# CHAPTER 59: SEX AND REPRODUCTION

## CHAPTER SYNOPSIS

Sexual reproduction increases genetic diversity even though such change is not always favored by natural selection. It has greatly contributed to the versatility of vertebrates. External fertilization is common in aquatic animals, eggs are laid in great quantities though few survive to adulthood. Three different strategies of development are associated with internal fertilization: oviparity, ovoviviparity, and viviparity. Most bony fish exhibit external fertilization, though some fertilize internally, and even fewer give birth to live young. Conversely, most cartilaginous fishes have internal fertilization and viviparous development. Amphibian fertilization is external with oviparous development divided into three stages. The young undergo lengthy development consisting of time spent in the egg and as a larva before becoming a terrestrial adult. Reptiles and birds are wholly terrestrial animals and exhibit internal fertilization. All birds are oviparous as are most reptiles, though some are either ovoviparous or viviparous. Fertilization in mammals is also internal and, excluding the monotremes, all are viviparous.

The male reproductive system continually produces sperm within the seminiferous tubules of the testes. Leydig cells located between the tubules secrete testosterone. This predominantly male hormone causes the indifferent embryonic gonads to develop into male external genitalia. Without testosterone, these same structures become female external genitalia. The male penis and female clitoris develop from the same structure, as do the male scrotal sacs and female labia majora.

Resurgence of testosterone production at puberty initiates sperm production and development of male secondary sexual characteristics. Upon completion of development, the sperm travel to the epididymis where they become fully motile. Sperm are then delivered to the vas deferens and exit through the urethra. The male penis is composed of erectile tissue, blood vessels, and the urethra. The penis becomes turgid when the erectile tissue is engorged with blood. Stimulation moves sperm into the urethra along with other seminal fluids produced by the seminal vesicles and prostate gland. Several hundred million sperm must be released to ensure fertilization.

Females do not produce eggs continually throughout life. At birth, each ovary possesses all of its primary oocytes arrested in prophase I of meiosis. The maturation of an egg within a Graafian follicle is initiated by follicle-stimulating hormone (FSH) which also causes a slow increase in estradiol (estrogen) production. The pituitary responds to these changes by producing luteinizing hormone (LH) and causes the release of the egg. It is swept into the fallopian tubules by beating cilia moving it toward the uterus. The corpus luteum secretes progesterone, which induces the proliferation of the uterine lining. When fertilization does not occur, progesterone and estradiol production ceases and the thickened, highly vascularized uterine lining is expelled.

Females of most mammal species have a sexual reproductive cycle called estrus that corresponds to the series of ovulation events in humans. Humans do not exhibit estrus cycles and are sexually receptive at all times. The human menstrual cycle lasts, on average, 28 days and incorporates successive hormone release to stimulate egg release (the follicular phase) and to prepare the uterus for possible pregnancy (the luteal phase).

Human intercourse is a complex series of events intertwining physiology and emotions. In both males and females these events are clinically separated into four phases: excitement, plateau, orgasm, and resolution. Being a highly emotional experience, intercourse is not always associated with procreation. Several forms of contraception exist to prevent unwanted birth. In general they include methods that kill or block sperm, inhibit egg maturation, or deter implantation of the embryo. The most effective birth control is abstinence, followed by permanent surgical intervention in either the male or the female.

## CHAPTER OBJECTIVES

- Define parthenogenesis, hermaphroditism, protogyny, and protandry.
- Explain the advantages and disadvantages of external fertilization.
- Describe the changes in reproductive strategy necessary for successful invasion of the land.
- Compare fertilization and reproduction among fishes, amphibians, reptiles, and birds.
- Compare the reproductive strategies of monotreme, marsupial, and placental mammals.
- Describe the structures and events associated with human spermatogenesis.
- Describe the structures and events associated with human oogenesis and indicate the ways in which it is significantly different from spermatogenesis.
- Understand the events associated with the follicular and luteal phases of the human female reproductive cycle.
- Indicate the hormonal events that signal initiation and termination of an individual female reproductive cycle as well as ovulation and menstruation.
- Understand the events associated with human intercourse and fertilization.
- Understand the various methods of birth control and the overall effectiveness of each.

## KEY TERMS

budding
clitoris
egg
estrous cycle
estrus
excitement
external fertilization
female secondary sexual characteristics
fission
gamete
gonad
granulosa cell
hermaphroditism
internal fertilization
labia majora
luteal phase
marsupial
menarche
menstrual phase
monotreme
orgasm
ovarian follicle
ovary
oviparity
ovoviviparity
parthenogenesis
placental mammal
plateau
proliferative phase
protandry
protogyny
resolution
secretory phase
sperm
*SRY* gene
testis
Viagra
viviparity
zygote

## CHAPTER OUTLINE

**59.0 Introduction**

I. REPRODUCTION IS EVOLUTION'S ESSENTIAL ACT

A. Animals Use Sound and Appearance to Attract Mates fig 59.1

B. Few Urges Are More Insistent than Sex

## 59.1 Animals employ both sexual and asexual reproductive strategies

I. ASEXUAL AND SEXUAL REPRODUCTION

A. Basics of Reproduction
1. Asexual reproduction is common in protists, cnidaria, tunicates
   a. Formation of identical twins is a form of asexual reproduction
   b. Two cells form from one in early embryo
2. Mitosis produces genetically identical cells from single parent
   a. Protists divide by fission
   b. Cnidarians asexually reproduce by budding
      1) Part of parent body separates from rest, becomes new individual
      2) Individual may be independent or remain as part of colony
3. Sexual reproduction occurs from union of two sex cells
   a. Gametes include sperm and egg
   b. Union of sperm and egg produces fertilized egg, called a zygote
   c. Zygote and further cells are diploid, contain both homologous chromosomes
4. Gametes are formed via meiosis in gonads
   a. Gonads include testes and ovaries
   b. Gametes are haploid

B. Different Approaches to Sex
1. Parthenogenesis occurs in many species
   a. Virgin birth, produces only females
   b. Some species of arthropods reproduce only by this mechanism
2. Some alternate between sexual and parthenogenesis in different generations
   a. Example: Honey bee reproduction
   b. Queen bee mates once, stores the sperm
   c. Controls release of sperm
      1) No sperm released, parthenogenetic male drones produced
      2) Sperm released, eggs develop into female queens or worker bees
3. Some lizards reproduce by parthenogenesis
   a. Populations exist that are solely female
   b. Eggs are viable even if not fertilized
4. Hermaphroditism is another reproductive variation
   a. Individual has both testes and ovaries, produces sperm and eggs fig 59.2a
   b. Tapeworm can self-fertilize, unlikely to encounter another tapeworm
   c. Most hermaphrodites do not self-fertilize, require second individual
      1) Example: Earthworms
      2) Two individuals, each functions as both male and female
      3) Each leaves to produce fertilized eggs
      4) Example: Deep sea fish
5. Many fish species change sex: Sequential hermaphroditism
   a. Protogyny = first female, changes from female to male fig 59.2b
   b. Protandry = first male, changes from male to female
   c. Sex change may be under social control
      1) Fish live in schools, reproduction limited to few dominant males
      2) If males removed, largest female changes sex to become dominant male

C. Sex Determination
1. Environmental changes can cause sex change in some animals
2. Human male and female reproductive systems appear similar for first forty days
   a. Cells that give rise to gametes migrate from yolk sac to embryonic gonads
   b. Gonads have potential to become ovaries or testes

3. Embryonic gonads are thus indifferent
   a. In males, Y chromosome has gene whose product will convert gonads into testes
   b. In females, lack Y and its proteins, gonads become ovaries
   c. Sex determining gene may be *SRY* gene fig 59.3
   d. Gene highly conserved during course of evolution of some vertebrates
4. When embryo testes form, they secrete testosterone, other hormones
   a. Promote development of male external genitalia, accessory reproductive organs
   b. Embryo lacking testes forms female external genitalia, accessory organs
5. All mammals develop as females unless masculinized by testes secretions

**59.2 The evolution of reproduction among the vertebrates has led to internalization of fertilization and development**

I. FERTILIZATION AND DEVELOPMENT

A. Sex Evolved in the Sea
1. Female marine fish produce eggs, or ova release into water
2. Males release sperm into water containing eggs
3. Union called external fertilization
4. Problems of external fertilization in water
   a. Dilution of gametes in expanse of sea water, disperse rapidly
   b. Release of gametes must be nearly simultaneous
   c. Reproduction restricted to seasonal periods
5. Problems of external fertilization on land
   a. Greater danger of desiccation of gametes
   b. Intense selective pressure to develop internal fertilization
6. Three strategies for embryonic and fetal development in internal fertilization
   a. Oviparity
      1) Some bony and cartilaginous fish, most reptiles, some amphibians, all birds
      2) Eggs fertilized internally
      3) Eggs laid outside mother's body to complete development
   b. Ovoviviparity
      1) Some bony and cartilaginous fishes, many reptiles
      2) Fertilized eggs retained within mother to complete development
      3) Embryos obtain nourishment from egg yolk
      4) Fully developed young hatch from eggs and are released
   c. Viviparity fig 59.4
      1) Most cartilaginous fishes, some amphibians, few reptiles, almost all mammals
      2) Embryonic and fetal young develop within mother
      3) Obtain nutrition from mother, not from egg yolk

II. FISH AND AMPHIBIANS

A. Fish
1. Most fertilization is external in bony teleosts
   a. Egg contains enough yolk to support embryo for short time
   b. Development speedy, young mature rapidly
   c. Eggs laid in great quantities, few grow to maturity
2. Fertilization internal in most cartilaginous fishes, development viviparous

B. Amphibians
1. Reproduction tied to the presence of water, fertilization external
   a. Gametes from both sexes released through cloaca
   b. Male grasps female and discharges sperm as eggs are laid fig 59.5

c. Most eggs develop in water
1) In two unusual species, eggs develop in vocal sacs and stomach fig 59.6
2) Young frogs leave mother through mouth
2. Development takes longer than fishes, not greater amount of yolk
3. Development divided into three stages
a. Embryo develops in egg, yolk provides nutrition
b. Aquatic larva hatches from egg, functions as feeding individual
c. Undergoes metamorphosis into terrestrial adult form

## III. REPTILES AND BIRDS

### A. Reptiles
1. Most are oviparous, eggs deposited outside of body to develop
2. Eggs fertilized internally before eggs are laid fig 59.7
3. Male penis injects sperm into female reproductive tract
4. Most are oviparous, lay eggs, and abandon them
a. Eggs are surrounded by leathery shell
b. Shell deposited as egg passes through oviduct
5. Others are ovoviviparous or viviparous

### B. Birds
1. All are oviparous and exhibit internal fertilization
2. Most male birds lack penis
3. All are oviparous
a. Egg passes through oviduct
b. Glands secrete albumin proteins, hard calcareous shell
c. Incubate eggs with homeothermic bodies fig 59.8
d. Young born relatively underdeveloped, require parental care

### C. Eggs of Reptiles and Birds Are Amniotic
1. Embryo develops within fluid-filled cavity surrounded by amnion membrane
2. Amnion is an extraembryonic membrane
a. Formed from embryonic cells
b. Lies outside body of embryo
3. Chorion lies inside egg shell, also extraembryonic as is yolk sac and allantois
4. Fish have one extraembryonic membrane, the yolk sac
5. Viviparous mammals also have extraembryonic membranes

## IV. MAMMALS

### A. Some Mammals Are Seasonal Breeders
1. Some reproduce once per year, others have shorter cycles
a. In latter, females usually undergo reproductive cycles
b. Males more constant in reproductive activity
2. Female cycling process
a. Ovulation: Periodic release of mature ovum from ovary
b. Most females receptive to males only around ovulation
c. Period of receptivity called estrus, cycle called estrus cycle
d. Cycling continues till pregnancy occurs
3. Estrous cycle involves changes in hormonal levels
a. Changes in secretion of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) by anterior pituitary
b. Cause changes in egg cell development, ovary hormone secretion

4. Humans and apes exhibit menstrual cycles
   a. Similar to estrus cycles in cyclic pattern of hormone secretion and ovulation
   b. Shed lining of ovary, called menstruation
   c. Individuals may engage in sexual intercourse at any time during cycle
5. Rabbits and cats are induced ovulators
   a. Ovulation not typically cyclic
   b. Copulation causes reflexive release of LH, triggers ovulation
6. Monotremes, primitive mammals, are oviparous fig 59.9a
   a. Include only duckbilled platypus and echidna
   b. Incubate eggs in nest
   c. Hatchlings lick milk from glands on mother's skin (lack nipples)
7. All other mammals are viviparous
   a. Marsupials born at early stage fig 59.9b
      1) Fetus completes development in pouch
      2) Obtains milk from mammary gland with nipples
   b. Placental mammals retained within mother's uterus fig 59.9c
      1) Nourished internally by mother via the placenta
      2) Placenta derived from chorion and mother's uterine lining
      3) Nutrients derived via diffusion from mother's blood

**59.3 Male and female reproductive systems are specialized for different functions**

I. STRUCTURE AND FUNCTION OF THE MALE REPRODUCTIVE SYSTEM

A. Structures of the Male fig 59.10
   1. If testes develop
      a. Seminiferous tubules form 43 to 50 days after conception
      b. Are site of sperm production
   2. Leydig cells between tubules secrete testosterone at 9 to 10 weeks
      a. Testosterone converts indifferent structures into male external genitalia
      b. Includes penis and scrotal sac that contains testes
      c. Without testosterone structures develop into female external genitalia
   3. Testis composed of tightly coiled seminiferous tubules fig 59.11
      a. Testes initially formed within abdominal cavity
      b. Descend through inguinal canal into the scrotum
      c. Temperature maintained slightly lower than core body temperature
      d. Lower temperature required for normal sperm development

B. Production of Sperm
   1. Walls of seminiferous tubule composed of germinal cells and supporting Sertoli cells
      a. Germinal cells become sperm via meiosis
         1) Cells near outer surface of tubule are diploid, 46 chromosomes
         2) Cells closer to lumen are haploid, 23 chromosomes
      b. Parent cell undergoes mitosis
         1) One cell forms sperm, other remains as parent cell
         2) Male never runs out of sperm-producing parent cells
         3) Produce 100 to 200 million sperm cells per day
      c. Diploid daughter cell called primary spermatocytes, begins meiosis
         1) Has 23 pairs of homologous chromosomes, each with two chromatids
         2) First division produces two haploid secondary spermatocytes
         3) Still composed of two chromatids
         4) Second meiotic division produces two haploid spermatids
         5) Each primary spermatocyte thus produces four haploid spermatids fig 59.11

d. All of these cells constitute germinal epithelium of seminiferous tubules
e. Walls of seminiferous tubules also contain Sertoli cells
1) Nurse developing sperm, secrete products needed for spermatogenesis
2) Help convert spermatids into spermatozoa by engulfing cytoplasm

2. Spermatozoa composed of head, body, and tail fig 59.12
a. Head encloses nucleus, capped by acrosome
1) Acrosome derived from Golgi apparatus
2) Contains enzymes that aid penetration into egg
b. Body and tail provide propulsion
1) Tail contains flagellum
2) Body contains centriole, mitochondria to generate energy

C. Male Accessory Sex Organs
1. Sperm delivered to epididymis, become fully motile after 18 hours fig 59.13
2. Sperm then enter vas deferens, one from each testis
a. Each joins with duct from one of two seminal vesicle glands fig 59.10
b. Continues as ejaculatory duct, enters prostate gland at base of urinary bladder
c. Prostate produces 60% of bulk of semen
3. In prostate gland, ejaculatory duct merges with urethra from urinary bladder
a. Semen carried out of body through urethra at tip of penis
b. Bulbourethral glands produce secretions to lubricate penis during coitus
4. Penis also contains three columns of erectile tissue fig 59.14
a. Two columns of corpora cavernosa on dorsal side
b. One column of corpus spongiosum on ventral side
5. Erection results from parasympathetic division of autonomic nervous system
a. Neurons release nitric oxide, arterioles in penis dilate
b. Erectile tissue engorges with blood, becomes turgid
c. Pressure compresses veins, blood flows in, not out
d. Drug sildenafil (Viagra) prolongs erection by stimulating release of NO in penis
e. Some mammals, like walrus, have penile bones
6. Erection and continued sexual stimulation results in ejaculation
a. Ejection of 5 milliliters of semen, contains 300 million sperm
b. Large amounts of sperm required for fertilization
c. Males considered sterile if they produce fewer than 20 million sperm per ml
d. Only 1% of semen is sperm, rest is seminal vesicles and prostate gland fluid

D. Hormonal Control of Male Reproduction
1. Anterior pituitary secretes gonadotropic hormones, FSH and LH
a. Named for actions in female reproductive cycle
b. Function in both male and female tbl 59.1
2. Functions of FSH and LH
a. FSH stimulates Sertoli cells to facilitate sperm development
b. LH stimulates Leydig cells to secrete testosterone
3. Secretions under negative feedback inhibition via hypothalamus
a. Gonadotropin releasing hormone (GnRH) stimulates release of FSH and LH
b. FSH causes Sertoli cells to release inhibin peptide hormone, inhibits FSH
c. LH stimulates testosterone, which feeds back to inhibit LH
1) Occurs directly at anterior pituitary
2) Also indirectly reduces GnRH secretion
4. Importance of negative feedback shown via removal of testes
a. Testosterone and inhibin now absent
b. Secretion of FSH and LH from anterior pituitary greatly increased

## II. STRUCTURE AND FUNCTION OF THE FEMALE REPRODUCTIVE SYSTEM

### A. Structure of the Female — fig 59.16

1. Ovaries develop more slowly than testes
2. Develop in absence of testosterone
   a. Female embryo develops clitoris and labia majoris
   b. Homologous to penis and scrotum in males
   c. Clitoris also contains corpora cavernosa, erectile tissue
3. Ovaries contain microscopic ovarian follicles
   a. Composed of egg and granulosa cells
   b. Ovarian follicles are functional units of ovary
4. At puberty, granulosa cells secrete estradiol (estrogen)
   a. Triggers menarche, onset of menstrual cycling
   b. Stimulates formation of female secondary sexual characteristics
   c. Causes breast development, production of pubic hair
   d. Estradiol and progesterone maintain female accessory organs
   e. Include fallopian tubes, uterus, vagina

### B. Female Accessory Sex Organs

1. Fallopian tubes transport ovum from ovaries to uterus
2. Uterus narrows to form cervix, opening to vagina — fig 59.17a
   a. Lined with stratified epithelial membrane, the endometrium
   b. Outer layer is shed during menstruation
   c. Inner layer generates new surface at next cycle
3. More complex female tracts in non-primate mammals
   a. Uterus divides to form uterine horns, each leads to fallopian tube — fig 59.13b,c
   b. Cats, dogs, cows have one cervix, two uterine horns
   c. Some marsupials have unconnected horns
      1) Have two cervixes, two vaginas
      2) Male marsupial has forked penis, enters both vaginas

### C. Menstrual and Estrus Cycles

1. Female ovary at birth contains 2 million ova which have initiated meiosis
   a. Meiosis arrested at first meiotic division
   b. Ova called primary oocytes
   c. Some follicles stimulated to develop during each cycle
2. Human menstrual cycle lasts 28 days on average
   a. Divided into follicular and luteal phases
   b. Two phases separated by ovulation

### D. Follicular Phase

1. Few follicles stimulated to grow in each cycle, only one achieves maturity
2. Fully mature follicle called Graafian follicle forms blister on ovary surface — fig 59.18
3. Primary oocyte in Graafian follicle completes first meiotic division
   a. Produces one large secondary oocyte, one small polar body
   b. Secondary oocyte acquires nearly all of cytoplasm
   c. Begins second meiotic division, arrested at metaphase II
   d. Does not complete second meiotic division unless fertilized in Fallopian tube

### E. Ovulation

1. Increased estradiol stimulates anterior pituitary to secrete LH
   a. Graafian follicle bursts, releasing secondary oocyte
   b. Oocyte released near fimbria, opening to fallopian tube
   c. Ciliated epithelial cells line tube, propel oocyte toward uterus

d. Disintegrates within one day if not fertilized
2. Stimulus of fertilization triggers completion of second meiotic division
   a. Forms mature ovum and second polar body
   b. Fusion of sperm and ovum nuclei produces diploid zygote fig 59.19
   c. Fertilization normally occurs in upper third of fallopian tube
   d. Takes three days to reach uterus, 2 to 3 days to implant in endometrium fig 59.20

F. Luteal Phase
1. After ovulation, LH stimulates empty Graafian follicle, develops into corpus luteum
   a. Second half of phase called luteal phase
   b. Corpus luteum secretes estradiol and progesterone
2. High levels of estradiol and progesterone exert negative feedback
   a. Inhibit FSH and LH secretion by anterior pituitary
   b. Acts as natural contraceptive mechanism
   c. Prevents development of new follicles and further ovulations
3. Development of endometrium fig 59.21
   a. During follicular phase
      1) Granulosa cells secrete increasing amounts of estradiol
      2) Stimulates growth of endometrium
      3) Also called proliferative phase of endometrium
   b. During luteal phase
      1) Combination of estradiol and progesterone
      2) Causes vascularization, becomes more glandular, enriched with glycogen
      3) Called secretory phase of the endometrium
4. Without fertilization, corpus luteum triggers own atrophy
   a. Secretes hormones to shut off LH production
   b. Atrophy may be assisted by luteolysin, paracrine regulator
   c. Abrupt decline in estradiol and progesterone causes sloughing of endometrium
   d. Process called menstruation, called menstrual phase of endometrium
5. With fertilization, regression of corpus luteum averted
   a. Secretes human chorionic gonadotropin (hCG)
   b. LH-like hormone produced by chorionic membrane of developing embryo
   c. Maintains high levels of estradiol and progesterone, prevents menstruation
   d. Pregnancy tests assay levels of embryonic hCG
6. Animals with estrus cycle do not menstruate
   a. Shed cells from endometrium, no accompanying bleeding
   b. Estrous cycle phases: Proestrus, estrus, metestrus, diestrus
   c. Correspond to proliferative, mid-cycle, secretory, menstrual endometrial phases

**59.4 Physiology of human sexual intercourse is becoming better known**

I. THE PHYSIOLOGY OF HUMAN SEXUAL INTERCOURSE

A. Sex Drive Is One of the Strongest Human Behaviors
1. Associated with social rules and customs
   a. Involves emotional as well as physical consequences
   b. Prevalence of strong taboos against discussions of sex prevented research
2. Physiological events divided into four phases
   a. Excitement
   b. Plateau
   c. Orgasm
   d. Resolution

B. Excitement
   1. Initiated by nervous system
   2. Increases respiratory rate, heart rate, blood pressure
   3. Nipples harden and become more sensitive
   4. Dilation of blood vessels may produce flushing of skin
   5. Increased circulation causes genital vasocongestion
      a. Causes erection of male penis
      b. Causes swelling of female clitoris
   6. Vagina walls become moist, muscles relax

C. Plateau
   1. Penetration of penis into vagina stimulates nerve endings in both
   2. Intensifies autonomic nervous system response
      a. Female begins pelvic thrusts
      b. Penis reaches greatest length

D. Orgasm
   1. Stimulation initiates a series of reflexive muscular contractions
   2. Female response
      a. Contractions initiated by hypothalamus, causes release of oxytocin
      b. Causes contractions of uterus and cervix
      c. Peaks may be singular and intense or multiple and less intense
   3. Male response
      a. Nerve signals from brain cause emission
      b. Cause contractions of vas deferens and prostate gland
      c. Sperm and seminal fluid move through urethra
      d. Violent contractions of muscles at base of penis cause ejaculation
      e. Orgasmic contraction is singular, intense wave

E. Resolution
   1. Male erection lost rapidly after ejaculation
      a. Refractory period lasts twenty minutes or longer
      b. Further arousal difficult
   2. Female arousal can be reinitiated immediately

II. BIRTH CONTROL

A. Human Intercourse Not Solely Associated with Reproduction
   1. Continual sexual receptivity is problematic
   2. Pregnancy avoided by birth control or contraception — fig 59.22
   3. Effectiveness of methods varies — tbl 59.2

B. Abstinence
   1. Complete lack of sex is simplest and most reliable method
   2. Limiting due to lack of emotional support of sexual relationship

C. Sperm Blockage
   1. Condom over the penis prevents transfer of sperm to vagina
      a. Decreases sensory pleasure in the male
      b. Failure rate is better, but not completely effective
      c. Additionally protects against AIDS and other sexually-transmitted diseases
   2. Cervix can be covered
      a. Accomplished by cervical cap or diaphragm
      b. Must be fitted by a physician, effectiveness varies

D. Sperm Destruction
   1. Douching is very ineffective
   2. Spermicidal jellies, foams, or sponges vary in effectiveness

E. Prevention of Ovulation
   1. Daily ingestion of hormones in a birth control pill
      a. Contain estrogen and progesterone
      b. Shut down production of pituitary LH and FSH
      c. Body acts as though ovulation has just occurred
      d. Low failure rate
   2. Implant capsules of hormones have a lower failure rate
   3. Short-term side effects may occur
   4. Long-term effects unknown, outweighs risk of pregnancy
      a. Benefits: Reduce endometrial and ovarian cancer, reduce osteoporosis
      b. Harm: Increase risk of breast and cervical cancer

F. Prevention of Embryo Implantation
   1. Insertion of an intrauterine device (IUD) into the uterus
      a. Irritation prevents implantation
      b. Low failure rate, considerable side effects
   2. Morning after pill contains large amounts of estrogen

G. Sterilization fig 59.23
   1. Failure rate approaches zero
   2. Method is irreversible, individual is permanently sterile
   3. Results in removal of a portion of the reproductive tract
      a. Vasectomy: A portion of each vas deferens is removed
      b. Tubal ligation: A portion of each fallopian tube is removed
      c. Hysterectomy: Complete removal of uterus

## INSTRUCTIONAL STRATEGY

### PRESENTATION ASSISTANCE:

Know your own ability to discuss this subject and the maturity of your audience to determine how detailed your lecture will be. Most biologists should be able to get through the physical description of the reproductive system without difficulty. The physiology of human intercourse may be more difficult. If you are uncomfortable, the potential for heckling is increased. It might be better to assign the topic as reading material.

Explain contraception carefully. Be informative without preaching. Again, know your audience.

Present additional information on the evolutionary aspects of the entire reproductive system.

### VISUAL RESOURCES:

Obtain different kinds of eggs, showing variation in size and yolk content. Try to obtain more than just avian eggs. Fish eggs are readily available in bait stores (caviar is a bit too expensive for most teachers), amphibian eggs can be collected in the early spring. A pet store that specializes in reptiles may have some infertile snake or lizard eggs, or at least the remains of already hatched eggs.