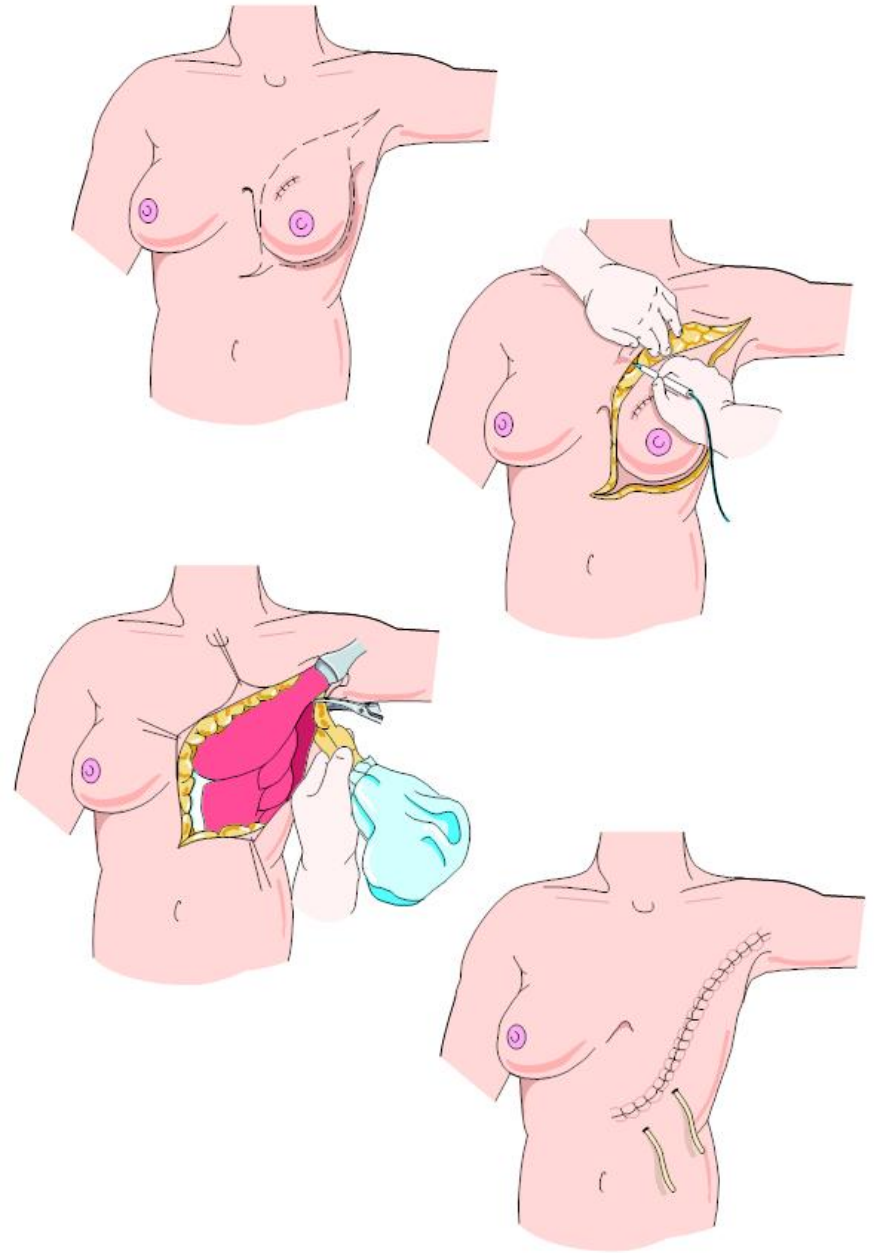
1. Fat
2. Cooper's ligament
3. Connective tissue
4. Pectoralis major
5. External intercostal
6. Internal intercostal
7. Nipple ducts

Breast Cancer



- Depending on the literature/study, somewhere between 70% and 85% of cancerous masses in breast tissue cause dimpling on the surface of the breast.
- On average, a malignant mass the size of a pin-head in the breast takes upwards of 6-7 years to show up on mammogram.











Mastectomy



Tanner Comments

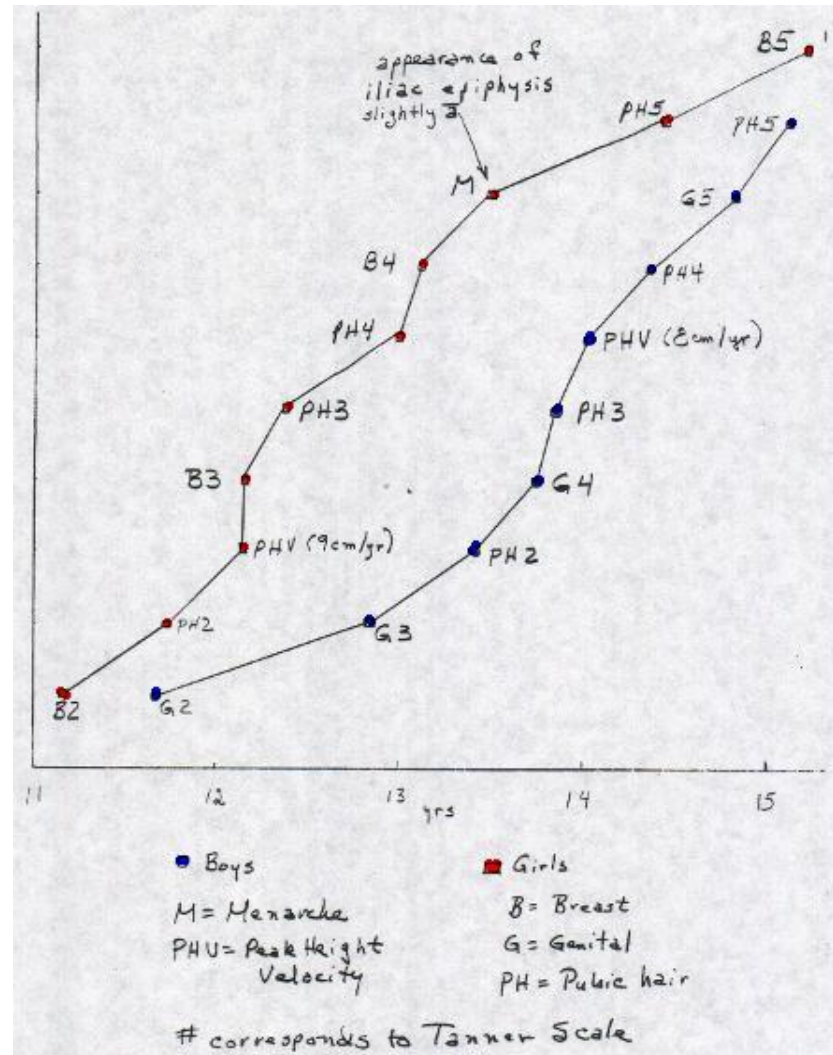
- Note that the Tanner stages include pubic hair development, as well.
- In general, if pubic hair appears before breasts, this is due to increased adrenal androgens secretion.
- If the breasts mature before the pubic hair appears, this is called testicular feminization.
- Note the ages at each stage.
- These ages are slowly changing.
- They seem to be getting less.
- It has been postulated that puberty may be coming earlier in girls due to the easy availability of fast foods.
- These foods are loaded with lipid.
- As the girl eats them and stores the lipid, she is able to synthesize the 3 estrogens sooner than if her body waited for the gonadostat to kick in were she a bit leaner.

Tanner Scale

TANNER STAGE	PUBIC HAIR	BREAST DEVELOPMENT
1	 Prepubertal	 Prepubertal
2	 Along labia 11.7 ± 1.2 years for $\sim 1/2$ year	 Breast bud 11.2 ± 1.1 years for ~ 1 year
3	 Darker, coarser more spread out 12.4 ± 1.1 years for ~ 0.5 year	 No separation of breast & areola 12.2 ± 1.1 years for ~ 1 year
4	 No spread to medial thighs 13 ± 1 years for ~ 1.3 years	 2 nd mound (areola & nipple) from breast 13.1 ± 1.2 years for ~ 2 years
5	 Adult in quantity - later up linea alba 14.4 ± 1.1 years Mature	 Mature - projection of nipple only 15.3 ± 1.7 years Mature

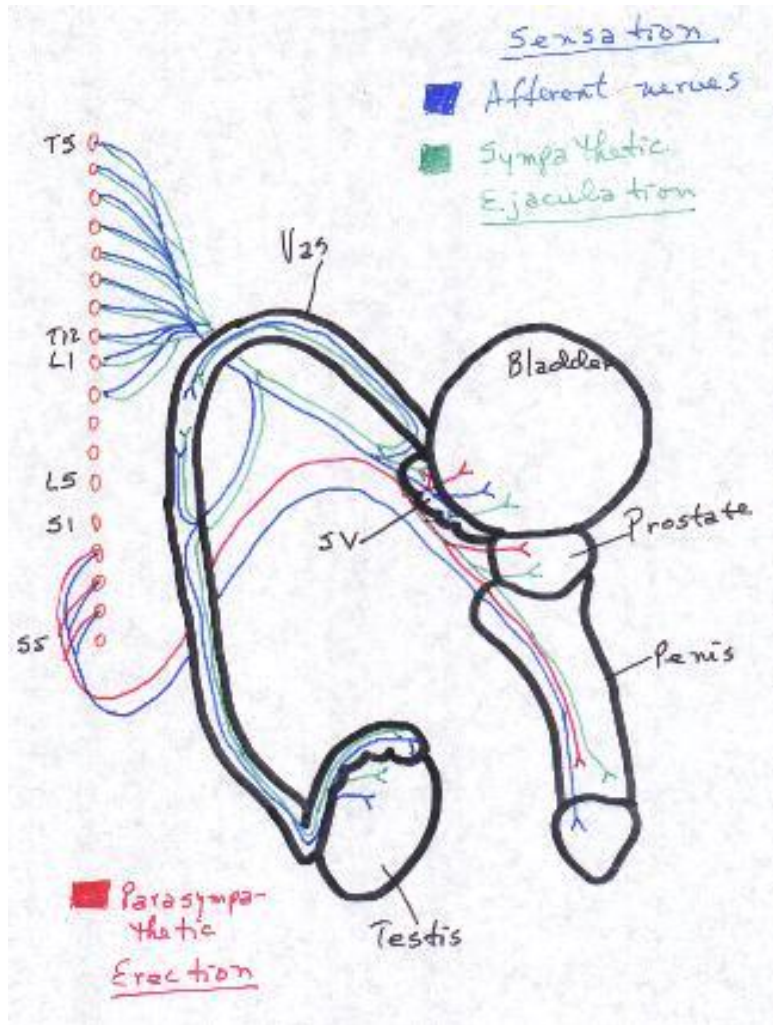
- Breast development (as well as pubic hair development) in girls follows a fairly predictable course of events and has been categorized into stages.
- These "Tanner" stages may be used to determine the progress at which a young woman is sexually developing.

Tanner Comparisons – Across Genders



The Physiology of Sexual Intercourse

Neurocircuitry



- The parasympathetic innervation through S2-S4, along with afferent nerves, provides for the recognition of sexual excitement leading to erection of the penis.
- The sympathetic innervation provides for signals to cause ejaculation.
- Note also the innervation of the bladder.

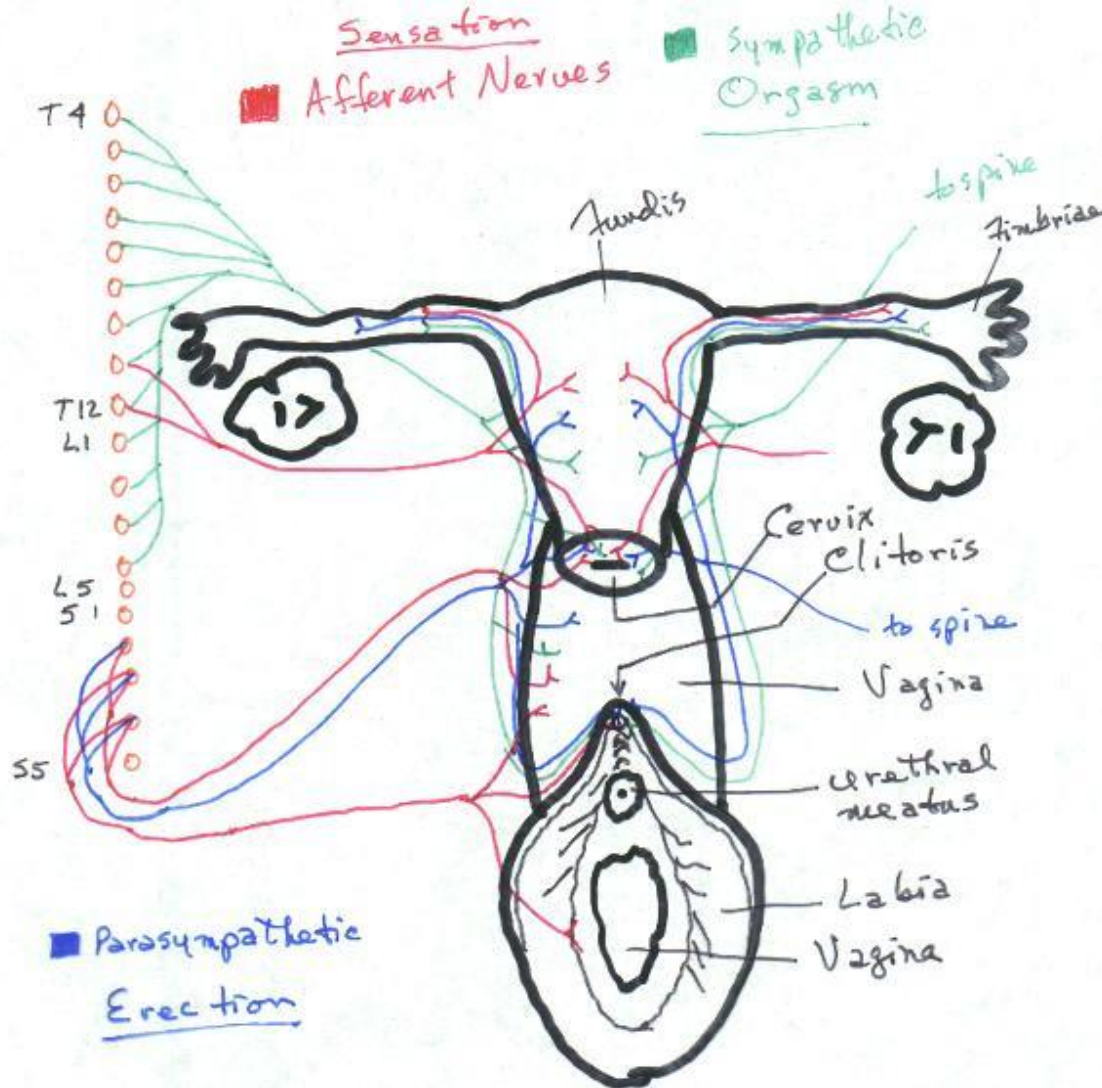
The Male

- The physiology of arousal in the male is elicited in numerous ways.
- The neurological mechanisms are what we have an interest in for this course.
- Sensory organs detect anal stimulation, skin stimulation, perineal stimulation as well as friction on the glans penis.
- All of these sensations are transmitted via the pudendal nerve to the sacral plexus.
- In addition, an inflamed/irritated urethra, bladder, prostate, seminal vesicles, testes and/or vas deferens drives transmissions to the sacral plexus.
- Likewise, the male's sexual drive causes sexual organs to overfill causing increased secretions and vasocongestion.
- These signals are also transmitted to the sacral plexus.
- Signals from the sacral plexus travel two directions:
 - 1) back to the penis, causing the penile arterial pressure to increase and blocking venous sinusoidal drainage and
 - 2) to an "uncharted" region of the cerebrum.
- The bottom line is that these signals all "cause" sexual sensation.

The Female

- The physiology of arousal in the female is elicited in numerous ways.
- The neurological mechanisms are what we have an interest in for this course.
- Sensory organs detect anal stimulation, groin stimulation, perineal stimulation as well as friction on the glans clitoris and labia or in the labial groove.
- All of these sensations are transmitted via the pudendal nerve to the sacral plexus.
- In addition, an inflamed/irritated urethra or bladder drives transmissions to the sacral plexus.
- Likewise, the female's sexual drive causes sexual organs to overfill causing increased secretions and vasocongestion.
- Furthermore, emotional states, learned behaviors and blood levels of estrogens, progesterone and corticoids govern the female's sexual drive.
- These signals are also transmitted to the sacral plexus.
- Signals from the sacral plexus travel two directions:
 - 1) back to the clitoris, causing the clitoral arterial pressure to increase and blocking venous sinusoidal drainage and
 - 2) to an "uncharted" region of the cerebrum.
- The bottom line is that these signals all "cause" sexual sensation.
- Nipple erection during this stage is due to small muscle fiber contraction during sexual excitement.

Neurocircuitry



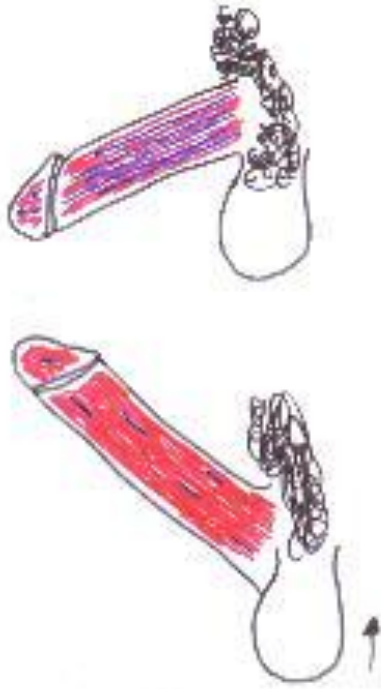
- Note that the same divisions of the autonomic nervous system provide for the identical functions in the female with one exception: the sympathetic division provides for impulses to cause orgasm.
- The parasympathetic innervation through S2-S4, along with afferent nerves, provides for the recognition of sexual excitement leading to erection of the clitoris.

Both Genders



- In both genders, the psyche is important, i.e., thinking, dreaming, fantasizing about things of a sexual nature enhances the stage of arousal.
- Ultimately, this all leads to orgasm in the female and ejaculation in the male (particularly nocturnal emission in the pubescent male).
- BUT .. what happens if the spinal cord is cut above the lumbosacral portion as in the graphic at right?
- Orgasms remain due to intact reflexes in the lumbosacral region.

Erection in The Male



It is not uncommon for pre-pubescent boys to have “first morning erections” upon awakening. This is due to REM sleep immediately preceding awakening, which leads to erection. The current thinking is that it’s the body “checking its systems” out and making sure they work. (Absence of norepinephrine causes the erection.)

- The physiology of male erection depends upon the degree of sexual stimulation he is receiving.
- Erection is caused by parasympathetic impulses from the sacral cord (S2, S3, S4) to the penis.
- These same motor nerves innervate the ischiocavernosus and bulbospongiosus muscles.
- The result is that penile arterioles dilate and the penile venules constrict.
- This puts high-pressure blood flow into the corpus spongiosum and the corpora cavernosa.
- The penis becomes erect and it is said to be in a state of TUMESCENCE, i.e., a condition of being swollen, or a swelling.
- NOTE: the amount of red indicates the amount of blood flowing into the penis in the graphic at right.
- The scrotum also begins to elevate as the penis becomes erect.

Fast facts on the average penis size

- While 85 percent of women may be satisfied with the size and proportion of their partner's penis, men are less sure of themselves.
- As much as 45 percent of men believe they have a small penis.
- Across studies, flaccid length average from 7 to 10 centimeters (2.8 to 3.9 inches).
- Flaccid circumference/girth average from 9 to 10 centimeters (3.5 to 3.9 inches).
- Erect lengths average from 12 to 16 centimeters (4.7 to 6.3 inches).
- Erect circumference is around 12 centimeters (4.7 inches).

Erection in The Female



relaxed

- ⇒ length: 3 ½ to 4 inch
- ⇒ diameter: < 1 inch

aroused ("tented")

- ⇒ length: 5 to 6 inch
- ⇒ diameter: 1 ½ to 2 ½ inch
(narrowest at vaginal opening)

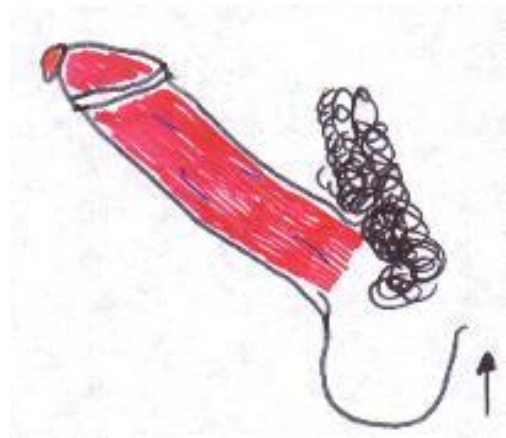
stretched

- ⇒ length: 8 to 9 inch
- ⇒ diameter: 2 ½ to 3 inch
(more during childbirth)

It is not uncommon for pre-pubescent girls to have "first morning erections" upon awakening. This is due to REM sleep immediately preceding awakening, which leads to clitoral erection and vaginal vasocongestion. The current thinking is that it's the body "checking its systems" out and making sure they work. (Absence of norepinephrine causes the erection.)

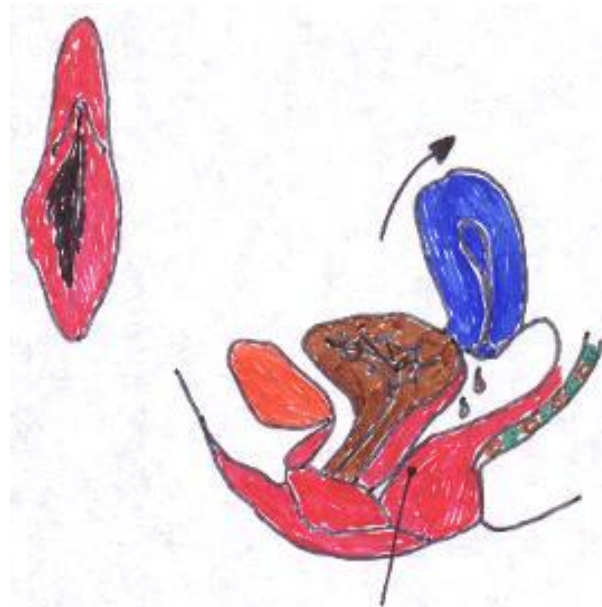
- The physiology of female erection depends upon the degree of sexual stimulation she is receiving.
- Erection is caused by parasympathetic impulses from the sacral cord (S2, S3, S4) to the clitoris.
- These same motor nerves innervate the ischiocavernosus muscle and cause the clitoris to retract under the clitoral hood, later.
- The result is that clitoral arterioles dilate and the clitoral venules constrict which puts high-pressure blood flow into the corpora cavernosa.
- The clitoris becomes erect and it is said to be in a state of TUMESCENCE, i.e., a condition of being swollen, or a swelling.
- During tumescence in the female, the introitus tightens by at least one-third due to venous congestion at the outer third of the vaginal barrel (location of the corpus spongiosum in the female).
- The vaginal barrel and labia minora thicken (called the orgasmic platform) due to VASOCONGESTION.
- The orgasmic platform "grips" the penis during intercourse, hence, penile size is only important psychologically, NOT physiologically.
- **Vasocongestion is one of TWO primary physiological responses to sexual intercourse in both the male and female.**
- NOTE: vaginal secretions increase and the uterus "swings" more to a posteroflexed position.

Male Lubrication



- Lubrication in the male is a parasympathetic response.
- Cowper's glands secrete mucous through the urethra.
- This mucous washes out residual urine in the urethra and increases the pH for the sperm (sperm require an alkaline pH for survival).
- Cowper's glands are a SMALL aid to lubrication for coitus as they only secrete 2-3 drops of lubricant.
- MOST of the lubrication for coitus is from the female.
- Without lubrication, the sexual sensations are decreased and pain is sensed, instead.
- The scrotum (dartos, cremaster) contracts.
- The testes increase about 50% in size (vasocongestion) and elevate more.
- The penis changes colors due to vasocongestion from "skin color" to pink to bright/deep red.

Female Lubrication

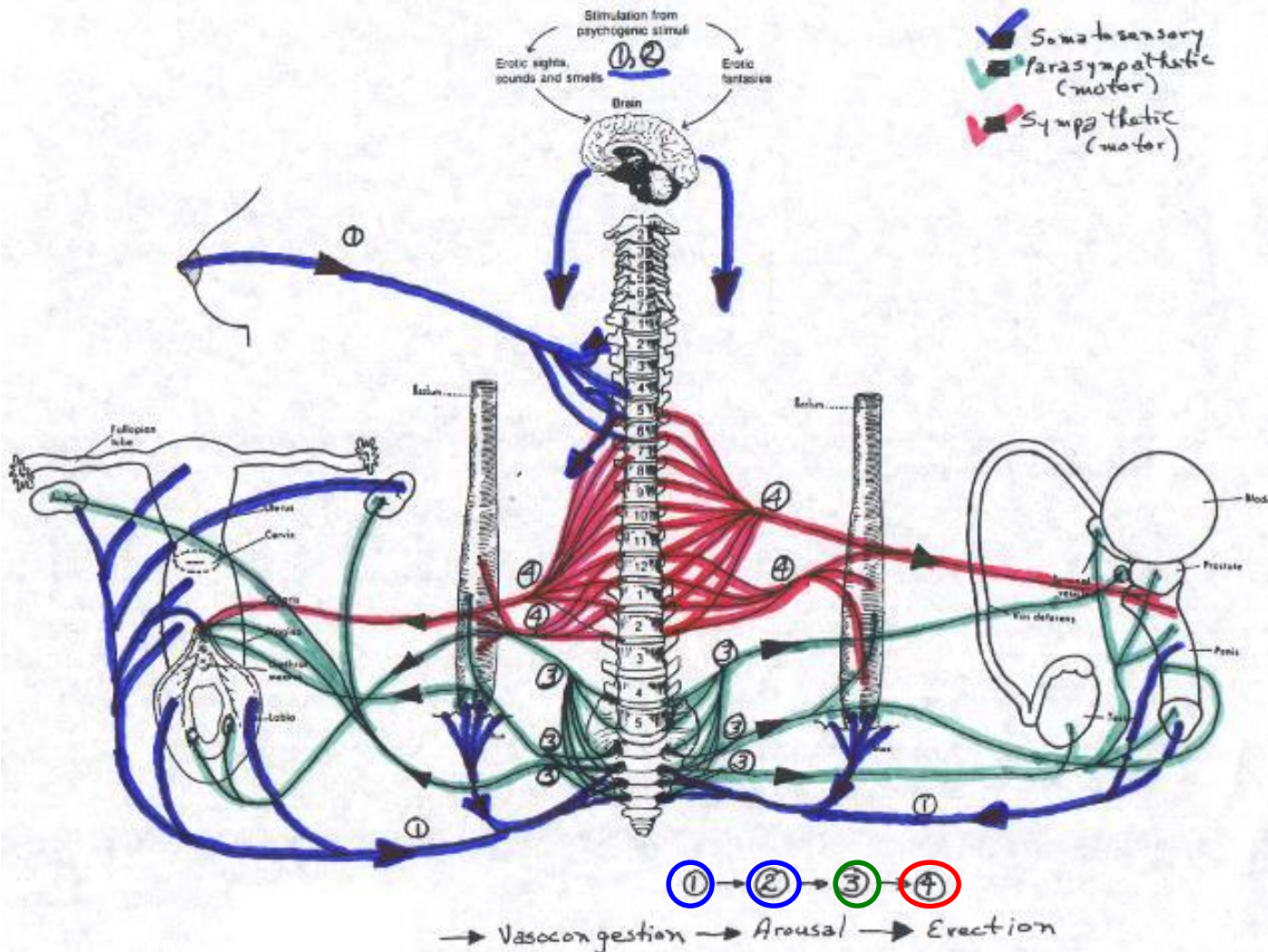


- Lubrication in the female is a parasympathetic response.
- Bartholin's glands secrete a slight amount of mucous.
- This mucous is NOT the primary mucous for coitus.
- MOST of the lubrication for coitus is due to the female's vaginal wall vasocongestion.
- Lubrication "squeezes" through the congested wall as a transudate.
- It provides for lubrication and it buffers the acidity (with semen) of the vagina for an appropriate sperm environment.
- It may be in levels so as to flow from the vagina and introitus moistening all tissues in its path, including the labia.
- Without lubrication, sexual sensations are decreased and pain is sensed, instead.
- The vagina changes colors due to vasocongestion from "skin color" to pink to bright/deep red.
- NOTE: the line on the lower side of the graphic is pointing to the orgasmic platform.

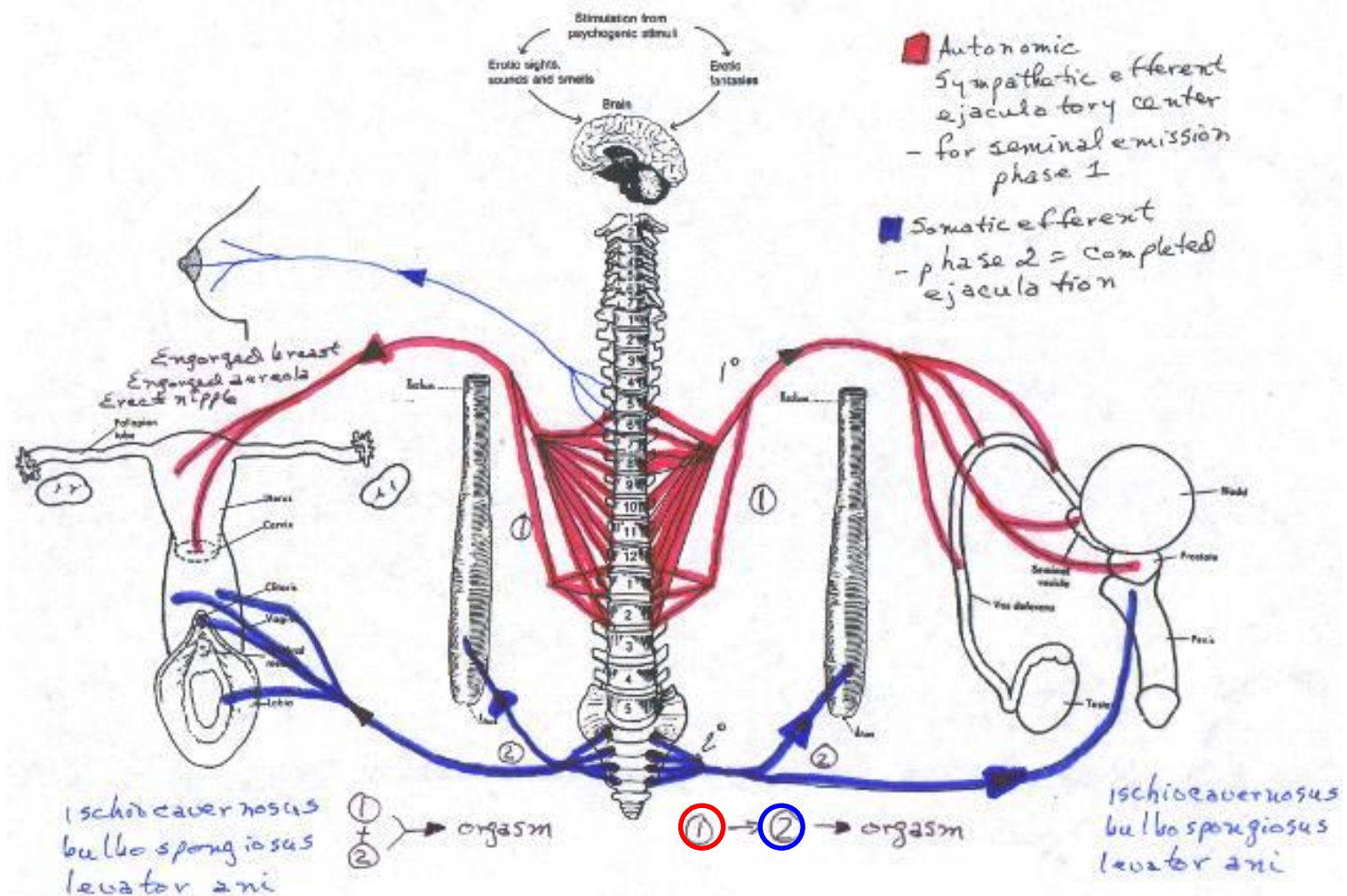
Neurocircuitry

- As you can see on the next slide, the external genitalia of both genders are innervated with somatosensory nerves.
- Stimulation of these areas (as well as mental stimulation) sends signals up and down the spinal cord.
- These sensations "trigger" the parasympathetic system to cause increased blood flow into these organs and decrease the flow OUT of these organs.
- The culmination of these processes is erection and engorgement of the penis, testes, clitoris and vaginal barrel.
- While erection is primarily a parasympathetic response to stimulation, the sympathetic division plays a role as a secondary center of arousal leading to further engorgement of the accessory reproductive organs.

The figure, below, illustrates the different phases required to cause either gender to attain erection



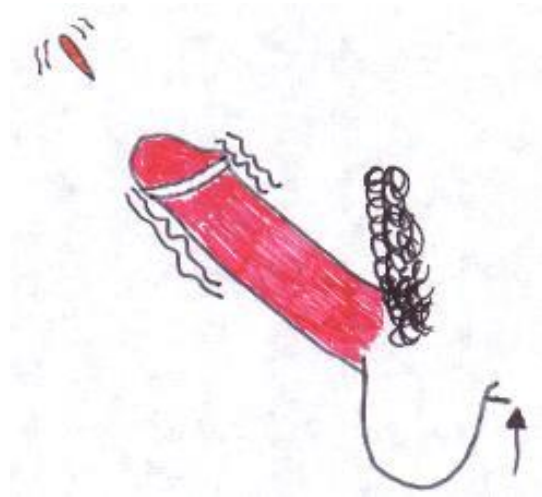
The figure, below, illustrates the sequence of neurological events leading to ejaculation in the male and orgasm in the female



Male Orgasm

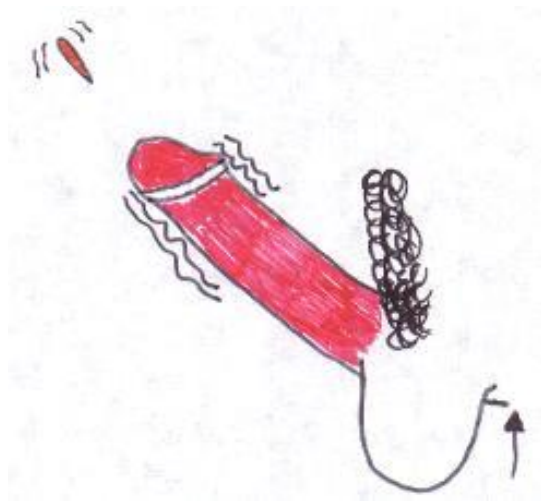
- In the male, orgasm is a two-stage process: emission and ejaculation.
- Emission occurs as a result of sympathetic efferent signals causing release of and mixing of seminal and prostatic fluids.
- Ejaculation occurs as a result of sympathetic signals causing spasmodic contractions of the ischiocavernosus, bulbospongiosus and levator ani muscles.

Orgasm: is the sudden discharge of accumulated sexual tension in a peak of sexual arousal.



- Male orgasm, as mentioned, earlier, is a two-staged process.
- Emission is due to sympathetic impulses from L1 and L2.
- They innervate the urethral crest and muscles of the epididymis, vas deferens, seminal vesicles, prostate and penile shaft (the genital organs).
- Emission is the "forerunner" to ejaculation.
- Epididymal, vas deferens and ampullary contractions expel sperm to the internal urethra.
- Contractions of the seminal vesicles and prostate expel fluids and ALL fluids mix to make semen.

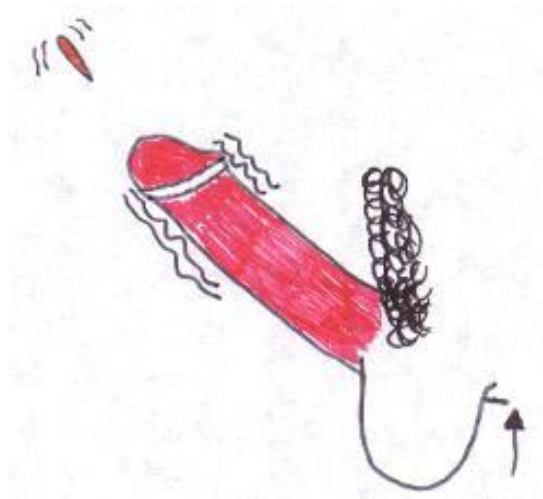
Orgasm



- Ejaculation occurs when the internal urethra fills with semen.
- Signals are sent to the pudendal nerve via the sacral plexus/cord.
- Rhythmic nerve impulses are transmitted from L1 and L2.
- Once the prostate contracts, ejaculation is inevitable, i.e., nothing will stop ejaculation at this point, a point of no return.
- Skeletal perineal muscles at the base of the erectile tissues contract with wave-like increases in pressure ("squirts").
- These spasms number about 4 to 5 in the prostate, seminal vesicles, vas deferens and urethra at 0.8-second intervals.
- Accompanying this are involuntary contractions of the internal and external sphincters.
- This last 3-15 seconds and is associated with a slight clouding of consciousness.
- Semen is ejaculated from the urethra to the exterior.
- The ejaculatory spurt is about 30-50 cm at 18 YOA and decreases from there to seepage by about 70 YOA.
- Muscles relax decreasing vasocongestion.
- The penis undergoes detumescence (unswelling) and the genitals disengage.
- A sense of relaxation is felt.

Orgasm

- In some instances (multiple sclerosis, diabetes, after some prostate surgeries), a male may experience retrograde ejaculations, i.e., he may ejaculate “backwards” into his bladder -- this is due to destruction of his sphincter vesiculi.



Female Orgasm

- In the female, orgasm appears to, biologically, be a single-phase process driven by sympathetic impulses, which cause the identical muscles as in the male to contract spasmodically.
- Women's nipples engorge with blood and actually increase in volume/size pre-, peri- and slightly post-orgasm.
- This effect is driven by somatic efferent (motor) impulses.
- Both genders may develop a sexual flush over their chest, shoulders and face, as well.
- Another difference between the two genders is the ability of women to achieve multiple orgasms in a very short period of time while the male requires a refractory period of "recovery" which increases with age prior to achieving his next orgasm and during which he is unable to achieve erection.

Orgasm: is the sudden discharge of accumulated sexual tension in a peak of sexual arousal.



- Sympathetic nerves drive the female orgasm, as well.
- OT is secreted during orgasm in both genders (causes uterus to contract in female and prostate in male).
- Perineal muscles contract giving 3-15 rhythmic spasms of the lower third of the vagina and uterus (from the fundus to the cervix).
- It is also known that the cervix "dips" down towards the vagina during orgasm.
- It is thought that this facilitates sperm movement into the uterus (if semen is present, of course).
- Involuntary spasms of both anal sphincters occur as well.
- Contractions/spasms occur at 0.8-second intervals for 3-15 seconds.

Orgasm



- Orgasm in females is also accompanied by a slight clouding of consciousness, a sense of satisfaction, peace and relaxation.
- Orgasm increases uterine and fallopian tube motility to increase chances of fertilization -- may be due to an increased rate of sperm transport.
- Orgasm is analogous to ejaculation in the male.
- The clitoris and vaginal barrel undergo detumescence just as the penis and testes.
- Ejaculatory inevitability does NOT happen in women, i.e., a female's orgasm can be stopped at any time.

MYOTONIA

- **MYOTONIA is the second of the two primary physiological responses to sexual intercourse.**
- It is a temporary rigidity after muscular contraction just before and peri-orgasm.
- BP also rises, as does the respiratory rate.

Bottom Line

- The bottom line is that, although there are anatomical differences in the anatomical design of the two reproductive systems, there are no physiological sexual differences between the genders.
- Most of the differences about which we read and experience are psychologically and sociologically "programmed" into us as we grow from babies to adults, progressing from home to school to adulthood.
- Sexually, we are truly a product of our environment, our biology and how we synthesized the two to fit our maps of the world.

Detumescence



- In both genders, detumescence is rapid.
- It is described as a "sense of well being" for both genders.
- In males, there is a refractory period that may run from minutes to hours with no further erection/orgasm.
- This increases as the male ages.
- In females, a refractory period does NOT exist.
- A female is capable of having multiple and successive orgasms with appropriate stimulation.

Detumescence -- Male

- In the male, detumescence occurs in two phases:
 - 1) partial disengorgement occurs due to contractions during/from orgasm (pumps blood out of erectile/genital tissues) and
 - 2) a slower phase where genital blood flow returns to levels at the pre-arousal state.
- If vasocongestion is not relieved in the male, PARTICULARLY if very high levels of arousal were reached, he may experience testicular aching and swelling of the vas deferens ("blue balls" [Epididymal Hypertension or Vasocongestion]).

Detumescence



- In both genders, detumescence is rapid.
- It is described as a "sense of well being" for both sexes.
- In males, there is a refractory period that may run from minutes to hours with no further erection/orgasm.
- This increases as the male ages.
- In females, a refractory period does NOT exist.
- A female is capable of having multiple and successive orgasms with appropriate stimulation.

Detumescence -- Female



- In the female, the orgasmic platform disappears after orgasm (contractions "pump" blood away from the genitals).
- The uterus "re-depresses" and "drops" the cervix into seminal pool -- see above graphic.
- The labia change colors back to normal and the vaginal length and width decreases.
- The clitoris disengorges and emerges from the hood.
- Stimulation of the genitals and breasts MAY be unpleasant post-orgasm.
- If vasocongestion does not occur in women, this leads to pelvic congestion and breast congestion with a secondary increase in size.

Vasocongestion

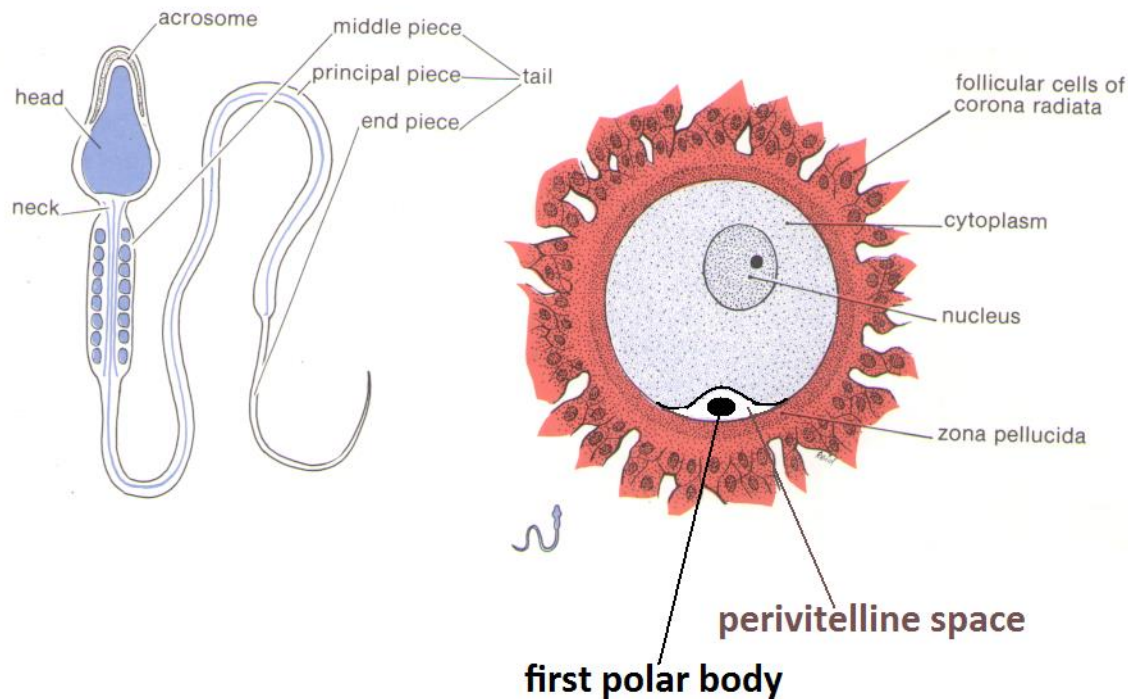
- Both genders' unrelieved vasocongestion may be relieved by orgasms ex post facto (nocturnal or otherwise).

Textbook Changing: Landmark MRI Study



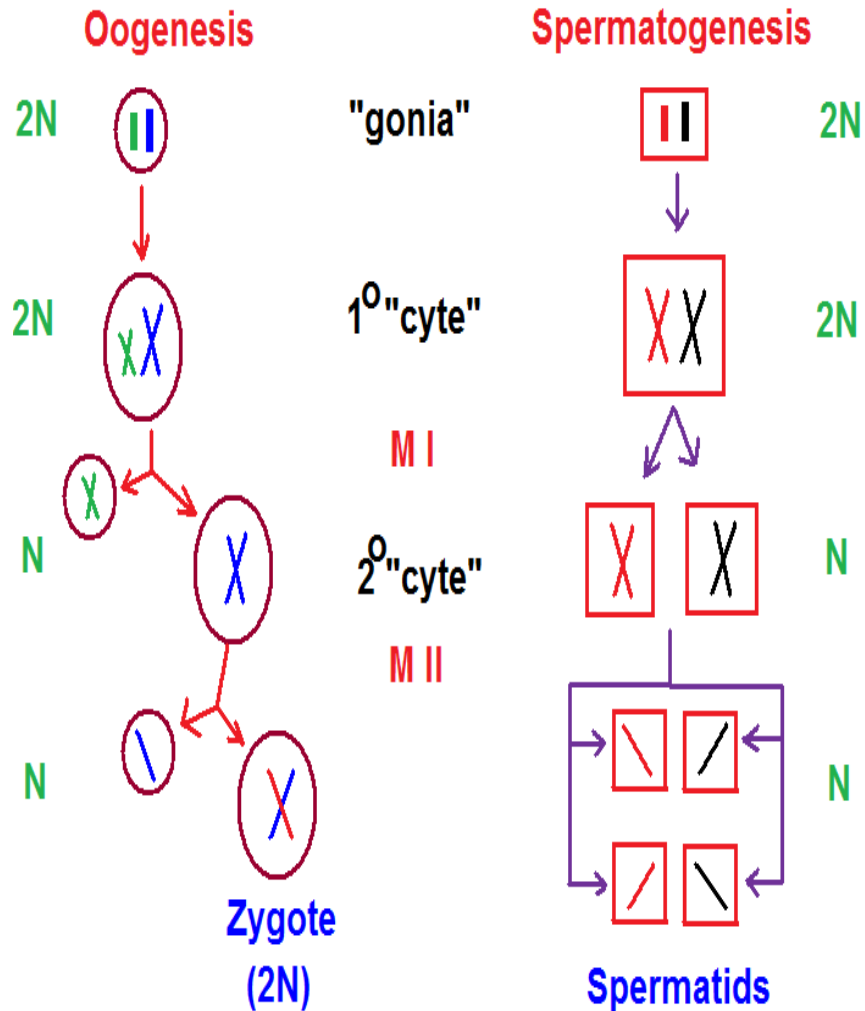
Magnetic resonance imaging of male and female genitals during coitus and female sexual arousal: *BMJ* 1999;319:1596; Pe = perineum

Gametogenesis – More or Less



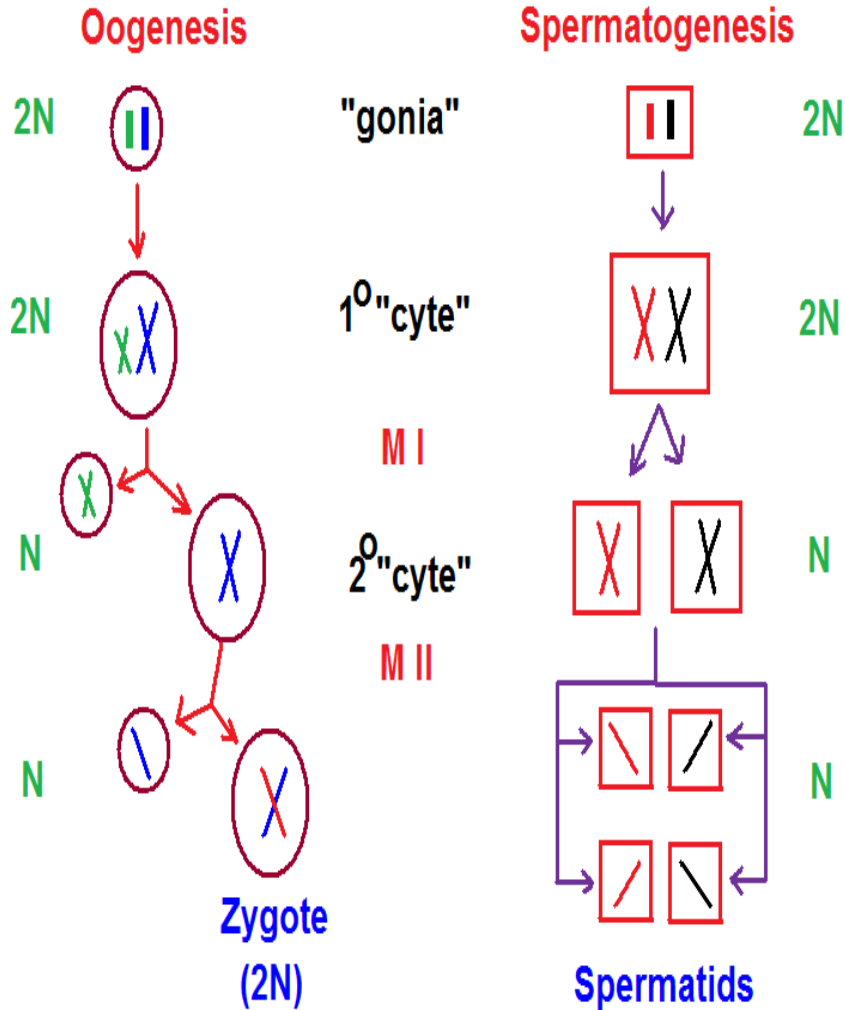
Gametes -- Anatomy

Where Gametes Come from



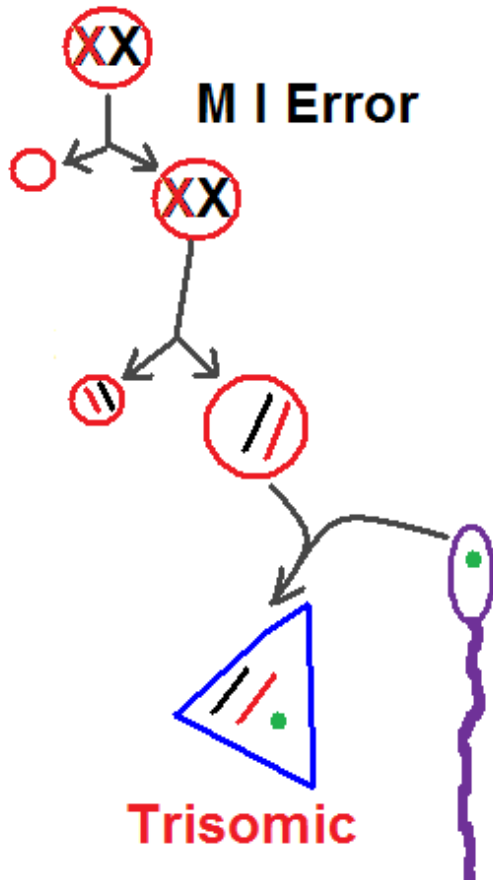
- In **spermatogenesis**, a 2N spermatogonium (stem cell before birth) undergoes mitosis to form a primary spermatocyte and is arrested in prophase I at birth.
- When puberty kicks in, this 2N cell undergoes meiosis I to form two secondary spermatocytes.
- These cells then undergo meiosis II to form four early spermatids which mature to late spermatids, then to spermatozoa.
- From the formation of the secondary spermatocytes on, the cells are N cells, i.e., have 23 chromosomes.

Where Gametes Come from



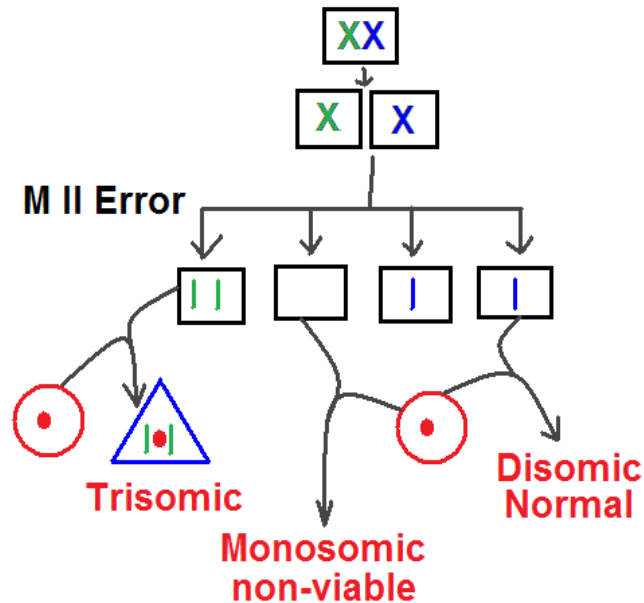
- In **oogenesis**, the 2N cells (oogonium/stem cells before birth) are arrested as primary oocytes in prophase I at birth.
- When puberty kicks in, the primary oocyte (primary follicle) grows and undergoes meiosis I to form a polar body and a secondary oocyte (the mature Graafian follicle).
- Once the Graafian follicle is ovulated, it must be fertilized by a sperm **BEFORE** it can undergo meiosis II.
- If that happens, then a zygote is formed that will differentiate into an embryo and then into a fetus.

Non-dysjunction – Meiosis I



- What happens, though, when non-dysjunction (non-separation during meiosis I or II) occurs?
- Specifically, non-dysjunction is the failure of a pair of chromosomes to separate at meiosis.
- Errors may occur in either meiosis I or II.
- In the case of meiosis I non-dysjunction, this may result in a trisomic zygote.

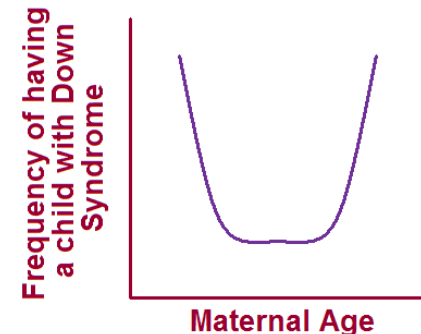
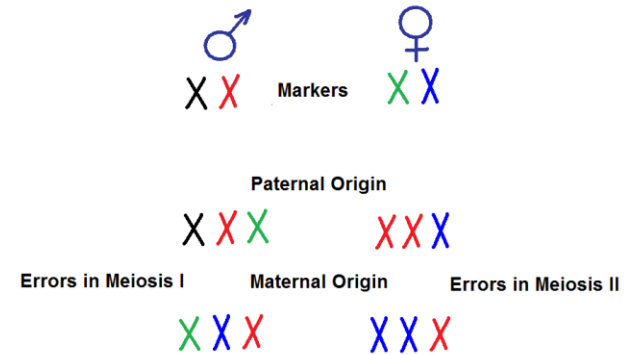
Non-dysjunction – Meiosis II



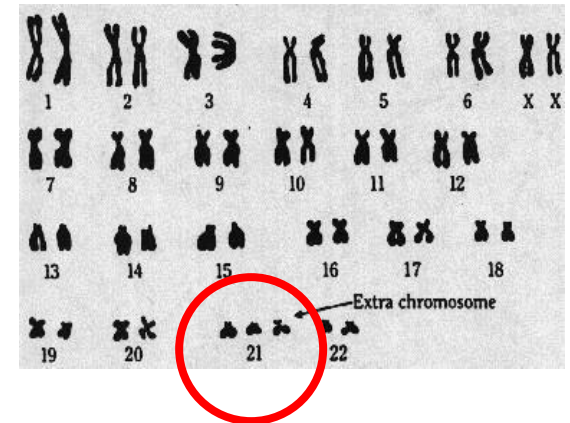
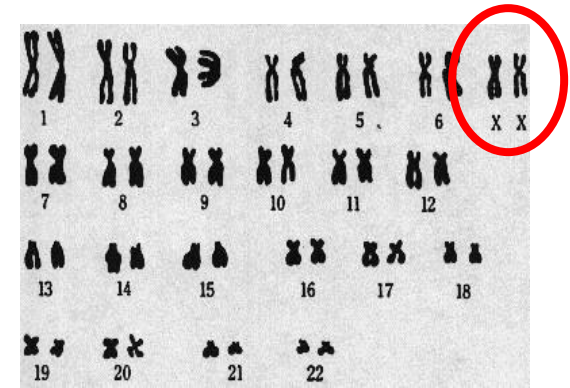
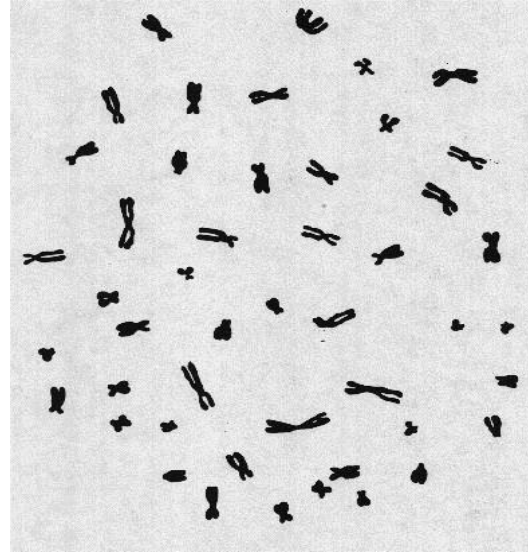
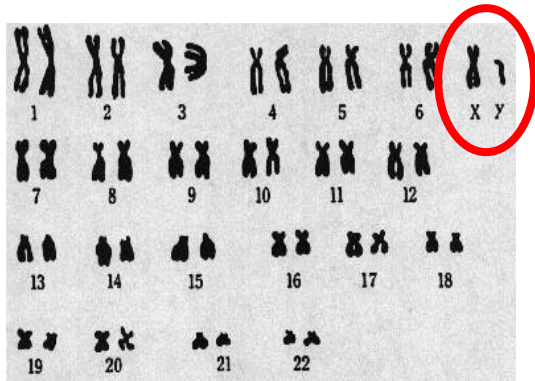
- What happens, though, when non-dysjunction (non-separation during meiosis I or II) occurs? Specifically, non-dysjunction is the failure of a pair of chromosomes to separate at meiosis. Errors may occur in either meiosis I or II.
- If it were to happen in the case of meiosis II in spermatogenesis, the resulting zygote could be monosomic, normal or trisomic.
- The monosomic zygote is not viable.
- In the case of trisomic zygotes that are carried to term, it is possible to determine the origin of the extra chromosome by using stains or fluorescent antibody techniques.
- By walking through the errors, above, in either stage of meiosis, you can see how the following illustration (next 2 slides) takes advantage of these errors by the 74 color coding of the extra chromosome using trisomy 21 as an example.

Trisomy 21 – Down Syndrome

- Did you note in the bottom of the graphic that the frequency of a woman having a child with trisomy 21 follows a "U-shaped" curve: the very young mother and the very old mother have the highest risks of having a child with Down Syndrome.
- Keep in mind that research is showing that at least a third of all cases of children with Down Syndrome are paternal in origin.
- I expect that will level out at 50% in the next 30-50 years.



Karyotyping

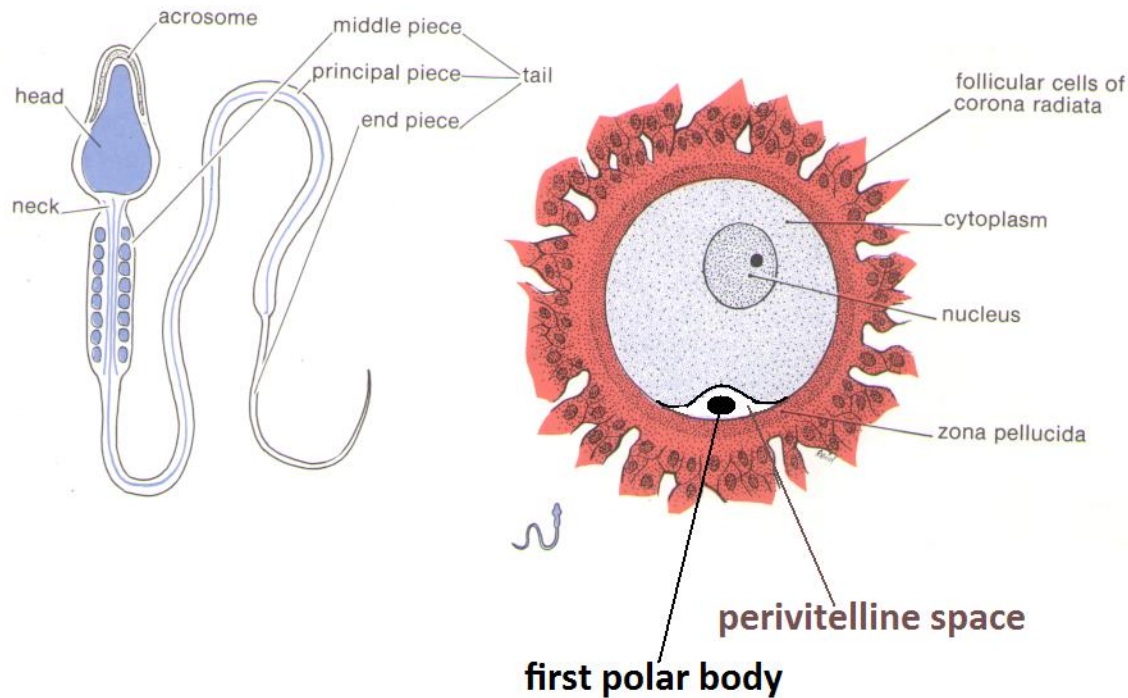


Zygote, Embryological, Fetal and Post-Natal Life Terminology

Pre-Natal Period

Zygogenesis – More or Less

Note: Study the Genetics Experiment Ahead of Time
(<http://www.drcarman.info/bio223lb/223lab05.pdf>)



Gametes -- Anatomy

This section deals with biological definitions throughout the synthesis, production and life of what will become a human being without emotion, i.e., these definitions are biomedical definitions from an objective point of view.

- During the prenatal period, there are numerous transitions and stages.
- The first 5 definitions are very capable of causing an emotional outburst unless one remembers that these are biomedical definitions and are presented as such.
- The emotional and/or ethical concerns do not apply to this discussion, i.e., this is an objective, and not subjective, approach to learning more about human development.
- An abortion is the birth of an embryo or fetus before it is viable.
- All terminations of pregnancy that occur before 20 weeks of gestation are called abortions.
- Spontaneous abortions end pregnancies usually during the first 12 weeks of gestation in about 15% of recognized pregnancies -- these are called miscarriages by the lay person.
- Miscarriage is used colloquially to refer to any interruption of pregnancy that occurs before term.
- Medically it is most accurate to use spontaneous abortion for the birth of an embryo or fetus to about 20 weeks of gestation.
- Thereafter, the event is termed a premature birth.
- Induced abortions are legal, purposeful abortions to end pregnancy.
- Therapeutic abortions are induced due to the mother's health; or to prevent the birth of a severely malformed infant.
- An abortus is any or all products of an abortion weighing 500 grams.

More

- An oocyte is the immature ovum, or female germ cell.
- A zygote is the beginning of a human being.
- It results from the fertilization of an oocyte by a sperm.
- The expression "fertilized ovum" means zygote and is redundant.
- The conceptus is the embryo or fetus and its membranes, i.e., the products of conception.
- It includes all structures that develop from the zygote, both embryonic and extraembryonic.
- Hence, it includes, besides the embryo/fetus, the placenta and membranes.

More

- Cleavage is the mitotic division of the zygote.
- It results in daughter cells called blastomeres.
- At each successive division, the blastomeres become increasingly smaller.
- The morula is a solid ball of cells consisting of 12 to 16 blastomeres.
- In Latin, *morus* means mulberry and this what the morula resembles.
- This stage occurs about 3 days after fertilization.
- The centrally located cells (the inner cell mass) will form the embryo.
- After the morula enters the uterus, a cavity develops inside it and fills with fluid.
- This changes the morula into a blastocyst.

More

- During gastrulation (the period during which the trilaminar disc forms), the embryo is sometimes called a gastrula.
- During neurulation (the period during which the neural plate forms and closes to form the neural tube) the embryo is sometimes called a neurula.
- The term embryo is not used until the second week of gestation, after the embryonic disc forms.
- The embryonic period extends until the end of the 8th week, by which time the beginnings of all major structures are present.
- The term fetus is used after the end of the 8th week.
- The fetal period is from the 9th week to the birth of the infant.
- The rate of body growth is remarkable (particularly during the 3d and 4th months) and weight gain is phenomenal during the terminal months.
- A trimester is how obstetricians commonly divide the nine calendar months, or periods of gestation, into three-month periods.

Post-Natal Period

- Infancy is the first year or so after birth.
- The body as a whole grows particularly rapidly during infancy: its total length increases by about half and the weight is usually tripled.
- The neonatal period is the first two weeks after birth.
- Childhood is the period from about 15 months to 12 or 13 years of age.
- Primary teeth appear and are replaced by permanent teeth.
- Growth just before puberty accelerates and is called the pre-pubertal growth spurt.
- Puberty is the period between 12 and 15 years for girls and 13 to 16 years in boys -- more or less.
- It is during this time when secondary sexual characteristics develop.
- Adolescence is the period of time 3 or 4 years after puberty.
- It extends from the earliest signs of sexual maturity until the attainment of physical, mental and emotional maturity.
- The general growth rate decelerates, but growth of some structures accelerates, e.g., the female breasts.
- Ossification and growth are virtually completed during early adulthood (18-25 years of age).
- Thereafter, developmental changes occur very slowly, usually resulting in the selective loss of highly specialized cells and tissues.

Periods of Gestation

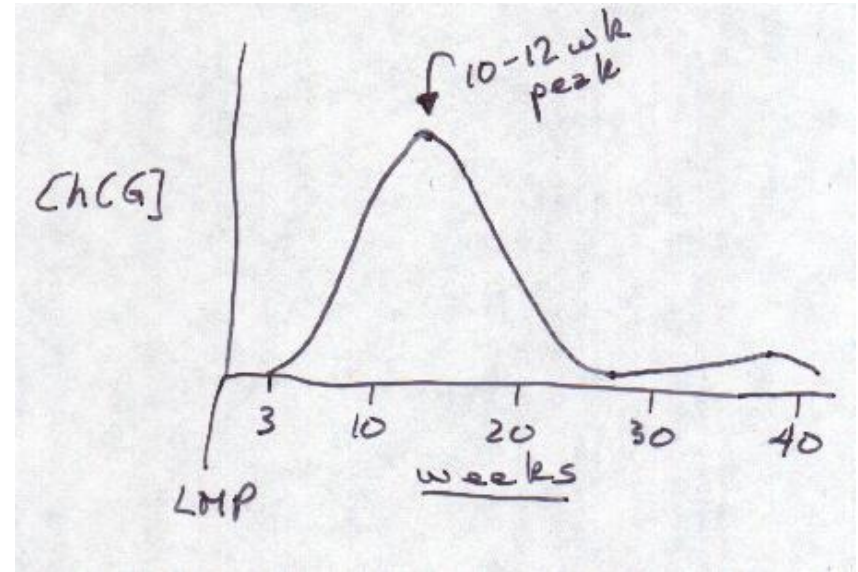
- Weeks 2-4 of gestation are considered to be the pre-embryonic period (discussed in BIOL 223).
- Weeks 4-8 are the embryonic period (discussed in BIOL 223).
- Weeks 9 through parturition are the fetal period (discussed in BIOL 223).
- Do NOT confuse with TRIMESTERS!

- **23 Oct 2013 – New ACOG Guidelines**

- **Babies delivered between 37 weeks and 39 weeks of pregnancy will now be considered "early term." The brain grows by about a third between week 35 and week 39 of pregnancy.**
- **"Full term" infants will be those born between 39 and 41 weeks. Babies born after 39 weeks have fewer poor outcomes such as breathing, hearing and learning problems, and a layer of fat to help keep the body warm is added during the last weeks of pregnancy.**
- **Babies born between 41 and 42 weeks of pregnancy will be thought of as "late term."**
- **Finally, those born at 42 weeks or later will still be considered "postterm."**

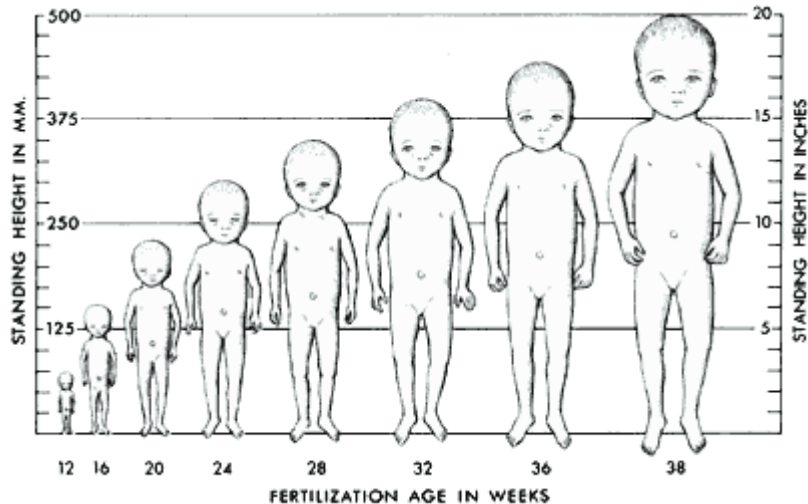
hCG

- The syncytiotrophoblast secretes human chorionic gonadotropin (hCG) that stimulates the CL of ovulation to differentiate into the CL of pregnancy.
- The trophoblast differentiates into the "pre-placenta" or syncytiotrophoblast which continues secreting hCG.
- The CL of ovulation secretes progesterone to 6-8 weeks of gestation, then the placenta takes over.
- When this occurs, it mimics taking the pill: when you take the placebo tablet, you go through progesterone withdrawal, causing break-through bleeding.
- It is not uncommon for women to experience a little "spotting" at the time of "switching" of progesterone-synthesizing tissues.
- hCG is detectable up to 2 weeks post-partum; the hCG peak occurs at about 10-12 weeks of gestation and occurs when the cytotrophoblast is at its maximum thickness.

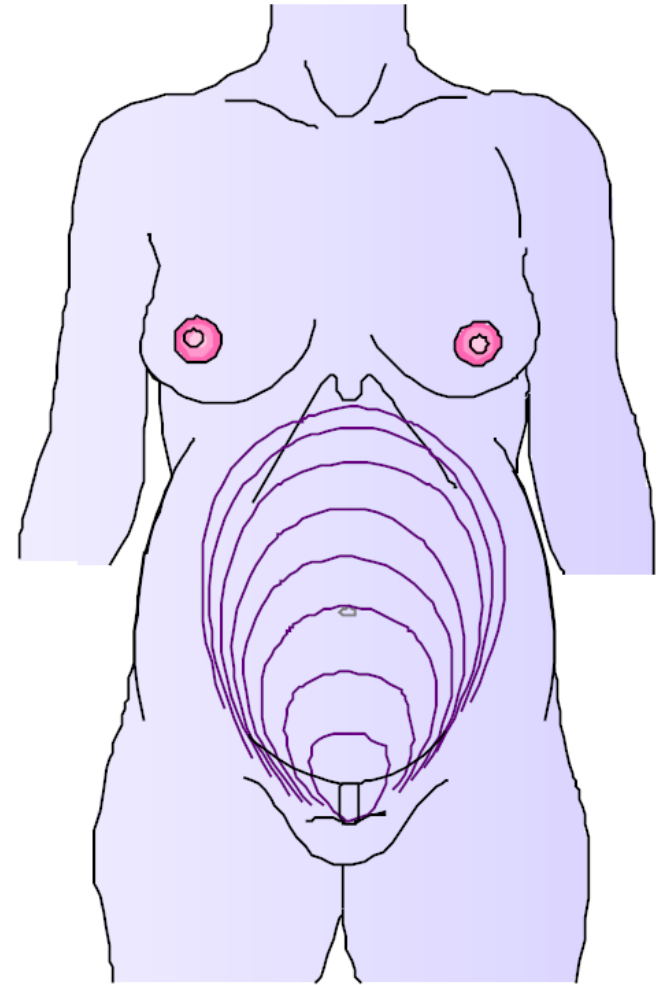


- ASIDE: At parturition, the CL of pregnancy secretes relaxin: a hormone that causes the pelvic ligaments to relax so that the pelvis spreads, allowing the baby to be born.

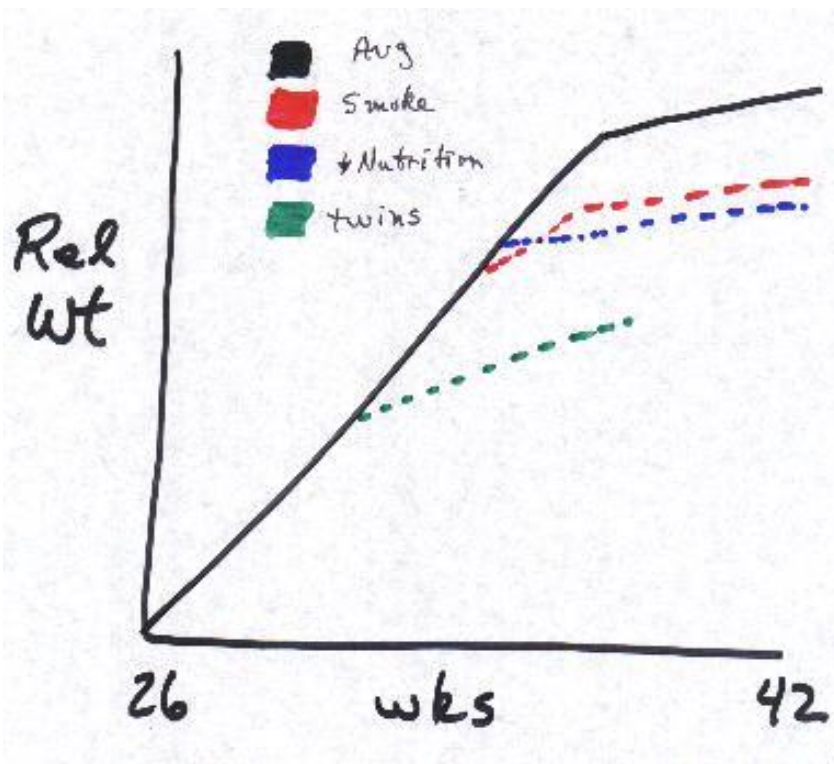
Overall Growth *in utero*



- Note that the growth is geometric in the second trimester and levels off in the last trimester -- almost representative of a rectangular hyperbola.
- Pretty incredible, huh?!



The rate of fetal growth has been extensively studied as researchers and clinicians, alike, wish to know what effects fetal growth as that generally has some effect upon extra-uterine life:



- Note that compared to average fetal growth rates, those born to mothers who smoke are about 13% smaller than those born to non-smoking mothers.
- Twins, by their very nature, are smaller than singleton births.
- Mothers who do not eat well during pregnancy give birth to babies who are smaller than those born to mothers who smoke -- it would be interesting to know the effects of both on a developing fetus.

Fetal Age Approximation

Age (weeks of gestation)	Characteristic -- identification clue
10	Intestine in abdomen; early fingernail development
12	Sex distinguishable
16	Ears stand out
18	Vernix caseosa ("cheesy covering") present; early toenail development
22	Skin wrinkled and red
28	Eyes open, good head of hair; testes are at the deep inguinal rings
32	Fingernails reach fingertips; skin pink and smooth; testes enter scrotum
36	Body plump; toenails reach toe tips; firm grasp
38	Prominent chest; breasts protrude; testes in scrotum; fingernails beyond fingers

Teratogens and Development

Androgens	Masculinizes female fetuses
Alcohol	Causes fetal alcohol syndrome, intra-uterine growth retardation, mental retardation
Lithium carbonate	Cardiovascular malformations
Methotrexate	Facial, skull, spine and extremities' skeletal malformations
Warfarin	Nasal hypoplasia, retardation, microcephaly
Cytomegalovirus	Micro- and hydrocephaly, retardation
Herpes simplex virus	Microcephaly, microphthalmia
Toxoplasma gondii	Microcephaly, cerebral calcifications, microphthalmia
Treponema pallidum	Congenital deafness, retardation, hydrocephaly
High radiation	Skeletal malformations; retardation

Critical periods in human development are summarized below.

These are the times when specific organ systems are most susceptible to teratogens:

0-2 Weeks of Gestation

Zygote to bilaminar disc

Usually NOT susceptible to teratogens; if is susceptible, causes death (spontaneous abortion) – may not be noticed by mother

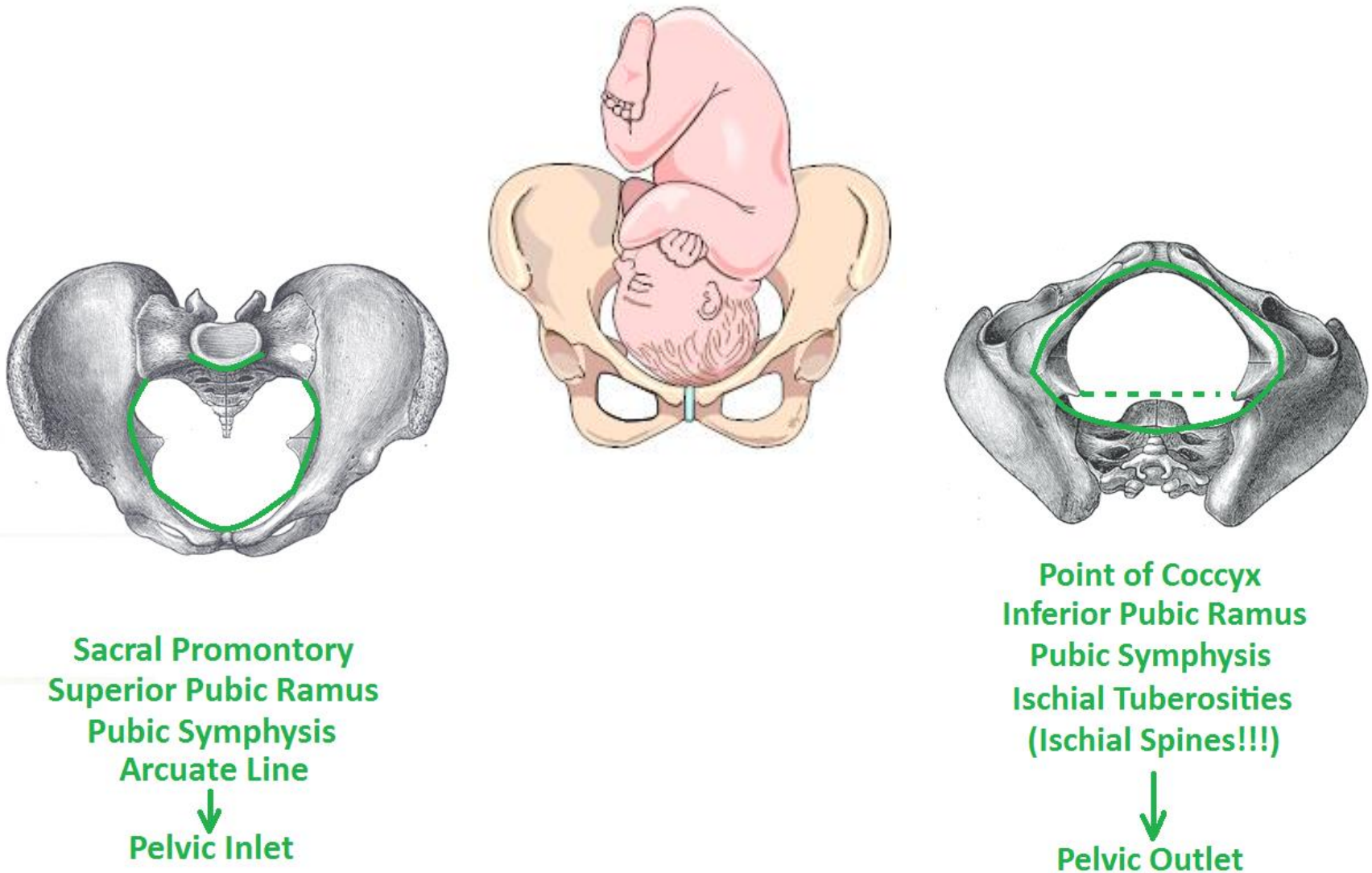
3-8 Weeks of Gestation

- [pre] embryonic
- Major morphological malformations
- 3-6 weeks: CNS (may be effected throughout gestation)
- 3-7 weeks: Heart
- 4-8 weeks: Upper/lower limbs; eyes (may be effected throughout gestation)
- 6-9 weeks: Teeth (may be effected throughout gestation); palate; external genitalia (may be effected throughout gestation)
- 7-9 weeks: External genitalia (may be effected throughout gestation)
- 4-9 weeks: Ear

9 Weeks to Term

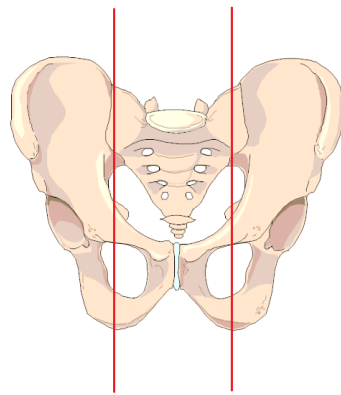
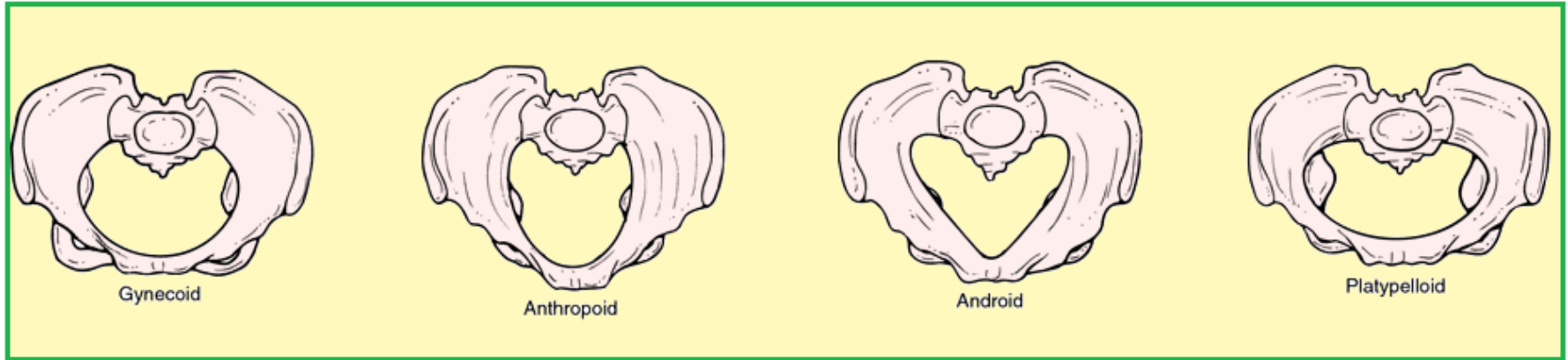
- Physiological defects and minor morphological malformations

Delivery of The Fetus: Preparation

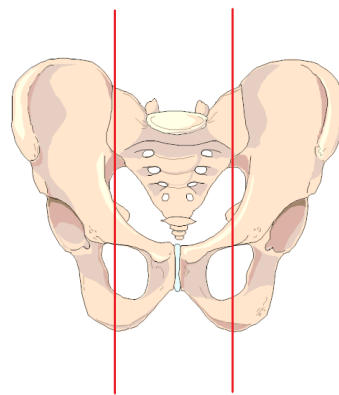


Pelvic Inlet & Outlet

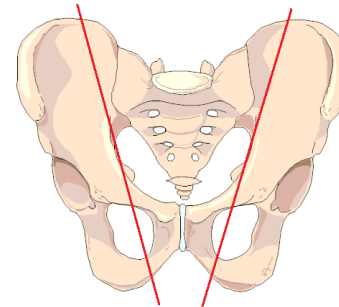
Generic Pelvis Types in Females



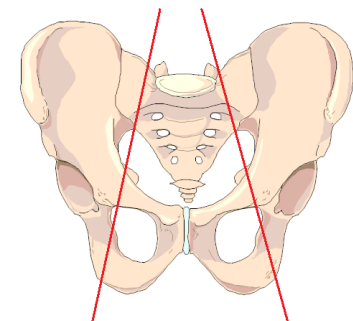
transverse ellipse --> circle



AP ellipse



Heart shaped



Kidney shaped



Gynecoid



Anthropoid

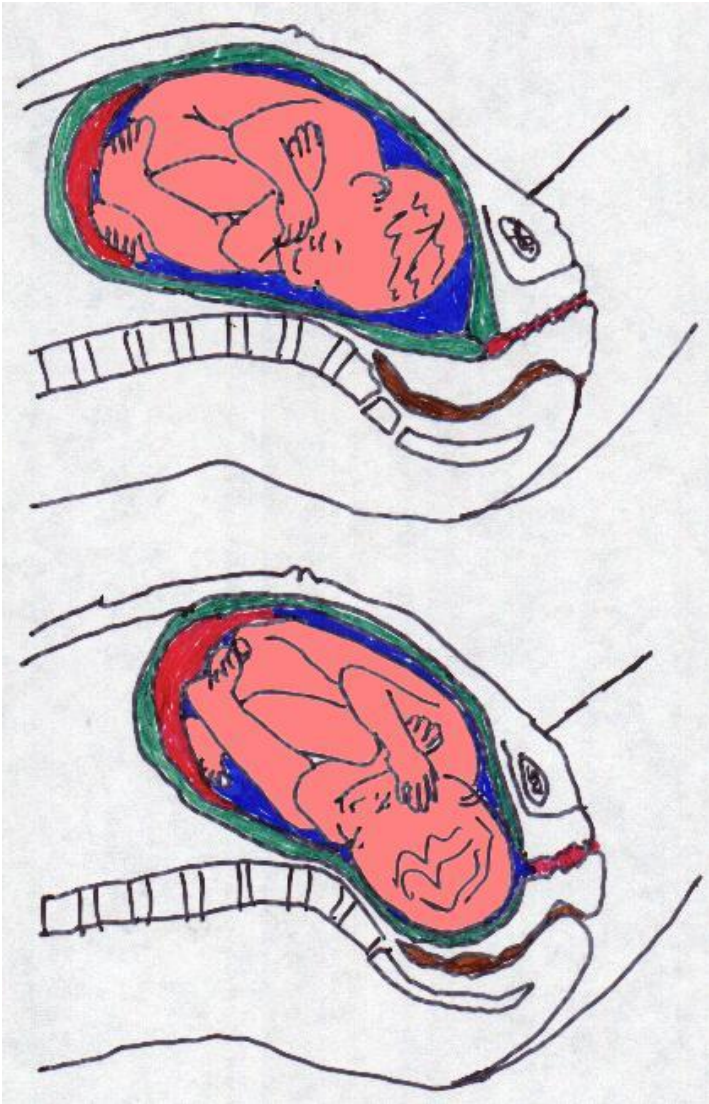


Android



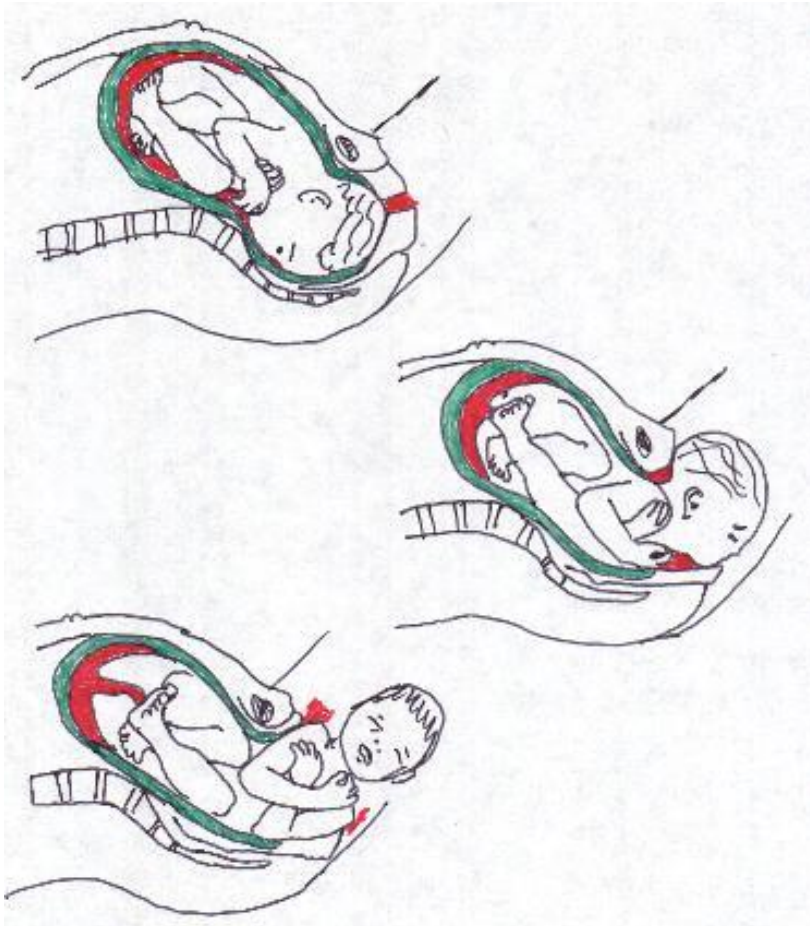
Platypelloid

Stage 1 – Labor and Delivery



- The figure illustrates the first stage (Stage I).
- For the purposes of this course, this stage is characterized by the baby (fetus) dropping further into the pelvic cavity, placing pressure on the cervix. Following this pressure, the cervix begins to dilate.

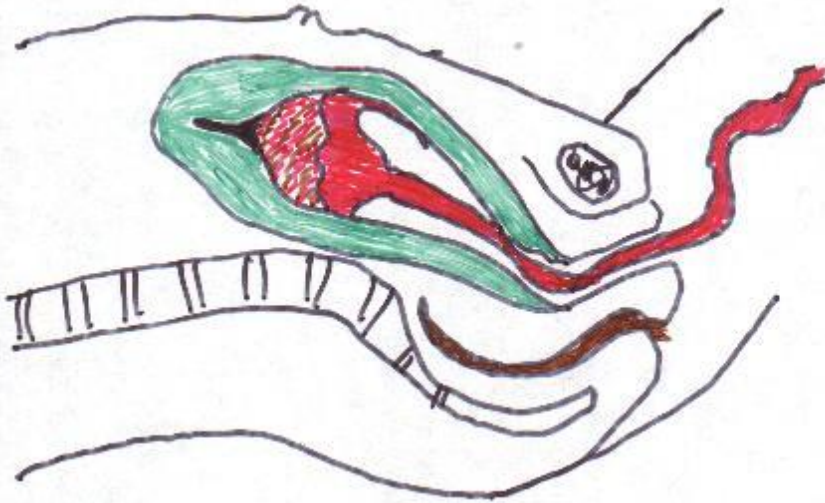
Stage 2: Labor and Delivery



- The graphic illustrates the second phase of labor and delivery: Stage II.
- This stage is characterized by full dilatation of the cervix and delivery of the newborn baby.

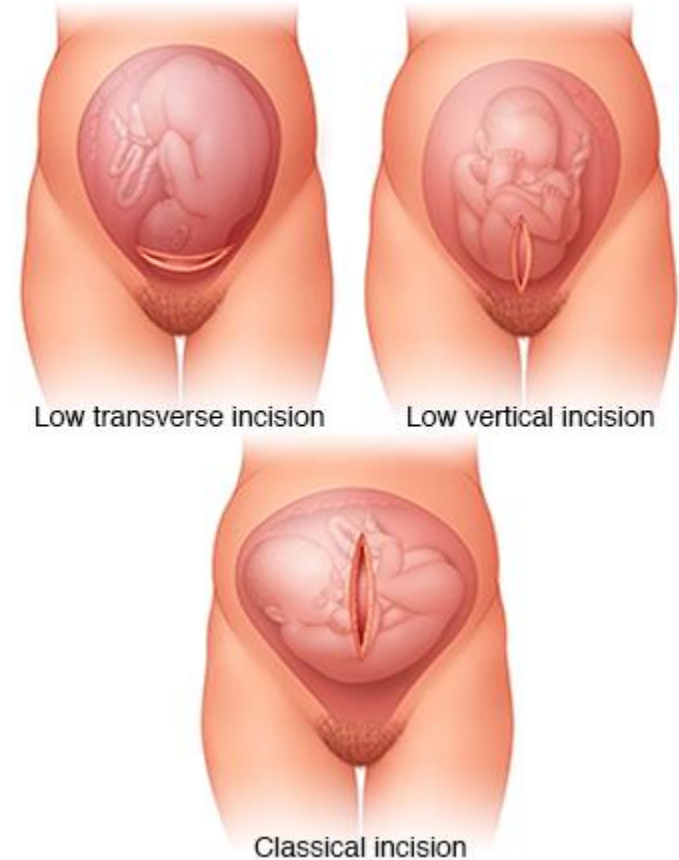
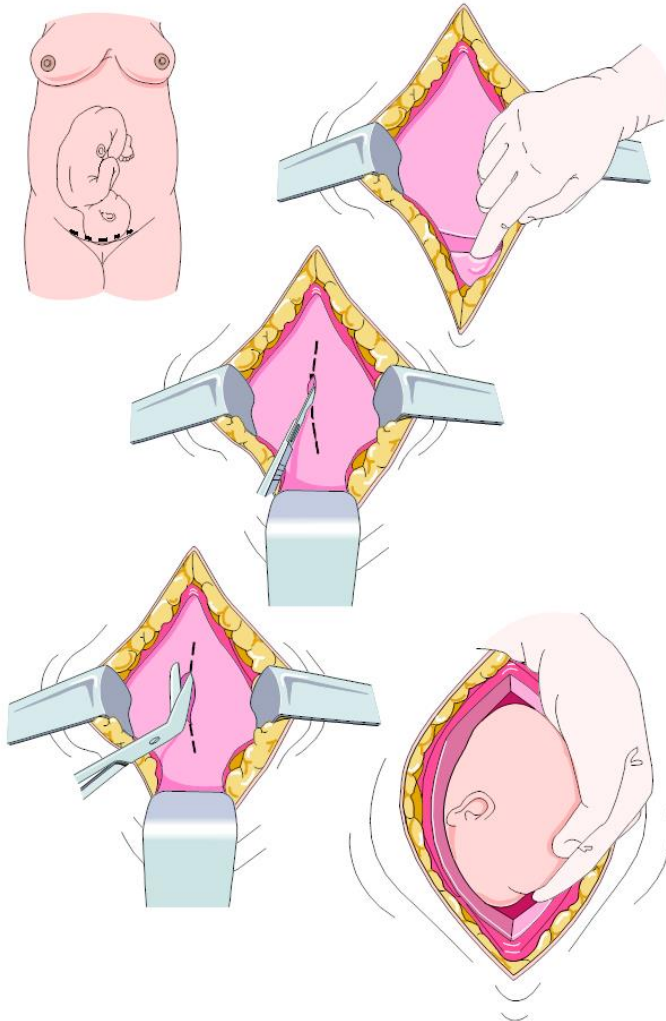
Stage 3: Labor and Delivery

- The graphic, right, illustrates the final stage of labor and delivery.



- This final stage (Stage III) is characterized by hematoma formation and delivery of the placenta. It is during this stage that fundus massage is useful in causing the uterus to contract upon itself, creating its own pressure dressing to stop uterine bleeding.

C-Section – Simple Graphics



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<https://www.mayoclinic.org/tests-procedures/c-section/multimedia/uterine-incisions-used-during-c-sections/img-20006738>