Reproduction

[Note: This is the text version of this lecture file. To make the lecture notes downloadable over a slow connection (e.g. modem) the figures have been replaced with figure numbers as found in the textbook. See the full version with complete graphics if you have a faster connection.]

Two modes of reproduction (Part I)

- **Asexual**

  ***genetic method*: mitosis**

  ***types*: fission (two organisms approximately equal in size), budding, fragmentation**

  ***advantages*: fast, can work without a mate (colonization easier)**

  ***examples*: bacteria, hydra, dandelion, starfish**

  Parthenogenesis is the formation of offspring from an egg without fertilization (e.g. male honey bee drones)

Two modes of reproduction (Part II)

- **Sexual**

  ***genetic method*: meiosis**

  ***cell types* (gametes): ovum from female, spermatozoa (generally motile) from male**

  ***advantage*: genetic variability, important for adaptation to changing environmental conditions**

Two modes of reproduction (Part III)

- **Some animals can reproduce by either mode.**

  ***Asexual reproduction* is used during good times for fast growth**

  ***Sexual reproduction* is used during hard times because fertilized eggs can withstand harsh conditions and genetic variation can generate adaptation**

- **Some animals are <u>hermaphrodites</u> with male and female sexual organs.**

  <u>Self-fertilization</u> possible but generally not used.

  During mating hermaphrodites commonly <u>exchange both eggs and sperm</u> and can produce twice as many offspring.

Two mechanisms of fertilization

- **External fertilization**
  Gametes are released into surroundings
  Generally found in aquatic environments (e.g. frogs, fish)
  ***advantages*: more offspring possible, dispersal of offspring**

- **Internal fertilization**
  female receives sperm from male in or near reproductive tract, fertilization occurs within body
  Some female animals can store sperm in spermatheca for as long as a year
  ***advantages*: better protection of developing young in shelled egg or in reproductive tract of mother (eutherian (placental) animals = develop in uterus)**

Human male reproductive system (Part I)

<u>scrotum</u> keeps testes ~2^{O}C cooler than body to allow spermatogenesis
<u>epididymus</u> completes maturation of sperm, 6 meters in 20 days
<u>accessory glands</u> secrete additional components of <u>semen</u>, glands include seminal vesicles, prostate, bulbourethral gland
secretions include mucus, fructose (energy for sperm), coagulating and anti-coagulating enzymes, ascorbic acid, prostaglandins (stimulate uterine contraction and thin mucus)

[See Fig. 46.8]

Human male reproductive system (Part II)

prostate gland enlarges in >50% of men over age 40 and almost all over age 70: common symptom is difficulty urinating, cancer also common
vas deferens is muscular tract that moves sperm during ejaculation
ejaculate is 2-5 ml in volume and contains 50-130 million sperm
sperm are produced continuously throughout human lifespan

Four sexual phases include:
1) excitement (vasocongestion = filling of tissues with blood, erection in men; myotonia = muscle tension, nipples, limbs),
2) plateau (maintenance),
3) orgasm (emission of semen into urethra, expulsion out of urethra),
4) resolution (return to normal, minutes to hours)

[See Fig. 46.8]

Hormonal control of male reproductive function

- **Lutenizing hormone (LH) stimulates Leydig cells in testes to make male hormones (androgens)**

- **Follicle stimulating hormone (FSH) stimulates spermatogenesis in seminiferous tubules**

[See Fig. 46.14]

Mitosis and meiosis in sperm production

- **Takes 65-75 days in humans**

- **Sertoli cells transfer nutrients to sperm**

[See Fig. 46.12]

Structure of human sperm

(flagellum)

[See Fig. 46.11]

Human female reproductive system (Part I)

Four sexual phases include:
1) excitement (vasocongestion = filling of tissues with blood, shaft of clitoris, labia; myotonia = muscle tension, nipple, limbs; Bartholin's gland lubricates), 2) plateau (maintenance), 3) orgasm (contraction of outer vagina and uterus), 4) resolution (return to normal, minutes to hours)

[See Fig. 46.9]

Human female reproductive system (Part II)

- Women are born with ~400,000 follicles and generally one develops into an egg every month
- menopause at 46-54 years occurs when ovaries become insensitive to LH and FSH, estrogen & progesterone production fall
- The oviduct (fallopian tube) sweeps released eggs from the abdominal cavity using cilia (reproductive tract is “open”)

[See Fig. 46.9]

Formation of oocyte and corpus luteum

- Follicle splits at ovulation into oocyte and corpus luteum (secretes estrogen and progesterone).
- Second meiosis into ovum doesn't occur until fertilization by sperm.

[See Fig. 46.13]

Hormonal control of female reproductive function

- **Follicle stimulating hormone (FSH) stimulates maturation of follicles in ovary**

- **Lutenizing hormone (LH) stimulates mature follicle to ovulate then form the corpus luteum, which secretes estrogen and progesterone**

[See Fig. 46.14 with modifications]

Coordination of the ovarian and menstrual cycles by hormones

- FSH stimulates growth of follicles (no LH receptors)
- estrogen made by follicle stimulates endometrium and storage of LH in pituitary
- LH receptors made, LH surge (triggered by estrogen) stimulates ovulation then formation of corpus luteum and secretion of progesterone for maintenance of endometrium
- corpus luteum disintegrates, decreasing production of hormones ⇒ menstruation

[See Fig. 46.15]

Time of ovulation can be predicted from other physiological changes during the cycle

[See family planning chart]

Body temperature during the cycles

- Non-primate mammals have estrus cycle (endometrium is reabsorbed).
- Estrus (heat) is receptive period and signals time for reproduction.
- Estrus cycle in rats is 5 days compared to 20-40 days for humans (30% in 27-29 day range).
- Fertilization occurs in oviduct (human sperm can live for ~3 days), cleavage of zygote at 24 hours, 3-4 days to reach uterus, 7 days to divide into blastocyst, 12 days to implant.

[See Fig. 46.16]

- **Implantation of embryo signals embryo and endometrium to form the placenta.**
- **Embryo also secretes hormones that prevent menstruation and possible spontaneous abortion. Human chorionic gonadotropin (HCG) acts like LH to stimulate corpus luteum to make estrogen and progesterone**
- **HCG can be detected in maternal urine in pregnancy test**

[See Fig. 46.17]

- **human pregnancy lasts 266 days (38 weeks) from conception (fertilization) or 40 weeks from start of menstrual cycle.**

- **Pregnancy (gestation) lasts 21 days in mice and rats, 60 days in dogs, 270 days in cows, 420 days in giraffes, and 600 days in elephants**

- **9 months in humans divided into trimesters of 3 months**

[See Fig. 46.18]

FIRST TRIMESTER

- **Organs develop (organogenesis) during first trimester,**

- **most of adult features present = fetus**

- **HCG secreted and placenta forms**

- **miscarriage common (~1/3 of pregnancies) when something's wrong with mother or fetus**

[See Fig. 46.18]

SECOND TRIMESTER

- **Growth continues**

- **fetus moves**

- **corpus luteum in ovary disintegrates, placenta now makes progesterone**

[See Fig. 46.18]

THIRD TRIMESTER

- **Estrogen at highest levels in mother, stimulates production of oxytocin receptors in uterus**

- **preparation for birth (parturition) includes turning of fetus**

[See Fig. 46.18]

[See Fig. 46.19]

Three stages of birth (parturition)

[See Fig. 46.20]

Methods of contraception

- **barrier methods (condoms, diaphragm, cervical cap, spermicidal cream)**
- **rhythm method (natural family planning)**
- **Intrauterine device (IUD)**
- **chemical contraceptives (combination pill, minipill, Norplant)**
- **sterilization (tubal ligation/cauterization in women, vasectomy in men)**

[See Fig. 46.21]

- combination pill is estrogen and progestin (synthetic progesterone-like compound) ⇓GnRH (both), ⇓FSH by estrogen ⇒ ⇓follicular development, ⇓LH by progestin ⇒ ⇓ovulation

- minipill, Norplant, and Depo-Provera are progestin only and thicken mucus so sperm can't enter uterus

- IUD's commonly release progestin or copper

- RU-486 (Mifepristone) blocks progesterone receptors

[See pictures of birth control]