Introduction: *Baby Bonanza*

- **Fertility drugs**
  - Increase the number of eggs that are ovulated
  - 10% of women taking fertility drugs become pregnant with more than one embryo
Introduction: *Baby Bonanza*

- Multiple births carry increased risk
  - Premature birth
  - Lower birth weight
  - Increased risk of mortality
    - Five times higher in twins
    - Twelve times higher in supertwins
ASEXUAL AND SEXUAL REPRODUCTION
27.1 Asexual reproduction results in the generation of genetically identical offspring

- **Asexual reproduction**
  - One parent produces genetically identical offspring
  - Very rapid reproduction
  - Can proceed via
    - Budding
    - Fission
    - Fragmentation/regeneration

Video: Hydra Budding
27.2 Sexual reproduction results in the generation of genetically unique offspring

- **Sexual reproduction** involves the fusion of **gametes** from two parents
  - Resulting in genetic variation among offspring
  - Increased reproductive success in changing environments
27.2 Sexual reproduction results in the generation of genetically unique offspring

- Some organisms can reproduce
  - Asexually or
  - Sexually

Video: Hydra Releasing Sperm
Eggs
27.2 Sexual reproduction results in the generation of genetically unique offspring

- Some animals exhibit hermaphroditism
  - One individual with male and female reproductive systems
  - Easier to find a mate for animals less mobile or solitary
27.2 Sexual reproduction results in the generation of genetically unique offspring

- Sperm may be transferred to the female by
  - **External fertilization**
    - Many fish and amphibian species
    - Eggs and sperm are discharged near each other
  - **Internal fertilization**
    - Some fish and amphibian species
    - Nearly all terrestrial animals
    - Sperm is deposited in or near the female reproductive tract
HUMAN REPRODUCTION
27.3 Reproductive anatomy of the human female

- Both sexes in humans have
  - A set of gonads where gametes are produced
  - Ducts for gamete transport
  - Structures for copulation
27.3 Reproductive anatomy of the human female

- **Ovaries** contain **follicles** that
  - Nurture eggs
  - Produce sex hormones
27.3 Reproductive anatomy of the human female

- **Oviducts** convey eggs to the **uterus** where **embryos** develop.

- The uterus opens into the **vagina** through the **cervix**.

- The **vagina**
  - Receives the penis during sexual intercourse
  - Forms the birth canal
Egg cell

Ovary
27.4 Reproductive anatomy of the human male

- **Testes** (singular testis) produce
  - Sperm
  - Male hormones

- **Epididymis** stores sperm as they develop further

- Several glands contribute to semen
  - Seminal vesicles
  - Prostate
  - Bulbourethral

Animation: Male Reproductive Anatomy
27.4 Reproductive anatomy of the human male

- During **ejaculation**
  - Sperm is expelled from the epididymis
  - The seminal vesicles, prostate, and bulbourethral glands secrete into the urethra
  - **Semen** is formed and expelled from the penis
1. **Contraction of vas deferens**
   - Sphincter contracts

2. **Contraction of seminal vesicle**
   - Urethra region here expands and fills with semen

3. **Contraction of prostate gland**
   - Sphincter contracts

4. **Contraction of epididymis**
   - Urethra region here expands and fills with semen

5. **Contraction of muscles around base of penis**
   - Sphincter remains contracted

6. **Semen expelled**
   - Sphincter relaxes
   - Contractions of urethra

---

*Note: Diagram depicts the reproductive system and the sequence of events during ejaculation.*
27.4 Reproductive anatomy of the human male

- Sperm production
  - Regulated by a negative feedback system of hormones
  - Involves the hypothalamus, pituitary, and testes
Stimuli from other areas in the brain

Hypothalamus

Releasing hormone

Anterior pituitary

FSH

LH

Negative feedback

Testis

Androgen production

Sperm production
27.5 The formation of sperm and egg requires meiosis

- **Spermatogenesis**
  - Occurs in *seminiferous tubules*
  - **Primary spermatocytes**
    - Formed by mitosis
    - Divide by meiosis I to produce secondary spermatocytes
  - **Secondary spermatocytes** divide by meiosis II to produce spermatids
  - Round spermatids differentiate into elongate sperm
  - Mature sperm released into seminiferous tubule
Differentiation and onset of Meiosis I

Primary spermatocyte (in prophase of Meiosis I)

Meiosis I completed

Secondary spermatocyte (haploid; double chromatids)

Meiosis II

Developing sperm cells (haploid; single chromatids)

Differentiation

Sperm cells (haploid)

Cross section of seminiferous tubule

Center of seminiferous tubule

Diploid cell

Penis

Scrotum

Testis

Epididymis

Testis

Seminiferous tubule
Sperm cells (haploid)

Developing sperm cells (haploid; single chromatids)

Secondary spermatocyte (haploid; double chromatids)

Primary spermatocyte (in prophase of Meiosis I)

Diploid cell

Center of seminiferous tubule
Differentiation

Sperm cells

Developing sperm cells (haploid; single chromatids)

Meiosis II

Meiosis I completed

Secondary spermatocyte (haploid; double chromatids)

Primary spermatocyte (in prophase of Meiosis I)

Differentiation and onset of Meiosis I

Diploid cell

Diploid cell
27.5 The formation of sperm and egg requires meiosis

- **Oogenesis**
  - Begins before birth—diploid cells start meiosis and stop
  - Each month about one **primary oocyte** resumes meiosis
  - A **secondary oocyte** arrested at metaphase of meiosis II is ovulated
  - Meiosis of the ovum is completed after fertilization
Differentiation and onset of Meiosis I

Completion of Meiosis I and onset of Meiosis II

Entry of sperm triggers completion of Meiosis II

Diploid cell in embryo

Primary oocyte
(arrested in prophase of Meiosis I; present at birth)

Secondary oocyte
(arrested at metaphase of Meiosis II; released from ovary)

Ovary

Corpus luteum

Growing follicle

Mature follicle

Ruptured follicle

Ovum (haploid)

Sperm

Ovulation

2n

n

First polar body

Second polar body

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Corpus luteum

Ovulation

Ruptured follicle

Mature follicle

Growing follicle

Ovary

**Primary oocyte**
(arrested in prophase of Meiosis I; present at birth)

**Secondary oocyte**
(arrested at metaphase of Meiosis II; released from ovary)

**Ovum**
(haploid)

**Sperm**
Differentiation and onset of Meiosis I

Completion of Meiosis I and onset of Meiosis II

Entry of sperm triggers completion of Meiosis II

Diploid cell in embryo

Primary oocyte (arrested in prophase of Meiosis I; present at birth)

Secondary oocyte (arrested at metaphase of Meiosis II; released from ovary)

Ovum (haploid)
27.6 Hormones synchronize cyclic changes in the ovary and uterus

- **Ovarian and menstrual cycles**
  - Occur about every 28 days
  - Hypothalamus signals the anterior pituitary to secrete follicle-stimulating hormone (FSH) and leuteinizing hormone (LH), which trigger
    - Growth of a follicle
    - Ovulation
<table>
<thead>
<tr>
<th>Hormone</th>
<th>Secreted by</th>
<th>Major Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Releasing hormone</td>
<td>Hypothalamus</td>
<td>Regulates secretion of LH and FSH by pituitary</td>
</tr>
<tr>
<td>Follicle-stimulating hormone</td>
<td>Pituitary</td>
<td>Stimulates growth of ovarian follicle</td>
</tr>
<tr>
<td>(FSH)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leuteinizing hormone (LH)</td>
<td>Pituitary</td>
<td>Stimulates growth of ovarian follicle and production of secondary oocyte; promotes ovulation; promotes development of corpus luteum and secretion of hormones</td>
</tr>
<tr>
<td>Estrogen</td>
<td>Ovarian follicle</td>
<td>Low levels inhibit pituitary; high levels stimulate hypothalamus; promotes endometrium</td>
</tr>
<tr>
<td>Estrogen and progesterone</td>
<td>Corpus luteum</td>
<td>Maintain endometrium; high levels inhibit hypothalamus and pituitary; sharp drops promote menstruation</td>
</tr>
</tbody>
</table>
27.6 Hormones synchronize cyclic changes in the ovary and uterus

- After ovulation, ovarian follicle becomes corpus luteum
- Corpus luteum secretes estrogen and progesterone, which
  - Stimulate the endometrium to thicken
  - Prepare the uterus for implantation of the embryo
  - Inhibit hypothalamus, reducing FSH and LH secretion
27.6 Hormones synchronize cyclic changes in the ovary and uterus

- If egg is fertilized
  - Embryo releases hormones that maintain the uterine lining
  - Menstruation does not occur

- If egg is not fertilized
  - Drop in LH shuts down corpus luteum and its hormones
  - Menstruation is triggered
  - Hypothalamus and pituitary stimulate development of a new follicle
27.6 Hormones synchronize cyclic changes in the ovary and uterus

Animation: Ovulation

Animation: Post Ovulation
A. Control by hypothalamus

- Hypothalamus
- Releasing hormone
- Anterior pituitary

- FSH
- LH

B. Pituitary hormones in blood

1. FSH
2. LH

- LH peak triggers ovulation and corpus luteum formation
- LH

C. Ovarian cycle

- Growing follicle
- Mature follicle
- Ovulation
- Corpus luteum
- Degenerating corpus luteum

- Pre-ovulatory phase

- Estrogen

D. Ovarian hormones in blood

- Estrogen
- Progesterone

- Post-ovulatory phase

- Progesterone and estrogen

E. Menstrual cycle

- Endometrium

- Menstruation

Days

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Control by hypothalamus

Hypothalamus

Releasing hormone

Anterior pituitary

FSH

LH

Inhibited by combination of estrogen and progesterone

Stimulated by high levels of estrogen

LH peak triggers ovulation and corpus luteum formation

Pituitary hormones in blood

FSH

LH
Pituitary hormones in blood

LH peak triggers ovulation and corpus luteum formation

Ovarian cycle

Growing follicle
Mature follicle
Ovulation
Corpus luteum
Degenerating corpus luteum

Pre-ovulatory phase
Post-ovulatory phase

Estrogen
Progesterone and estrogen
Ovarian cycle

Growing follicle

Mature follicle

Ovulation

Corpus luteum

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Pre-ovulatory phase

Estrogen

Post-ovulatory phase

Progesterone and estrogen

D Ovarian hormones in blood

Estrogen

Progesterone

Estrogen

Progesterone and estrogen
Ovarian hormones in blood

D

Estrogen

Progesterone

3

7

8

Menstrual cycle

E

Endometrium

Menstruation

Days

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27.7 CONNECTION: Sexual activity can transmit disease

- Bacterial diseases can often be cured
  - **Chlamydia**
    - Most common bacterial STD
    - Often produces no symptoms
    - Can lead to pelvic inflammatory disease and infertility

- Viral diseases can only be controlled

- Latex condoms provide the best protection against disease transmission
## Table 27.7: STDs Common in the United States

<table>
<thead>
<tr>
<th>Disease</th>
<th>Microbial Agent</th>
<th>Major Symptom and Effects</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bacterial</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlamydia</td>
<td><em>Chlamydia trachomatis</em></td>
<td>Genital discharge, itching, and/or painful urination; often no symptoms in women; pelvic inflammatory disease (PID)</td>
<td>Antibiotics</td>
</tr>
<tr>
<td>Gonorrhea</td>
<td><em>Neisseria gonorrhoeae</em></td>
<td>Genital discharge; painful urination; sometimes no symptoms in women; PID</td>
<td>Antibiotics</td>
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<tr>
<td>Syphilis</td>
<td><em>Treponema pallidum</em></td>
<td>Ulcer (chancre) on genitalia in early stages; spreads throughout body and can be fatal if not treated</td>
<td>Antibiotics can cure in early stages</td>
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<td><strong>Viral</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Genital herpes</td>
<td>Herpes simplex virus type 2, occasionally type 1</td>
<td>Recurring symptoms: small blisters on genitalia, painful urination, skin inflammation; linked to cervical cancer, miscarriage, birth defects</td>
<td>Valacyclovir can prevent recurrences</td>
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<td>Genital warts</td>
<td>Papillomavirus</td>
<td>Painless growths on genitalia; some of the viruses linked to cancer</td>
<td>Removal by freezing</td>
</tr>
<tr>
<td>AIDS and HIV infection</td>
<td>HIV</td>
<td>See Module 24.13</td>
<td>Combination of drugs</td>
</tr>
<tr>
<td><strong>Protozoan</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trichomoniasis</td>
<td><em>Trichomonas vaginalis</em></td>
<td>Vaginal irritation, itching, and discharge; usually no symptoms in men</td>
<td>Antiprotozoal drugs</td>
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<tr>
<td><strong>Fungal</strong></td>
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<td></td>
<td></td>
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<tr>
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<td><em>Candida albicans</em></td>
<td>Similar to symptoms of trichomoniasis; frequently acquired nonsexually</td>
<td>Antifungal drugs</td>
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</tr>
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27.8 CONNECTION: Contraception can prevent unwanted pregnancy

- **Contraception** is the deliberate prevention of pregnancy
- Methods are effective to varying degrees
### TABLE 27.8  CONTRACEPTIVE METHODS

<table>
<thead>
<tr>
<th>Method</th>
<th>Pregnancies/100 Women/Year*</th>
<th>Used Perfectly</th>
<th>Typically</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth control pill (combination)</td>
<td>0.1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Vasectomy</td>
<td>0.1</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Tubal ligation</td>
<td>0.2</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Rhythm method</td>
<td>1–9</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Withdrawal</td>
<td>4</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Condom (male)</td>
<td>3</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Diaphragm and spermicide</td>
<td>6</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Spermicide alone</td>
<td>6</td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>

*Without contraception, about 85 pregnancies would occur.*
Skin patch
PRINCIPLES OF EMBRYONIC DEVELOPMENT
27.9 Fertilization results in a zygote and triggers embryonic development

- Embryonic development begins with fertilization
  - The union of sperm and egg
  - To form a diploid zygote
27.9 Fertilization results in a zygote and triggers embryonic development

- Sperm are adapted to reach and fertilize an egg
  - Streamlined shape moves more easily through fluids
  - Many mitochondria provide ATP for tail movements
  - Head contains
    - A haploid nucleus
    - Tipped with an acrosome containing penetrating enzymes
27.9 Fertilization results in a zygote and triggers embryonic development

- Fertilization events
  - Sperm squeeze past follicle cells
  - Acrosomal enzymes pierce egg’s coat
  - Sperm binds to vitelline layer
  - Sperm and egg plasma membranes fuse
  - Egg is stimulated to develop further
  - Egg and sperm nuclei fuse
1. The sperm squeezes through cells left over from the follicle.
2. The sperm's acrosomal enzymes digest the egg’s jelly coat.
3. Proteins on the sperm head bind to egg receptors.
4. The plasma membranes of sperm and egg fuse.
5. The sperm nucleus enters the egg cytoplasm.
6. A fertilization envelope forms.
7. The nuclei of sperm and egg fuse.

Key:
- Sperm Nucleus
- Acrosome
- Plasma membrane
- Sperm head
- Acrosomal enzymes
- Receptor protein molecules
- Vitelline layer
- Jelly coat
- Cytoplasm
- Egg cell
- Sperm nucleus
- Egg nucleus
- Zygote nucleus
27.10 Cleavage produces a ball of cells from the zygote

- Cleavage is a rapid series of cell divisions
  - More cells
  - Embryo does not get larger
  - Thus new cells are smaller in size

Video: Sea Urchin Embryonic Development
Zygote → 2 cells
Zygote → 2 cells → 4 cells
Zygote

2 cells

4 cells

8 cells
Zygote → 2 cells → 4 cells → 8 cells → Many cells (solid ball)
Zygote
- 2 cells
- 4 cells
- 8 cells
- Many cells (solid ball)
- Blastula (hollow ball)
- Cross section of blastula
- Blastocoel
27.11 Gastrulation produces a three-layered embryo

**Gastrulation**

- Cells migrate
- The basic body plan of three layers is established
  - **Ectoderm** outside—becomes skin and nervous systems
  - **Endoderm** inside—becomes digestive tract
  - **Mesoderm** in middle—muscle and bone
- A rudimentary digestive cavity forms
Blastula (end of cleavage)

Animal pole

Blastocoel

Vegetal pole

Gastrulation (cell migration)

Blastocoel shrinking

Formation of a simple digestive cavity

Blastopore

Gastrula (end of gastrulation)

Ectoderm

Mesoderm

Endoderm

Simple digestive cavity
Blastula (end of cleavage)

Animal pole

Blastocoel

Blastopore

Vegetal pole

Formation of a simple digestive cavity

Gastrulation (cell migration)

Blastocoel shrinking

Blastopore
Gastrulation (cell migration)

Blastocoel shrinking

Formation of a simple digestive cavity

Gastrula (end of gastrulation)

Ectoderm

Mesoderm

Endoderm

Simple digestive cavity
<table>
<thead>
<tr>
<th>Embryonic Layer</th>
<th>Organs and Tissues in the Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ectoderm</td>
<td>Epidermis of skin; epithelial lining of mouth and rectum; sense receptors in epidermis; cornea and lens of eye; nervous system</td>
</tr>
<tr>
<td>Endoderm</td>
<td>Epithelial lining of digestive tract (except mouth and rectum); epithelial lining of respiratory system; liver; pancreas; thyroid; parathyroids; thymus; lining of urethra, urinary bladder, and reproductive system</td>
</tr>
<tr>
<td>Mesoderm</td>
<td>Skeletal system; muscular system; circulatory system; excretory system; reproductive system (except gametocyte-forming cells); dermis of skin; lining of body cavity</td>
</tr>
</tbody>
</table>
27.12 Organs start to form after gastrulation

- Organs develop from the three embryonic layers
  - Stiff **notochord** forms the main axis of the body
    - Later replaced by the vertebral column
  - **Neural tube** develops above the notochord and will become the
    - Brain
    - Spinal cord

Video: Frog Embryo Development
Neural fold  Neural plate
Neural fold → Neural plate → Neural tube

Outer layer of ectoderm
27.12 Organs start to form after gastrulation

- As the embryo elongates
  - Paired somites form along the sides of the notochord
    - Future muscle
    - Future bone and other connective tissues
  - Later, somites hollow out to form a coelom
  - Other systems also develop
Tissues and organs develop by

- Changes in cell shape
- Cell migration
- Programmed cell death
Apoptosis

Dead cell engulfed and digested by adjacent cell
27.13 Multiple processes give form to the developing animal

- **Induction**
  - Adjacent cells and cell layers
  - Influence each other’s differentiation via chemical signals
27.14 EVOLUTION CONNECTION: Pattern formation during embryonic development is controlled by ancient genes

- **Pattern formation** organizes the animal body

- Tissues and organs develop
  - In their proper positions
  - At the correct times
Limb buds develop anteriorly and posteriorly.
27.14 EVOLUTION CONNECTION: Pattern formation during embryonic development is controlled by ancient genes

- Spatial variations of chemicals guide this organization

- **Homeotic genes** contain
  - Nucleotide sequences (homeoboxes)
  - Homeotic genes guide pattern formation in embryos
  - Very similar homeotic genes occur in diverse groups
    - Yeast, plants, animals
    - Reveal the shared evolutionary history of life
Fly chromosome

Mouse chromosomes

Fruit fly embryo (10 hours)

Mouse embryo (12 days)

Adult fruit fly

Adult mouse
HUMAN
DEVELOPMENT
27.15 The embryo and placenta take shape during the first month of pregnancy

- Human fertilization occurs in the oviduct

- Cleavage produces a **blastocyst**
  - Inner cell mass becomes the embryo
  - **Trophoblast**
    - Outer cell layer
    - Attaches to the uterine wall
    - Forms part of the **placenta**
Fertilization of ovum
Ovulation
Secondary oocyte
Cleavage starts
Ovary
Blastocyst (implanted)
Endometrium
Uterus
Endometrium

Future embryo

Blood vessel (maternal)

Future yolk sac

Multiplying cells of trophoblast

Trophoblast

Uterine cavity
27.15 The embryo and placenta take shape during the first month of pregnancy

- Four extraembryonic membranes develop
  - **Amnion**
    - Surrounds the embryo
    - Forms a fluid-filled amniotic cavity that protects the embryo
  - **Yolk sac**
    - In reptiles, it stores yolk
    - No yolk in humans
    - Yolk sac is source of important cells
      - First germ cells
      - First blood cells
27.15 The embryo and placenta take shape during the first month of pregnancy

- **Allantois**
  - Contributes to the umbilical cord
  - Forms part of urinary bladder
  - In reptiles it stores embryonic waste

- **Chorion**
  - Contributes to the placenta
  - Secretes human chorionic gonadotropin (HCG), which prevents menstruation in mammals
Amnion
Chorion
Allantois
Yolk sac

Chorionic villi
Embryo:
Ectoderm
Mesoderm
Endoderm
27.15 The embryo and placenta take shape during the first month of pregnancy

- Placenta
  - Close association of
    - Embryonic chorion
    - Mother’s blood vessels
  - Site of
    - Gas exchange—from mother to embryo
    - Nutrient exchange—from mother to embryo
    - Waste exchange—from embryo to mother
27.16 Human development from conception to birth is divided into three trimesters

- First trimester
  - Time of most radical change for mother and embryo
  - Embryo forms—looks like other vertebrate embryos
  - Extraembryonic membranes form
  - All major organ systems are established
  - At 9 weeks after fertilization, now called a fetus
    - Can move its arms and legs
    - Starts to look distinctly human
5 weeks (35 days)
9 weeks (63 days)
27.16 Human development from conception to birth is divided into three trimesters

- Second trimester
  - Increase in size
  - Refinement of human features
  - At 20 weeks
    - About 19 cm long (7.6 in.)
    - Weighs about 0.5 kg (1 lb.)
14 weeks (98 days)
20 weeks (140 days)
Third trimester

- Time of rapid growth
- Circulatory and respiratory systems mature
- Muscles thicken and skeleton hardens
- Ends with birth
- Babies born at start of third trimester (28 weeks) may survive with extensive medical care
At birth (280 days)
27.17 Childbirth is hormonally induced and occurs in three stages

- Hormonal changes induce birth
  - Estrogen makes the uterus more sensitive to oxytocin
  - Oxytocin acts with prostaglandins to initiate labor
  - Cervix dilates
  - Baby is expelled by strong contractions of the uterus
  - Placenta dislodges and is expelled after the baby
Estrogen

from ovaries

Induces oxytocin receptors on uterus

Oxytocin

from fetus and pituitary

Stimulates uterus to contract

Stimulates placenta to make Prostaglandins

Stimulate more contractions of uterus

Positive feedback
27.17 Childbirth is hormonally induced and occurs in three stages

- Labor occurs in three stages
  - Dilation of the cervix
  - Expulsion: delivery of the infant
  - Delivery of the placenta
1 Dilation of the cervix

2 Expulsion: delivery of the infant

3 Delivery of the placenta
1 Dilation of the cervix
Expulsion: delivery of the infant
Delivery of the placenta

1. Uterus
2. Placenta (detaching)
3. Umbilical cord
New techniques can help many infertile couples

- About 15% of couples wanting children are infertile
- Drug therapies
  - Impotence—erectile dysfunction
  - To induce ovulation
- Assisted reproductive technologies (ART)
- *In vitro* fertilization (IVF)
Implantation

- Zygote
  - Collected egg
  - Collected sperm
  - In vitro fertilization
  - 8-cell embryo
  - Implantation
Oogenesis

2n
Primary oocyte

Primary spermatocyte

Secondary spermatocyte

Secondary spermatocyte

Sperm

Once per month

n
Polar body

n
Polar body

Fertilization

2n
Ovum

n
Polar body

2n
Zygote
Cleavage

Zygote → 2-cell embryo → Many celled solid ball → Blastula (cross section) → Gastrula (cross section)

Gastrulation

Ectoderm
Mesoderm
Endoderm
You should now be able to

1. Explain how fertility drugs have affected multiple births in the United States

2. Compare the types of asexual and sexual reproduction

3. Describe the structures and functions of the male and female human reproductive tracts

4. Describe and compare spermatogenesis and oogenesis

5. Describe the events of the menstrual cycle

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You should now be able to

6. Describe the nature of the most common STDs
7. Describe the most common forms of birth control
8. Relate the structure of sperm to its roles in fertilization
9. Describe the processes of cleavage and gastrulation
10. Describe the functions of the four extraembryonic membranes
You should now be able to

11. Describe the main changes that occur during each trimester of human development

12. Describe the most common reproductive technologies