

Reproductive System

Function: producing offspring

propagation of the species

‡ in terms of evolution – the *only* reason all the other systems exist

only major system that doesn't work continuously

‡ only activated at puberty

in 7th week of embryonic development genes are activated that trigger differentiation of gonads

Anatomy of Male Reproductive System

Major Organs

External sexual organs:

penis and scrotum

Internal structures form continuous tube:

Testes

epididymus

vas deferens

ejaculatory duct

urethra in penis

Accessory organs

seminal vesicles

prostate gland

bulbourethral glands

1. Penis and Scrotum

transfer organ

glans ‡ expanded head

prepuce ‡ foreskin

both have modified sebaceous glands that produce waxy secretion
= **smegma**

inside penis are three cylindrical bodies called **erectile tissue**

‡ fill with blood during sexual arousal

scrotum keeps testes at cooler temperature for sperm development

2. Testes (=testicles)

primary reproductive organ of male

has dual function

a. **hormone secretion:**

‡ testosterone

1. development and maintenance of secondary sexual characteristics
2. stimulates protein synthesis
3. promotes growth of skeletal muscles

b. **spermatogenesis:**

‡ formation and maturation of sperm cells

a. **seminiferous tubules**

in cross section:

seminiferous tubules appear roughly circular where sperm cells are produced

b. **interstitial cells**

are scattered between the seminiferous tubules

endocrine cells ‡ testosterone

3. Epididymis

epididymis is highly coiled, 18' tube that sits on outside of testes

Once produced sperm move to epididymis where they mature and are stored until "duty calls"

stored sperm remain fertile for 40-60 days

older sperm disintegrate and are reabsorbed by epididymis

4. Vas Deferens (=ductus deferens)

a long muscular tube leading from **epididymis** in scrotum, through the **inguinal canal** into the **pelvic cavity** and around the posterior side of the **bladder** where it unites with ducts from the **seminal vesicles**

5. Ejaculatory Duct

ducts from **seminal vesicles** join vas deferens to form a short ejaculatory duct that passes through the **prostate gland** and joins the urethra

6. Urethra

ejaculatory duct connects with urethra inside the prostate gland

urethra opens to outside via the **penis**

penis contains **erectile tissues** that surrounds the urethra

‡ fills with blood to produce an erection

2 **corpus cavernosum** (upper)

1 **corpus spongiosum** (lower – surrounds urethra)

Accessory Organs

three accessory glands secrete fluids that mix with the sperm = **semen**

1. seminal vesicles (paired)

pair of glands dorsal to bladder, each ~5 cm long

secrete viscous yellowish liquid rich in fructose, prostaglandins and other nutrients that comprises ~60% of the semen

fructose serves as energy source for sperm

2. prostate gland (single)

inferior to bladder, ~3 cm diameter

surrounds ejaculatory duct at junction with urethra

secretes a thin, milky, liquid that protects sperm from the acidity of male urethra and female vagina

3. bulbourethral glands (paired)

small (~1cm) pea-shaped glands below prostate

during sexual arousal they produce a clear, slippery fluid that lubricates the head of the penis in preparation for intercourse

also protects sperm by helping to neutralize the acidity of residual urine in urethra

during arousal some of this fluid may appear at tip of penis and

may contain sufficient sperm to fertilize the egg even without actual ejaculation

Semen (=seminal fluid)

mixture of sperm and glandular secretions

typical discharge is 3 – 5 ml

~10% is sperm and fluids from spermatic ducts

30% prostatic fluid

60% fluid from seminal vesicles

trace from bulbourethral glands

today sperm count in healthy young male ranges between 40-120M sperm/ml

a sperm count lower than 35 M/ml is usually associated with infertility

Physiology of Male Reproductive System

the anterior pituitary gland serves as the primary control of reproductive function

at puberty Ant Pituitary secretes FSH & large amounts of LH (ICSH)

FSH & LH cause testes to increase in size and begin sperm production

LH † triggers testes to produce testosterone

the secretion of FSH and LH is fairly constant from day to day in males

male hormone (=androgens) are secreted mainly by **interstitial cells** of testes

main male hormone is **Testosterone**

additional testosterone is secreted by Adrenal Cortex

Testosterone functions:

1. local effects on sperm development in seminiferous tubules

decrease in testosterone can cause sterility

2. stimulates general protein synthesis

3. promotes muscular development, bone growth,
thickening of skin and growth of facial and body hair
4. development and maintenance of secondary sexual characteristics
hair pattern
thickening of vocal cords and enlargement of larynx to
lower of voice pitch
5. behavioral changes (~sex drive, aggression, courtship behaviors)

Androgens are also produced in women
ovary & adrenal cortex
relatively weak
promotes protein synthesis, growth
not masculinizing

Negative feedback loop maintains constant level of testosterone in blood:
‡ high testosterone levels inhibit LH

Spermatogenesis

process of sperm production ‡ process takes ~ 70-80 days

sperm are produced in **seminiferous tubules**

sperm develop from a type of stem cell = **spermatogonia**

Steps of spermatogenesis:

1. **spermatogonia** remain dormant in childhood
2. at puberty they begin to divide (mitosis)
3. some **spermatogonia** begin moving away
from the wall of the tubule and enlarge to become **primary spermatocytes**
4. **primary spermatocyte** undergoes meiosis I
to produce **secondary spermatocytes**
5. **secondary spermatocytes** undergo another division to produce
spermatids

one primary spermatocyte produces 4 spermatids
6. spermatids mature into sperm cells

by the time spermatozoa form they are near the lumen of the seminiferous tubules

spermatozoa are released and washed down the tubule to the epididymus

Spermatozoan Structure

composed of a **head** and a **tail**

head

long “pear” shaped

acrosome – contains enzymes that will be used to penetrate the egg

tail

includes

midpiece ‡ produce the ATP needed for propulsion

flagellum ‡ means of locomotion

Anatomy of Female Reproductive System

External Sexual Organs:

vulva

mammary glands

Internal structures and organs

ovaries

oviducts

uterus

vagina

1. Vulva

at external opening of vagina

accessory structures of female reproductive tract

mons pubis

labia majora

labia minor

clitoris (homologous to male penis)

bartholins gland (for lubrication, homologous to bulbourethral glands in males)

function:

sensory arousal

glands for lubrication

2. Breasts (Mammary Glands)

nutrient rich food for nursing infant

in developing countries often the best meals a person gets in his/her lifetime

‡ diseases associated with cessation of nursing

each breast consists of several lobes of **secretory cells** embedded in connective tissue

ducts from individual glands unite to form single duct

‡ duct exits through **nipple**

3. Ovaries

perform two major functions:

1. oogenesis

formation of eggs

2. hormone secretions

mainly estrogen and progesterone

cortex of ovaries are covered by layer of small epithelial cells

= **germinal epithelium**

within follicles are partially developed egg cells

‡ newborn baby already contains ~2 million eggs that have partially developed

ovaries and other internal reproductive organs are held in place by several connective tissue ligaments:

ovarian ligament – connects ovary to uterus

suspensory ligament – connects ovary to pelvic wall

broad ligament – encloses uterine tube and connects it to sides of uterus

4. Uterine Tubes(=oviducts, fallopian tubes)

open at one end to receive the egg at ovulation

opening is enlarged and partially surrounds ovary feathery projections = **fimbriae**

ciliated along its length and muscular wall to move egg down to uterus

fertilization occurs here

5. Uterus

a thick pear-shaped, muscular organ

subdivided into:

- fundus** = upper portion
- body** = mid portion
- cervix** = lower portion that extends into the vagina

receives egg from oviduct

‡ if fertilized, holds embryo and fetus during development

3 layers:

- perimetrium** (=visceral peritoneum) ‡ serous tissue
- myometrium** ‡ muscle layers
- endometrium** ‡ inner mucous lining

8 **ligaments** hold uterus in place

6 are mainly extensions of peritoneum

1 pr (= **round ligaments**) are fibromuscular cords

6. Vagina (birth canal)

leads to outside of body

muscular tube ‡ wall is thin but very distensible

mucosa secretes lubricating fluid during sexual arousal

at its lower end, mucosa folds inward and forms a membrane
= the **hymen**

which is ruptured by strenuous activity, insertion of tampons as
menstrual cycle begins or first intercourse

not connected to urethra

Physiology of Female Reproductive System

the major female reproductive processes:

- a. **hormone secretion** by ovary
- b. development of **follicle cells** surrounding egg
- c. **oogenesis & ovarian cycle** ‡ maturation of egg
- d. **menstrual cycle** ‡ development & shedding of uterine lining

in women, all are cyclic events
‡ not continuous as in males

involve a complex combination of several interdependent hormonal cycles

Hormone production

Puberty: Ant Pituitary begins secreting FSH and LH
~7-8 yrs old

FSH & LH production increases until ~11-13 yrs old
‡ triggers menstrual cycle & development of secondary sex characteristics

FSH & LH stimulate follicle cells in ovary to begin secreting estrogen & progesterone

Estrogen function:

1. development and maturation of reproductive tract
2. development and maintenance of secondary sexual characteristics
 - change in fat distribution
 - enlargement of mammary glands
 - inhibits growth of extremities
3. behavioral changes (~sex drive, courtship behaviors)

Progesterone function:

1. has its greatest effect on estrogen primed tissues
2. changes that favor pregnancy and lactation
 - endometrial thickening
 - development of mammary glands

Oogenesis

in fetus, immature egg cells (=oogonia) multiply by mitosis until 5th month of gestation

during reproductive years, 10-20 primary oocytes and follicles begin to develop each month.

normally just one of these reaches maturity and ovulates and the rest degenerate

as follicle cells develop, egg develops within under influence of FSH & LH from Ant. Pituitary

egg undergoes meiosis but stops as **secondary oocyte** (metaphase II) until fertilization

only ~400 – 500 follicles will ever develop into mature ova and be released by ovaries during a woman's reproductive years

when woman reaches menopause (~50 yrs) very few primary follicles are left in ovaries

‡ reproduction ceases

Development of Follicle Cells

within the ovary immature egg cells = **primary oocytes** are enclosed within **primordial follicles**

each month secretions of FSH stimulates some of these to develop into **primary follicles**

mitosis & development of these cells ‡ they begin to produce **estrogens**

by 10 days or so only one primary follicle remains and has matured into a mature follicle (= **graafian follicle**)

mature (graafian) follicle contains egg surrounded by fluid filled **antrum**
‡ this is the follicle that will ovulate

after ovulation, the follicle collapses and becomes the **corpus luteum**
‡ secretes large amounts of progesterone

egg nest ‡ follicle ‡ antrum develops ‡ Graafian follicle ‡ ovulation ‡ Corpus Luteum ‡ Corpus Albicans

corpus albicans = scar tissue

the maturation of the egg, ovulation, hormone production and preparation of uterine lining are all cyclic events

these cycles are roughly 28 days long and have different names depending on the process in focus

The Ovarian Cycle

divided into:

a. follicular phase

a single follicle matures and is released at ovulation
lasts ~12 days

b. luteal phase

remaining follicle cells develop into corpus luteum
lasts ~11 days

c. menstrual phase

uterine endometrium is shed =menstruation
lasts ~5 days

The Menstrual Cycle

This cycle is tied to variations in several hormones

4 phases:

menstrual phase (days 1-6)

shedding of uterine lining if no fertilization

proliferative (follicular) phase (days 6-12)

as follicle develops it secretes increasing amounts of estrogen
endometrium cells proliferate

ovulatory phase (days 12-16)

ovulation ‡ release of mature egg from ovary

secretory (luteal) phase (days 16-28)

follicle cells left behind after ovulation develop into corpus
luteum

corpus luteum secretes increasing amounts of progesterone
continued increase in development of endometrium

Mammary Glands

during pregnancy breast development is stimulated by **estrogen** and
progesterone secreted by placenta

at birth shedding of placenta

‡ cuts off source of these hormones

‡ stimulates Ant. Pit. to secrete prolactin

Prolactin stimulates lactation (devel of milk in glands)
usually takes several days for full milk production

Suckling of infant further stimulates secretion of
prolactin

oxytocin (from Post. Pituitary)

‡ promotes ejection of milk into ducts

+feedback: more suckling ‡ more milk released