Chapter 46

Animal Reproduction

PowerPoint Lectures for
Biology, Seventh Edition
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Lectures by Chris Romero

- Overview: Doubling Up for Sexual Reproduction
- The two earthworms in this picture are mating
- Each worm produces both sperm and eggs, which will fertilize
  - And in a few weeks, new worms will hatch

Figure 46.1

- A population transcends finite life spans
  - Only by reproduction

- Concept 46.1: Both asexual and sexual reproduction occur in the animal kingdom
- Asexual reproduction is the creation of new individuals
  - Whose genes all come from one parent

- Sexual reproduction is the creation of offspring
  - By the fusion of male and female gametes to form a zygote
- The female gamete is the egg
- The male gamete is the sperm

Mechanisms of Asexual Reproduction

- Many invertebrates reproduce asexually by fission
  - The separation of a parent into two or more individuals of approximately the same size

Figure 46.2

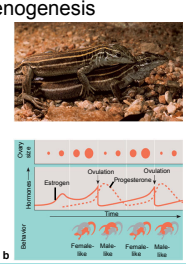
- Also common in invertebrates is budding
  - In which two new individuals arise from outgrowths of existing ones
- Another type of asexual reproduction is fragmentation, which
  - Is the breaking of the body into several pieces, some or all of which develop into complete adults
  - Must be accompanied by regeneration, the regrowth of lost body parts

Reproductive Cycles and Patterns

- Most animals exhibit cycles in reproductive activity
  - Often related to changing seasons
- Reproductive cycles
  - Are controlled by hormones and environmental cues

- Animals may reproduce exclusively asexually or sexually
  - Or they may alternate between the two
- Some animals reproduce by parthenogenesis
  - A process in which an egg develops without being fertilized

- Among vertebrates, several genera of fishes, amphibians, and lizards, including whiptail lizards
  - Reproduce exclusively by a complex form of parthenogenesis



(a) Both lizards in this photograph are *C. uniparens* females. The one on top is playing the role of a male. Every two or three weeks during the breeding season, individuals switch sex roles.

(b) The sexual behavior of *C. uniparens* is correlated with the cycle of ovulation mediated by sex hormones. As blood levels of estrogen rise, the ovaries grow, and the lizard behaves like a female. After ovulation, the estrogen level drops abruptly, and the progesterone level rises; these hormone levels correlate with male behavior.

Figure 46.3a, b

- Sexual reproduction presents a special problem for certain organisms
  - That seldom encounter a mate
- One solution to this problem is hermaphroditism
  - In which each individual has both male and female reproductive systems

- Another remarkable reproductive pattern is sequential hermaphroditism
  - In which an individual reverses its sex during its lifetime

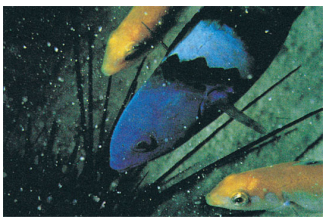


Figure 46.4

- Concept 46.2: Fertilization depends on mechanisms that help sperm meet eggs of the same species
- The mechanisms of fertilization, the union of egg and sperm
  - Play an important part in sexual reproduction

- Some species have external fertilization, in which
  - Eggs shed by the female are fertilized by sperm in the external environment

Figure 46.5

- Other species have internal fertilization, in which
  - Sperm are deposited in or near the female reproductive tract, and fertilization occurs within the tract

- In either situation, fertilization requires critical timing
  - Often mediated by environmental cues, pheromones, and/or courtship behavior
- Internal fertilization
  - Requires important behavioral interactions between male and female animals
  - Requires compatible copulatory organs

Ensuring the Survival of Offspring

- All species produce more offspring than the environment can handle
  - But the proportion that survives is quite small

- The embryos of many terrestrial animals
  - Develop in eggs that can withstand harsh environments
- Instead of secreting a shell around the embryo
  - Many animals retain the embryo, which develops inside the female

- Many different types of animals
  - Exhibit parental care to ensure survival of offspring

Figure 46.6

Gamete Production and Delivery

- To reproduce sexually
  - Animals must have systems that produce gametes

- The least complex systems
  - Do not even contain distinct gonads, the organs that produce gametes in most animals

- The most complex reproductive systems
  - Contain many sets of accessory tubes and glands that carry, nourish, and protect the gametes and the developing embryos

- Many animals with relatively simple body plans
  - Possess highly complex reproductive systems

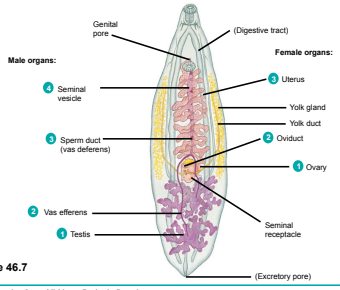
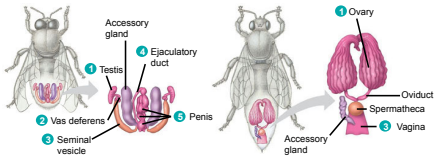


Figure 46.7

- Most insects
  - Have separate sexes with complex reproductive systems



(a) Male honeybee. Sperm form in the testes, pass through the sperm duct (vas deferens), and are stored in the seminal vesicle. The male ejaculates sperm along with fluid from the accessory glands. (Males of some species of insects and other arthropods have appendages called claspers that grasp the female during copulation.)

(b) Female honeybee. Eggs develop in the ovaries and then pass through the oviducts and into the vagina. A pair of accessory glands (only one is shown) add protective secretions to the eggs in the vagina. After mating, sperm are stored in the spermatheca, a sac connected to the vagina by a short duct.

Figure 46.8a, b

- Concept 46.3: Reproductive organs produce and transport gametes: focus on humans

Female Reproductive Anatomy

- The female external reproductive structures include
  - The clitoris
  - Two sets of labia

- The internal organs are a pair of gonads
  - And a system of ducts and chambers that carry gametes and house the embryo and fetus

- Reproductive anatomy of the human female

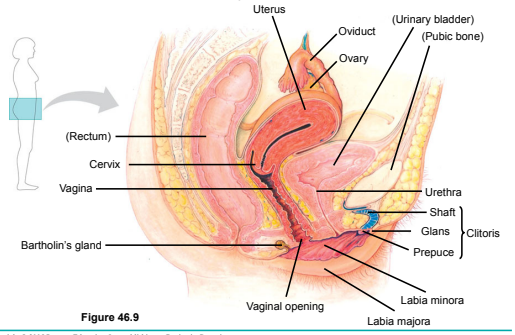
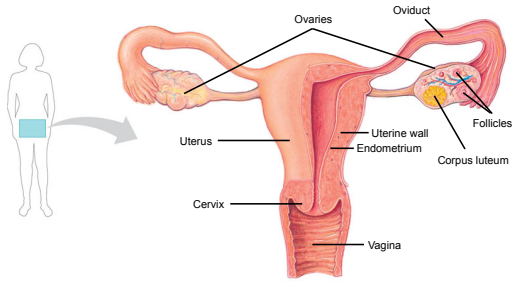


Figure 46.9



Ovaries

- The female gonads, the ovaries
  - Lie in the abdominal cavity

- Each ovary
  - Is enclosed in a tough protective capsule and contains many follicles
- A follicle
  - Consists of one egg cell surrounded by one or more layers of follicle cells

- The process of ovulation
  - Expels an egg cell from the follicle
- The remaining follicular tissue then grows within the ovary
  - To form a solid mass called the corpus luteum, which secretes hormones, depending on whether or not pregnancy occurs

Oviducts and Uterus

- The egg cell is released into the abdominal cavity
  - Near the opening of the oviduct, or fallopian tube
- Cilia in the tube
  - Convey the egg to the uterus

Vagina and Vulva

- The vagina is a thin-walled chamber
  - That is the repository for sperm during copulation
  - That serves as the birth canal through which a baby is born

- The vagina opens to the outside at the vulva
  - Which includes the hymen, vestibule, labia minora, labia majora, and clitoris

Mammary Glands

- The mammary glands are not part of the reproductive system
  - But are important to mammalian reproduction
- Within the glands
  - Small sacs of epithelial tissue secrete milk

Male Reproductive Anatomy

- In most mammalian species
  - The male's external reproductive organs are the scrotum and penis
- The internal organs
  - Consist of the gonads, which produce sperm and hormones, and accessory glands

- Reproductive anatomy of the human male

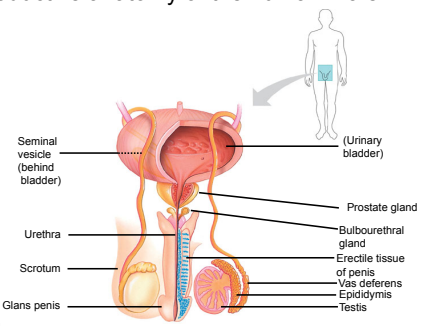
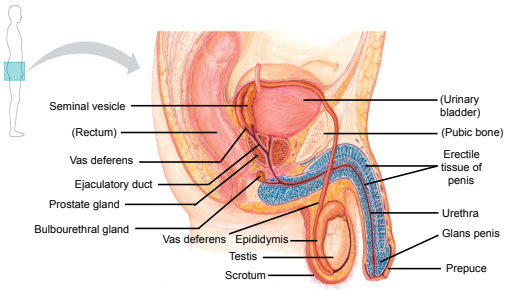


Figure 46.10



Testes

- The male gonads, or testes
  - Consist of many highly coiled tubes surrounded by several layers of connective tissue
- The tubes are seminiferous tubules
  - Where sperm form

- Production of normal sperm
  - Cannot occur at the body temperatures of most mammals
- The testes of humans and many mammals
  - Are held outside the abdominal cavity in the scrotum, where the temperature is lower than in the abdominal cavity

Ducts

- From the seminiferous tubules of a testis
  - The sperm pass into the coiled tubules of the epididymis
- During ejaculation
  - Sperm are propelled through the muscular vas deferens, the ejaculatory duct, and exit the penis through the urethra

Glands

- Three sets of accessory glands
  - Add secretions to the semen, the fluid that is ejaculated
- A pair of seminal vesicles
  - Contributes about 60% of the total volume of semen

- The prostate gland
  - Secretes its products directly into the urethra through several small ducts
- The bulbourethral gland
  - Secretes a clear mucus before ejaculation that neutralizes acidic urine remaining in the urethra

Semen in the Female Reproductive Tract

- Once in the female reproductive tract
  - A number of processes, including contractions of the uterus, help move the sperm up the uterus

Penis

- The human penis
  - Is composed of three cylinders of spongy erectile tissue
- During sexual arousal
  - The erectile tissue fills with blood from the arteries, causing an erection

Human Sexual Response

- Two types of physiological reactions predominate in both sexes
  - Vasocongestion, the filling of tissue with blood
  - Myotonia, increased muscle tension

- The sexual response cycle can be divided into four phases
  - Excitement, plateau, orgasm, and resolution

- Concept 46.4: In humans and other mammals, a complex interplay of hormones regulates gametogenesis
- The process of gametogenesis
  - Is based on meiosis, but differs in females and males

- Oogenesis is the development of mature ova

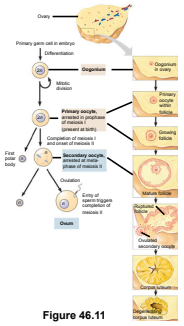


Figure 46.11

- Spermatogenesis is the production of mature sperm

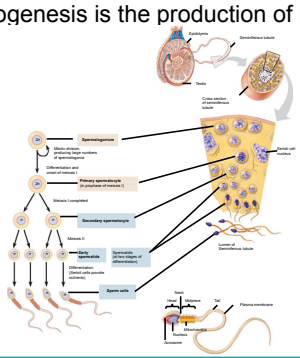


Figure 46.12

- Oogenesis differs from spermatogenesis
  - In three major ways

- First, during the meiotic divisions of oogenesis
  - Cytokinesis is unequal, with almost all the cytoplasm monopolized by a single daughter cell, the secondary oocyte

- Second, sperm are produced continuously throughout a male's life
  - Which is not the case in oogenesis
- Third, oogenesis has long "resting" periods
  - While spermatogenesis produces sperm in uninterrupted sequence

The Reproductive Cycles of Females

- In females
  - The secretion of hormones and the reproductive events they regulate are cyclic

Menstrual Versus Estrous Cycles

- Two different types of cycles occur in females

- Humans and other primates have menstrual cycles
  - While other mammals have estrous cycles
- In both cases ovulation occurs at a time in the cycle
  - After the endometrium has started to thicken in preparation for implantation

- In menstrual cycles
  - The endometrium is shed from the uterus in a bleeding called menstruation
  - Sexual receptivity is not limited to a specific timeframe
- In estrous cycles
  - The endometrium is reabsorbed by the uterus
  - Sexual receptivity is limited to a “heat” period

The Human Female Reproductive Cycle: A Closer Look

- The female reproductive cycle
  - Is one integrated cycle involving two organs, the uterus and ovaries

- Cyclic secretion of GnRH from the hypothalamus
  - And of FSH and LH from the anterior pituitary orchestrates the female reproductive cycle
- Five kinds of hormones
  - Participate in an elaborate scheme involving both positive and negative feedback

- The reproductive cycle of the human female

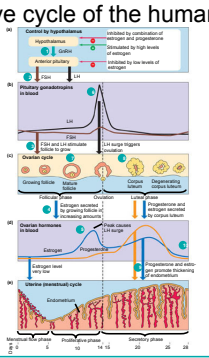


Figure 46.13a–e

The Ovarian Cycle

- In the ovarian cycle
  - Hormones stimulate follicle growth, which results in ovulation
- Following ovulation
  - The follicular tissue left behind transforms into the corpus luteum

The Uterine (Menstrual) Cycle

- Cycle after cycle
  - The maturation and release of egg cells from the ovary are integrated with changes in the uterus
- If an embryo has not implanted in the endometrium by the end of the secretory phase
  - A new menstrual flow commences

Menopause

- After about 450 cycles, human females undergo menopause
  - The cessation of ovulation and menstruation

Hormonal Control of the Male Reproductive System

- Testosterone and other androgens
  - Are directly responsible for the primary and secondary sex characteristics of the male

- Androgen secretion and sperm production
  - Are both controlled by hypothalamic and pituitary hormones

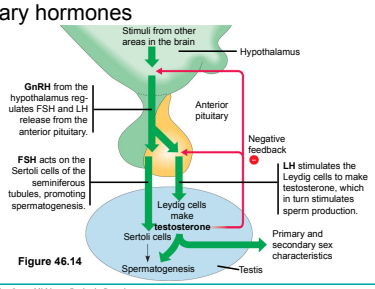


Figure 46.14

- Concept 46.5: In humans and other placental mammals, an embryo grows into a newborn in the mother's uterus

Conception, Embryonic Development, and Birth

- In humans and most other placental mammals
  - Pregnancy, or gestation, is the condition of carrying one or more embryos in the uterus

- Fertilization of an egg by a sperm, conception
  - Occurs in the oviduct

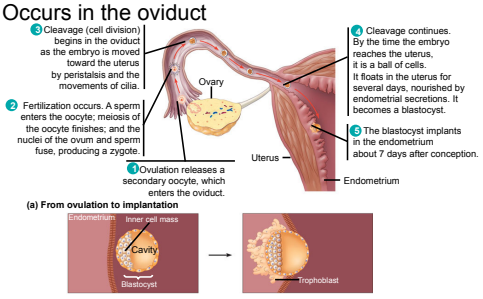


Figure 46.15a, b (b) Implantation of blastocyst

- After fertilization
  - The zygote undergoes cleavage and develops into a blastocyst before implantation in the endometrium

First Trimester

- Human gestation
  - Can be divided into three trimesters of about three months each
- The first trimester
  - Is the time of most radical change for both the mother and the embryo

- During its first 2 to 4 weeks of development
  - The embryo obtains nutrients directly from the endometrium
- Meanwhile, the outer layer of the blastocyst
  - Mingles with the endometrium and eventually forms the placenta

- Blood from the embryo
  - Travels to the placenta through arteries of the umbilical cord and returns via the umbilical vein

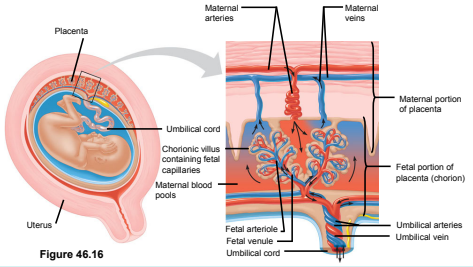
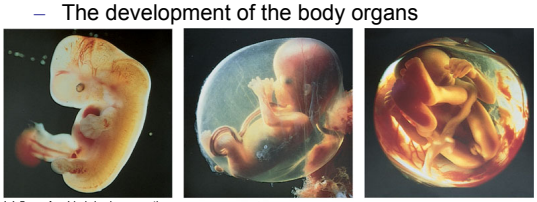


Figure 46.16

- The first trimester is the main period of organogenesis
  - The development of the body organs



(a) 5 weeks. Limb buds, eyes, the heart, the liver, and rudiments of all other organs have started to develop in the embryo, which is only about 1 cm long.

(b) 14 weeks. Growth and development of the offspring, now called a fetus, continue during the second trimester. This fetus is about 6 cm long.

(c) 20 weeks. By the end of the second trimester (at 24 weeks), the fetus grows to about 30 cm in length.

Figure 46.17a–c

Second Trimester

- During the second trimester
  - The fetus grows and is very active
  - The mother may feel fetal movements
  - The uterus grows enough for the pregnancy to become obvious

Third Trimester

- During the third trimester
  - The fetus continues to grow and fills the available space within the embryonic membranes

- A complex interplay of local regulators and hormones
  - Induces and regulates labor, the process by which childbirth occurs

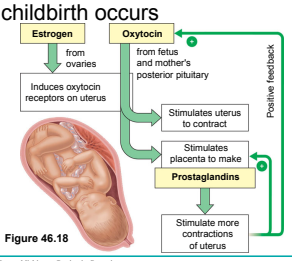


Figure 46.18

- Birth, or parturition
  - Is brought about by a series of strong, rhythmic uterine contractions

- The process of labor has three stages

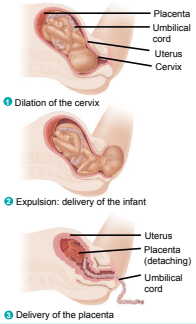


Figure 46.19

The Mother's Immune Tolerance of the Embryo and Fetus

- A woman's acceptance of her "foreign" offspring
  - Is not fully understood
  - May be due to the suppression of the immune response in her uterus

Contraception and Abortion

- Contraception, the deliberate prevention of pregnancy
  - Can be achieved in a number of ways

- Some contraceptive methods
  - Prevent the release of mature eggs and sperm from gonads
  - Prevent fertilization by keeping sperm and egg apart
  - Prevent implantation of an embryo

- Mechanisms of some contraceptive methods

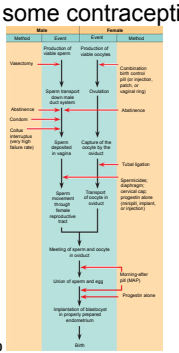


Figure 46.20

Modern Reproductive Technology

- Recent scientific and technological advances
  - Have made it possible to deal with many reproductive problems

- Amniocentesis and chorionic villus sampling
  - Are invasive techniques in which amniotic fluid or fetal cells are obtained for genetic analysis

- Noninvasive procedures
  - Usually use ultrasound imaging to detect fetal condition

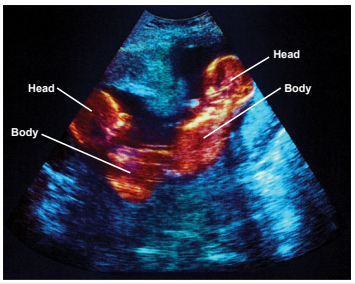


Figure 46.21

- Modern technology
  - Can help infertile couples by *in vitro* fertilization