Chapter 29
Development, Growth, and Aging

Prenatal Development

• From conception to birth: three stages
  – **Germinal period**: first 2 weeks of development during formation of primitive germ layers
  – **Embryonic period**: second to end of 8th week, organ systems develop
  – **Fetal period**: last 30 weeks, organ systems grow and mature

• **Clinical age**: mother’s last menstrual period (LMP) used to calculate age of unborn child

• **(Postovulatory age)**: describes timing of developmental events; calculated as 14 days less
Fertilization

- Zygote divides to form 2 cells about 18-39 hours after fertilization
  - 2 cells divide to form 4, 8, and so on
  - Pluripotent: Ability to develop into wide range of tissues

- Morula: solid ball of 12 or more cells
- Blastocyst or hollow sphere of cells
  - Implantation: burrowing into uterine wall
  - Placenta develops from trophoblast cells
Formation of Placenta

A. Frontal section of the uterus and uterine tube showing development 7 days after fertilization

B. Implantation of the blastocyst with syncytiotrophoblast beginning to invade the uterine wall at 8-12 days

C. (Baby’s part)

Placenta Formation

C. Intermediate stage of placental formation at about 14-20 days. As maternal blood vessels are encountered by the syncytiotrophoblast, lacunae are formed and filled with maternal blood (mother’s part)

D. Cytotrophoblast cords surround the syncytiotrophoblast and lacunae, and embryonic mesoderm enters the cord at about 1 month
Mature Placenta and Fetus

Formation of the Germ Layers

- **Amniotic cavity**: forms inside inner cell mass and surrounded by layer of cells called the amnion or amniotic sac. Forms after implantation
  - **Embryonic disk**: composed of ectoderm and endoderm and is part of the inner cell mass
  - Amniotic cavity eventually surrounds the developing embryo providing a protective
- **Yolk sac**: forms inside blastocoele from endoderm
- (soon makes first blood cells)
**Primitive Streak**
Mesoderm and **notochord** formation

**Neural Tube Formation**
Formation of Digestive Tract

Structures Associated with the Gut

- Evaginations: outpocketing
- **Allantois**, part of which becomes the bladder
- Other evaginations become
  - Anterior pituitary, thyroid gland, lungs, liver, pancreas
- **Branchial arches**: solid bars of tissue form along lateral surface of head. Sides of gut expand between them to form pouches
  - Central pouch is pharynx
  - Others (pharyngeal pouches) become the auditory tubes, tonsils, thymus and parathyroids
- Body cavities begin to form at this time: **coelom**
  - Fuses first around the heart as the pericardial cavity
  - Expands posteriorly to become the **pleural and peritoneal Cavities**.
Limb Bud Development and Face Development

- **Limb bud development**
  - Arms and legs appear at about 28 days
  - Apical ectodermal ridge develops on lateral margin of each limb and stimulates outgrowth
  - Limb tissue laid down in proximal-to-distal sequence

- **Face development**
  - Fusion of 5 embryonic structures
    - Frontonasal process
    - Maxillary processes
    - Mandibular processes
  - Nasal placodes
    - SEE PICTURE
  - (Cleft lip)
    - Failure of frontonasal and 2 maxillary processes to fuse
Organ Systems Development

- **Skin**
  - Epidermis derived from **ectoderm**
  - Dermis derived from mesoderm or neural crest cells as in face
- **Skeleton**: develops from **mesoderm** or neural crest cells
- **Muscle**: **myoblasts** are early embryonic cells that develop into skeletal muscle fibers
- **Nervous System**: derived from **neural tube** and neural crest cells (from ectoderm)

Heart Development

2 endothelial tubes fuse...
Lung Development
from foregut (endoderm)

Kidney (from Mesoderm)
Urinary Bladder Development
Reproductive System Development

Growth of the Fetus

- Fetus: at 60 days embryo becomes a fetus
- Fetal period: from day 60 to birth
  - Rapid growth
  - Lanugo: fine soft hair covering
  - Vernix caseosa: waxy coat of protection
Embryos and Fetuses at Different Ages

Parturition—See Models

- **Parturition**: process by which a baby is born (Giving Birth)
- **In mother**
  - Estrogens overcome inhibitory influence of progesterone
  - Oxytocin is released
- **In fetus**
  - Adrenal gland is enlarging prior to parturition due to influence of fetal hypothalamus
- **Labor**
  - First stage: onset of regular uterine contraction until cervix dilates to fetal head diameter
  - Second stage: from maximum cervical dilation until baby exits vagina (delivery)
  - Third stage: expulsion of placenta from uterus (afterbirth)
Factors Influencing Parturition

Circulatory Conditions in Fetus
Apgar Scores

Assessment of Newborn Baby

- **Appearance**, **Pulse**, **Grimace**, **Activity**, **Respiratory effect**
- Rated on scale of 0-2, 2 denotes normal function
- Total Apgar score is sum from five characteristics

<table>
<thead>
<tr>
<th>Appearance (skin color)</th>
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<td>White or blue</td>
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<table>
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<tbody>
<tr>
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<tr>
<td>&gt; 100 bpm</td>
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<th>Grimace (reflex grimace initiated by stimulating the plantar surface of the foot)</th>
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<tr>
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<tr>
<td>Facial grimaces, slight body movement</td>
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<td>Facial grimaces, extensive body movement</td>
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<tr>
<td>Limbs partially flexed, little movement, poor muscle tone</td>
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<tr>
<td>Active movement, good muscle tone</td>
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<tr>
<td>Slow, irregular respiration</td>
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<tr>
<td>Good, regular respiration, strong cry</td>
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Hormonal Control of Lactation

- Oxytocin, **Prolactin**
- Hypothalamus
- Anterior pituitary
- Posterior pituitary
- Mammary gland
- Spinal cord

**Hypothalamus**

**Anterior pituitary**

**Posterior pituitary**

**Oxytocin** (milk letdown)

**Prolactin** (milk production)
## First Year After Birth

- **Brain still developing.** Believed all neurons present at birth, but growth occurs because of increase in neuroglia.
- **Myelination continues; neurons make new connections**
- 6 weeks: hold head up and smiles
- 3 months: limbs move aimlessly except for thumb sucking; can follow object with eyes
- 4 months: can raise itself by its arms, can grasp objects, coo, gurgle, roll from back to side, listen to a voice or music, hold head erect, play with hands
- 5 months: laugh, reach, turn head to follow object, lift head and shoulder, sit with support, roll over
- 8 months: recognize familiar people, sit up, reach for specific objects
- 12 months: pull self to standing position, may walk, can pick up objects and examine them, can understand much of what is said and may say several words

## Life Stages

- **EARLY:** Germinal period/Embryo/Fetus
- **Neonate:** birth to 1 month post partum
- **Infant:** 1 month to 1-2 years (when child can walk)
- **Child:** 2 to puberty; many emotional characteristics of a person form at this stage
- **Adolescent puberty:** 11/14 years to 20 years
  - Major physical and physiological changes that affect emotions and behavior
  - Puberty in females: 11-13 years. In males, 12-14 years
  - Period of rapid growth at puberty followed by period of slower growth
  - Adult stature by 17-18 in females; 19-20 in males
- **Adult:** 20 years to death
  - Young adult: 20-40 years
  - Middle age: 40-65 years
  - Older adult: 65 to death
Aging

• Cells such as liver and skin continue to proliferate throughout life
• Cells such as neurons cease to divide once they have reached a certain number; dead cells not replaced. After reaching a peak, neurons die, at first at a rapid rate, then slower as the person ages
• Mitochondrial DNA function declines
• More and more cross-linking occurs between collagen fibers making tissues more rigid and less elastic
  – Difficulty in near vision
  – Joints, blood vessels, kidneys, lungs, heart follow
• Total number of skeletal and cardiac muscle fibers decline. Strength of skeletal muscle peaks between 20 and 30 years, declines after
• Decline in cardiac function: results in lowered cardiac output, less oxygen and nutrients reach cells

Aging

• Atherosclerosis: deposit and hardening of materials in lesions in large and medium-sized arteries. Result in arteriosclerosis which, in turn, can result in a thrombus and/or embolus
• Progressive aging of cells due to exposure to toxic substances
• Free radicals: atoms or molecules with an unpaired electron. Can react with and alter cells leading to dysfunction, cancer, or cell damage
• Poor diet may lead to vitamin deficiency
• Decrease in ATP production
• Immune system is less responsive to outside antigens but more responsive to self antigens
• Genetic component: longevity
• (Progeria: genetic trait causing premature aging)
• Ability to adjust to stress decreases