**Chapter 13**

**Is There Something in the Water?  
Reproductive and Developmental Biology**

**Principles of Animal Reproduction – Asexual Reproduction**

* In asexually reproducing organisms, one parent produces offspring that are genetically identical to the parent
  + **Binary fission** – cells break away from parent to form offspring (e.g., sponges)
  + **Budding** – daughter cell remains attached to parent and breaks away when mature

**Sexual reproduction**

* Sexual reproduction combines genomes and creates variable offspring.
  + **Females** = individuals that produce large gametes (sex cells)
  + **Males** = individuals that produce small gametes
  + Organs that produce **gametes** are called **gonads.**
  + **Ovaries** produce eggs in females and **testes** produce sperm.
  + **Zygote** results from the fusion of two gametes.
  + **Hermaphrodites** have both male and female reproductive systems.
* Method of fertilization is variable.
* **Internal fertilization** – sperm deposited in or near female reproductive tract. Mammals, birds, reptiles, and sharks use internal fertilization.
* **External fertilization** – eggs laid, male deposits sperm over eggs (usually in water). Most fish and amphibians use external fertilization.
  + Very susceptible to contaminants

**Environmental Contaminants and Sexual Reproduction**

* Developing frogs are extremely sensitive to environmental chemicals.
* Research showed that some chemicals can act as endocrine disruptors, interfering with normal gonad development.
  + Male amphibians have been feminized.
  + These chemicals affect animals living in water.
  + Are humans affected by drinking contaminated water?

**Male Reproductive Anatomy**

* In addition to producing sperm, testes also produce hormones.

**Endocrine Disruptors**

* DES is a chemical known to act as an endocrine disruptor.
  + Daughters of women who took DES have a higher rate of infertility.
  + Most common cause of male infertility is the inability to produce healthy sperm.
  + In developed countries, sperm counts are declining.

**Gametogenesis**

* **Gametogenesis** is the production of gametes
* It involves the process of meiosis.
  + Reduces number of chromosomes by ½
  + Human body cells contain 46 chromosomes, gamete contain 23
  + Male and female gametes undergo further development to become functional

**Male Infertility**

* 90% of male infertility related is to problems with sperm formation or production.
  + Low sperm counts
  + Improperly shaped sperm
  + Low motility
  + Chemical exposure (e.g., pesticides) can decrease sperm viability
  + Male infertility increases with alcohol and drug use, including cigarettes

**The Menstrual Cycle**

* **Menstrual cycle** is the cyclic changes in the uterus in response to hormones.
* **Menstruation** is the sloughing off of the endometrial lining in response to no fertilized egg.
* Day one of the cycle involves the bleeding due to the sloughing off of the endometrium.
* During day one the hypothalamus releases GnRH to stimulate the release of FSH from the anterior pituitary gland.
* FSH triggers the ovaries to start maturing a follicle and to produce estrogen.
* Once the follicle is mature and ready for ovulation the GnRH triggers the release of LH from the anterior pituitary gland.
* The LH surge triggers ovulation.
* After the release of the egg, progesterone is produced to finish rebuilding the endometrium and get the uterus ready for implantation.
* If the egg is not fertilized then it does not implant, and negative feedback by the progesterone triggers day one again.
* Changes that occur in the uterus are dependent upon the interaction between uterus, brain, and endometrium
* The menstrual cycle is self-regulating through feedback loops.

**Human Reproduction**

* Birth control methods vary widely because of interaction with endocrine system.
* Some are hormonally based; others rely on prevention of fertilization through a variety of means.

**Female Infertility**

* One cause of female infertility is **endometriosis**, a condition where tissues that line the uterus also grow (and shed) in the ovaries and oviducts.
  + Can cause damage and scarring to ovarian tissue
  + Can disrupt ovulation
  + Painful
  + Scientists are trying to determine if it is related to exposure to environmental chemicals.

**Fertilization**

* **Development** is the series of events that take place after fertilization.
* About 300 million sperm are ejaculated, but only about 200 actually reach egg in oviduct.

**Endocrine Disruptors and Fertilization**

* Industrial solvents can mimic hormones and interfere with sperm development and fertilization.
  + Misshapen sperm cannot swim effectively and are unable to fertilize egg.
  + Males who are exposed to solvents, such as those working as mechanics or dry cleaners, have a larger number of abnormal sperm.
  + The impact of hormone mimics on the developing fetus is unknown.

**Human Embryonic Development**

* Human zygote undergoes a series of **cleavage** to produce an **embryo**.
* The three tissue layers ultimately give rise to all body structures.
  + **Ectoderm** is the outer layer and gives rise to the skin, nervous system, and sense organs.
  + **Mesoderm** is the middle layer and gives rise to the bulk of the body.
  + **Endoderm** is the inner layer and gives rise to the digestive and respiratory organs.
* Growth of a particular tissue or organ relies on chemical stimulus.
  + Development is very sensitive to disruption.

**Development of Human Reproductive Organs**

* Until week 7 of development, male and female reproductive organs are not differentiated.
* They require hormonal stimulus to become male or female.

**Endocrine Disruptors and Development of Reproductive Organs**

* Endocrine disruptors have been thought to increases the rate of **cryptorchidism**.
* Cryptorchidism occurs when the testes do not descend into the scrotum.
* This decreases reproductive success due to the increase temperature in the abdomen.

**Pregnancy**

* Pregnancy, or gestation, involves carrying a developing baby inside the female reproductive tract; in humans this takes about 38 weeks.
  + Embryo implants in the wall of the uterus
  + A **placenta** must develop to sustain pregnancy
    - Maternal and fetal blood supplies are closely intertwined in the placenta, allowing exchange of nutrients and wastes
* Endocrine disrupter exposure during pregnancy can lead to low birth weight and premature birth.

**Childbirth**

* The hormone oxytocin uses a positive feedback loop to induce labor.

**Is the Water Safe to Drink?**

* The idea of endocrine disruptors in the water supply is disturbing, but do we need to be concerned? What is being done about this issue?
  + EPA requires monitoring of municipal water supplies.
  + It’s unclear what is a safe level of chemicals.
  + Studies show the human body can be affected by endocrine disruptors, but there is no evidence yet of this happening from contaminated water.