Reproduction:

General introduction:

There are two main methods of reproduction:

Asexual - This only involves a single animal, and the genes of the offspring all come from the parent (without going through sperm/egg fusion).

Sexual - This requires the fusion of egg and sperm to develop a *zygote*.

A zygote is a fertilized egg cell.

Some types of asexual reproduction:

Fission - the parent splits into two more or less equal halves. Each half then goes on to grow and mature.

Budding - a bit similar to fission, but the parent buds off new individuals that are smaller than the parent. This new individual can remain attached to the adult, or separate and go off on it's own.

Corals (cnidarians) - the young stay attached.

Hydra (also cnidarians) - the young detach.

Fragmentation - the body breaks into several pieces, each of which can then form a new individual.

[This does not include merely re-growing limbs (or tail)].

Starfish are a good example of animals that can do this

Parthenogenesis - The egg develops without being fertilized.

The young may be haploid or diploid, depending on whether or not the haploid egg doubles before developing.

Found in many animals, e.g. Rotifers, Daphnia, sharks, and whiptail lizards.

Some animals may reproduce both sexually and asexually.

Corals again are a good example.

In general, sexual reproduction is used during more stressful times, and asexual reproduction when times are good (why?).

Sexual reproduction - In this case, obviously, fertilization is required. The sperm must meet up with and fertilize an egg.

This can be a problem for sessile organisms. How to get the sperm to the female?

How, for example, can a parasite find a member of the opposite sex?

One solution is to become a hermaphrodite.

A hermaphrodite has both female and male functional reproductive structures.

This makes it easier to find a mate (every member of the same species is a potential partner).

Also, since two individuals can exchange sperm, potentially twice as many offspring can be produced (though this aspect is really a bit more complicated).

Sequential hermaphroditism.

Some organisms may change their sex during their lifetime.

Some fish, for example, become male as they get older, others become female.

Methods of fertilization:

External - the union of sperm and egg occurs outside the body.

Typically, eggs are released by the female, then the male covers the eggs with sperm.

Many animals will do this (frogs, many fish, etc.)

Internal - sperm are deposited in or near the female reproductive tract, and fertilization occurs within the female reproductive tract.

This is what we're most familiar with.

We should also be aware of the following breakdown regarding births:

Oviparous - the animal lays eggs, the embryos develops within eggs, and the eggs hatch.

Lots of animals: birds, many reptiles, many fish, many amphibians, etc.

Viviparous - the young develops inside body of mother, AND gets nutrients from mother.

Typically, mammals, and just possibly a few reptiles.

Ovoviviparous - animal develops inside egg (or similar structure), but the egg is kept inside the body of the mother until the young has developed.

Many reptiles and some fish (e.g., sharks) are examples.

(Note that obviously a “shell” is not put around the egg).

Human reproductive system:

Male system:

Externally, consists of the *scrotum* and *penis*.

Internally **[2 OVERHEADS, fig. 27.4 A & B, p. 538]** there are lots of parts:

Testes - sperm forms in the testes.

But body temperature is too high for normal formation of sperm, so the testes must are often kept outside body

The scrotum is often about 2 degrees colder than the body.

In many animals, the testes don't descend except during the breeding season.

Epididymis - once they form in the testes, the sperm move into the epididymis.

This is basically a coiled tube, and is used to store and give time for the sperm to mature.

It takes about 20 days for sperm to move through the epididymis.

Vas deferens - during ejaculation, sperm are moved from the epididymis into the vas deferens.

This tube leads from the epididymis almost all the way to the urethra.

Seminal vesicles - these contribute volume, but also fructose (energy) and other substances, particularly prostaglandins.

Fluid from the seminal vesicles joins the vas deferens.

Together they form a short *ejaculatory duct* that takes the sperm and fluid from the seminal vesicles into the urethra.

(Remember - the urethra is the duct coming from the bladder going to the outside).

Prostate gland - a large gland at the base of the bladder.

This contributes anticoagulant enzymes, and some more nutrients.

This causes the most common medical problem in men over age 40.

In about half these cases it enlarges.

Almost all men over 70 have enlarged prostates.

Usually this is noncancerous, but it obviously needs to be checked.

Bulbourethral glands (sometimes “Cowper's glands)

secrete a clear mucus before ejaculation.

Also helps neutralize any leftover acidity from the urine as well as in the vagina.

Overall, semen that is finally ejaculated has the following properties:

It is slightly basic, which helps neutralize the acidity in the female reproductive tract.

It contains anticoagulants which help keep the sperm liquid in later stages.

The prostaglandins have two functions:

They thin the mucus at the opening to the uterus

They help stimulate contractions of the uterus to move sperm further into the female reproductive tract.

(We'll see prostaglandins again later).

Female reproductive system **[2 OVERHEADS, fig. 27.3A & C, p. 536 - 537]**.

Externally consists of the *clitoris*, two sets of *labia* around the clitoris and the opening to the *vagina*.

Internally (working from inside out):

Ovaries - female gonads. These lie in the abdominal cavity. Each ovary contains follicles.

(*gonads* - organs that make gametes (in humans, ovaries or testes))

Follicles - consist of an egg and numerous “supporting cells". All follicles will have developed before birth.

After puberty, one follicle matures and releases it's egg during each menstrual cycle.

The cells of the follicle are also responsible for producing estrogen (which means that the levels of estrogen vary throughout the menstrual cycle).

Ovulation - the process of releasing eggs into the *fallopian tubes* (or *oviducts*).

Corpus luteum - after ovulation, the follicle develops into a *corpus luteum*.

This maintains the hormones necessary for the maintenance of the uterine lining.

If the egg is not fertilized, this disintegrates.

Fallopian tubes - passage for eggs to travel from the ovaries (after ovulation) to the uterus.

Cilia lining the oviduct help move the egg into the oviduct, and also help transport the egg from the oviduct into the *uterus*.

On rare occasions, the egg may move out of the oviduct into the abdominal cavity (despite the cilia).

If this is a fertilized egg, this can lead to an ectopic pregnancy (very dangerous).

Similarly rare - the egg stays in the oviducts

Again, if this is a fertilized egg this can develop into a tubal pregnancy (also very dangerous).

Uterus - a thick, muscular organ that can expand and hold the fetus as it develops. The inside lining (endometrium) is highly vascularized. The uterus opens into the *cervix*.

Cervix - a constricted area at base of uterus that connects to the vagina. Also protects the opening to the uterus.

Female reproductive cycle.

Most mammals actually have an *estrous* cycle.

Most of the uterine lining is re-absorbed if there is no pregnancy

Hormonal changes are much more pronounced (levels of hormones go up and down a lot more).

Can be shut off.

Some animals only come into estrous once or twice a year.

The *menstrual* cycle (as in humans) **[OVERHEAD, fig. 27.6, p. 543]**:

Usually the first day of menstruation is considered "day 1" (sometimes “day 0”).

When flow ends, 3-4 days later (varies), the uterine lining is very thin, and no ripe follicles are in the ovaries.

FSH (Follicle stimulating hormone) is produced by the pituitary - this simulates follicle production.

Together with *LH* (Lutenizing hormone), this causes the follicles to release *estrogen*.

Eventually, one follicle becomes "dominant"; this causes the others to stop growing.

Estrogen is made by the follicle as it grows; this causes the lining of the uterus to become thicker (This phase usually lasts 9-10 days).

The high level of estrogen eventually causes a surge in LH production from the pituitary.

This LH surge triggers ovulation (at this point, the follicle is “mature”).

The Follicle then stops growing, and LH then causes the follicle to change into a corpus luteum.

The corpus luteum continues to release estrogen, though at slightly reduced levels.

It also starts releasing *progesterone*.

Progesterone changes the surface of the uterus to allow for implantation.

Progesterone also slows FSH and LH production

(This prevents the start of another ovulation cycle (it's also the mechanism behind some birth control pills)).

If no fertilization occurs, the corpus luteum begins to disintegrate (after about 11 days).

As a result, progesterone levels fall, the uterine lining can't be maintained, and LH and FSH production is restored.

Some of the uterine lining is reabsorbed, the rest is sloughed off and the cycle starts over

Here's a summary:

FSH & LH → follicle production → estrogen production
↓
growth of uterine lining, eventually LH surge

LH surge → ovulation → release of egg → follicle develops into corpus luteum

Corpus luteum → progesterone → prepares & maintains uterine lining
↓
suppresses LH & FSH production

Finally, the corpus luteum disintegrates, so the last pathway above stops. The uterine lining is lost, and FSH and LH production start up again (first pathway above)

(If fertilization occurs, the corpus luteum is maintained, and uterine lining is maintained).

Pregnancy

Pregnancy causes the growth of the placenta

The corpus luteum does not disintegrate, ovulation stops, breasts enlarge.

The *placenta* is the place of exchange for nutrients and gases between fetus and mother.

Note that there is no direct exchange of fluid between the mother and young **[OVERHEAD, not in book, but see 27.15F, p. 555]**.

As the fetus gets older, increasing levels of estrogen will also cause the formation of oxytocin receptors in the uterus.

Oxytocin is produced by both the mother and the fetus.

Eventually levels of oxytocin climb high enough that they cause the placenta to secrete prostaglandins

Together with oxytocin, prostaglandins stimulate contractions of the uterus **[OVERHEAD, fig. 27.17A, p. 558]**.

A few comments about the immune system:

Mechanisms are in place (this is not that well understood) that prevent the mother's immune system from attacking the fetus

(Remember that half of the fetus' genes are from the father - which could potentially cause an immune response).

Much of the immunity for infants is provided through breast milk.

Antibodies are passed to the infant through the mother's breast milk.

Inflammations, various infectious diseases and stomach problems are much less common in infants that are breast fed.