Child Growth and Development

Pregnancy and Prenatal Development

Chapter 4

Prepared by:
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From: Papalia, Olds, Feldman
Prenatal Development: Three Stages

• Germinal stage
  – Zygote

• Embryonic stage
  – Embryo

• Fetal stage
  – Fetus

• Principles of development:
  – Cephalocaudal*
  – Proximodistal*
Germinal Stage

• Fertilization to 2 weeks
• Zygote divides
  – Mitosis
  – Within 24 hours, 64 cells
  – Travels down the fallopian tube, approximately 3 – 4 days
  – Changes to a blastocyst
  – Cell differentiation begins
    • Embryonic disk
      – Differentiates into two layers
        » Ectoderm: outer layer of skin, nails, hair, teeth, sensory organs, nervous system, including brain and spinal cord
        » Endoderm: digestive system, liver, pancreas, salivary glands, respiratory system
      – Later a middle layer, mesoderm, will develop into skin, muscles, skeleton, excretory and circulatory systems
  – Implants about the 6th day after fertilization
  – Only 10% - 20% of fertilized ova complete the task of implantation
• 800 billion cells eventually
Germinal Stage (cont)

• **Blastocyst develops**
  - Amniotic sac, outer layers, amnion, chorion, placenta and umbilical cord
  - Placenta allows oxygen, nourishment, and wastes to pass between mother and baby
    - Maternal and embryonic tissue
    - Placenta filters some infections
    - Produces hormones
      - To support pregnancy
      - Prepares mother’s breasts for lactation
      - Signals contractions for labor
  - Umbilical cord is connected to embryo
    - Mother’s circulatory system not directly connected to embryo system, no blood transfers
Embryonic Stage: 2 – 8 weeks

- Second stage of gestation
- Organs and major body systems develop rapidly
  - Respiratory, digestive, nervous
  - Critical period!*
    - Embryo most vulnerable to destructive influences in prenatal environment
<table>
<thead>
<tr>
<th>Period of dividing zygote, implantation, and bilaminar embryo</th>
<th>Neural tube defects (NTDs)</th>
<th>Mental retardation</th>
<th>CNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morula</td>
<td>TA, ASD, and VSD</td>
<td>Heart</td>
<td></td>
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<tr>
<td>Embryonic disc</td>
<td>Amelia/Meromelia</td>
<td>Upper limb</td>
<td></td>
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<tr>
<td>Morula containment</td>
<td>Amelia/Meromelia</td>
<td>Lower limb</td>
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<tr>
<td>Amnion</td>
<td>Cleft lip</td>
<td>Upper lip</td>
<td></td>
</tr>
<tr>
<td>Blastocyst</td>
<td>Low-set malformed ears and deafness</td>
<td>Ears</td>
<td></td>
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<tr>
<td>Embryonic disc</td>
<td>Microphthalmia, cataracts, glaucoma</td>
<td>Eyes</td>
<td></td>
</tr>
<tr>
<td>Not susceptible to teratogenesis</td>
<td>Enamel hypoplasia and staining</td>
<td>Teeth</td>
<td></td>
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<tr>
<td>Death of embryo and spontaneous abortion common</td>
<td>Cleft palate</td>
<td>Palate</td>
<td></td>
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<tr>
<td></td>
<td>Masculinization of female genitalia</td>
<td>External genitalia</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Common site(s) of action of teratogens</th>
<th>Less sensitive period</th>
<th>Highly sensitive period</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA — Truncus arteriosus; ASD — Atrial septal defect; VSD — Ventricular septal defect</td>
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</table>
Embryonic Stage (cont)

• Most severely defective embryos usually do not survive beyond first trimester
  – 3-month period

• Spontaneous abortion (miscarriage) occurs
  – 1 in 4 pregnancies end in miscarriage
    • May possibly be as high as 1 in 2
    • 3 out of 4 spontaneous abortions occur during first trimester
    • Most miscarriages result from abnormal pregnancies
      – 50% - 70% abnormal chromosomes
  – Males more likely to spontaneously abort or be stillborn
<table>
<thead>
<tr>
<th></th>
<th>Conception</th>
<th>Birth</th>
<th>Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>125</td>
<td>105</td>
<td>96</td>
</tr>
<tr>
<td>Female</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
Fetal Stage: 8 Weeks - Birth

- Presence of bone cells signals fetal stage*
- No passive passengers
  - Breathe, kick, turn, flex, somersault, squint, swallow, make a fist, hiccup, suck their thumbs
- Pain may be felt during third trimester
- Ultrasound detects outline of fetus
- Significant changes between 28 – 32 weeks that explain why premature infants at this age have better outcomes
- Males more active during gestation
  - Inborn
Fetal Stage (cont)

• Olfactory system begins to develop 14 weeks
  – Oldest memory
• Fetus responds to mother’s voice, heartbeat, and vibrations of her body
  – Hear, touch
  – Begins about 26 weeks of gestation, plateaus at 32 weeks
• “Learn” and “remember”
  – Newborn prefers mother’s voice
  – Newborn prefers mother’s native language
Prenatal Development: Environmental Influences

- Maternal factors
  - Nutrition and maternal weight
  - Malnutrition
  - Physical activity and strenuous work
  - Drug intake
    - Medical drugs
    - Alcohol
    - Nicotine
    - Marijuana, cocaine, methamphetamine
  - HIV/AIDS
  - Maternal illnesses
  - Stress
  - Age
  - Outside environmental hazards
Prenatal Development: Environmental Influences (cont)

- **Maternal factors**
  - Nutrition and maternal weight
    - Need 300 – 500 more calories a day
    - Need extra protein
    - Weight gain of 25 – 35 pounds less likely to have birth complications
  - Overweight before pregnancy
    - Highest risk of stillbirth or losing baby during first week of life
    - Higher neural-tube defects
    - Higher heart defects
    - More birth defects
    - Complications of pregnancy higher: miscarriage, difficulty inducing labor, higher cesarean
  - Underweight more likely to have dangerously small babies
  - What woman eats is important
    - Fish is brain food
      - High mercury levels
    - Folic acid
      - Prevents anencephaly and spina bifida
      - Now in grain products in US since 1998
      - Childbearing age women encouraged to take folate supplements daily
Prenatal Development: Environmental Influences (cont)

• Maternal factors
  – Malnutrition
    • More likely to die in early adulthood
    • Increase stroke rates in middle age
    • Developing brain
      – Antisocial personality disorders at age 18
    • Low vitamin D in mothers children have low bone mineral content at age 9
    • Link between fetal undernutrition and schizophrenia
    • Dietary supplements help
Prenatal Development: Environmental Influences (cont)

• Maternal factors
  – Physical activity and strenuous work
    • Moderate exercise doesn’t endanger fetus of healthy woman
    • Regular exercise helps prevent constipation, improves respiration, circulation, muscle tone, and skin elasticity
      – Keep heart rate under 150
    • Employment is not harmful
      – Unless long hours, strenuous work, occupational fatigue
Prenatal Development: Environmental Influences (cont)

• Maternal factors
  – Drug intake (everything makes its way to the fetus)
    • Medical drugs
      – DES
        » Taken from late 1940’s to early 1950’s for prevention of miscarriage
        » Daughters in puberty got cervical cancer, vaginal cancer
        » In midlife, twice the risk of breast cancer
        » Sons have had malformations in genital tract
      – Prozac
        » Infants have disrupted neurobehavioral activity, increased risk of severe respiratory failure
Prenatal Development: Environmental Influences (cont)

• Maternal factors
  – Drug intake
    • Medical drugs
      – Thalidomide
        » Taken from 1957 to 1960’s for morning sickness
        » 10,000 – 20,000 children born in 46 countries
        » 100,000 miscarried
        » Predominantly Germany and Great Britain

American Academy of Pediatrics committee on Drugs, 1994: No medication be prescribed for a pregnant or breast-feeding woman unless it is essential for her health or the child’s
Prenatal Development: Environmental Influences (cont)

• Maternal factors
  – Drug intake
    • Alcohol
      – Fetal alcohol syndrome (FAS)
      – 5 in 1000 born in the US
      – Retarded growth
      – Facial and bodily malformations
      – Disorders of the central nervous system
        » Short attention span, learning disabilities, memory problems
        » Slow reaction time
        » Distractibility
        » Restlessness
        » Hyperactivity
      – FAS and FAE occur 1 in 100 US births
      – Most common cause of mental retardation*
      – Leading preventable cause of birth defects in US*
      – No known safe amount of alcohol
Fig. A: Fetal Alcohol Syndrome, Diagnosis, Epidemiology, Prevention, and Treatment, (Institute of Medicine, 1996).

Fig. B: Reprinted with permission from S. & Smith, (1978). Copyright 1978 by the New England Journal of Medicine, Massachusetts Medical Society.

Fig. C and D: Reprinted with permission from Jones et al. (1973). Copyright 1973 by the Lancet Ltd.

small eyes (distance from A to B)

smooth philtrum thin upper lip

Discriminating Features
- short palpebral fissures
- flat midface
- short nose
- indistinct philtrum
- thin upper lip

Associated Features
- epicanthal folds
- low nasal bridge
- minor ear anomalies
- micrognathia

In the Young Child

Please do not copy or distribute this photograph without permission from Susan Astley, Ph.D.
Prenatal Development: Environmental Influences (cont)

• Maternal factors
  – Drug intake
    • Nicotine
      – Single most important factor in low birth weight in developed countries*
      – Increased miscarriage
      – Growth retardation
      – Stillbirth
      – Small head circumference
      – SIDS
      – Colic
      – Hyperkinetic disorder
      – Long-term respiratory
      – Neurological, cognitive and behavioral problems
      – Males with reproductive problems
      – Offspring with diabetes
      – School age: poor attention span, hyperactivity, anxiety, learning and behavior problems, perceptual-motor and linguistic problems, poor IQ scores, low grade placement, neurological problems
Prenatal Development: Environmental Influences (cont)

- **Maternal factors**
  - **Drug intake**
    - **Caffeine**
      - 4 or more cups of coffee a day increased SIDS
      - 8 or more cups of coffee a day dramatically increased fetal death
    - **Marijuana**
      - Mixed studies
      - Heavy use can lead to birth defects, LBW, withdrawal-like symptoms at birth, increased attention disorders, learning problems later in life
        » Possibly suggests problems with the frontal lobe
    - **Cocaine**
      - Associated with spontaneous abortion, delayed growth, premature labor, LBW, small head size, birth defects, impaired neurological development
      - High exposure, childhood behavior problems
      - Studies controversial, as are laws charging pregnant women
  - **Methamphetamine**
    - LBW, SGA
Prenatal Development: Environmental Influences (cont)

– HIV/AIDS
  • Virus may cross placenta during pregnancy, labor/delivery, or breast milk
  • Biggest risk: if she doesn’t know she is HIV +
  • Significant decrease as a result of AZT, now <2%

– Maternal illnesses
  • Colds, flu, urinary tract and vaginal infections, STIs
  • Screened for thyroid functioning (cognitive functioning)
  • Rubella before 11th week: deafness, heart defects
  • Diabetes in mother: 2 – 5 times more likely to develop birth defects: heart and spinal cord
  • Toxoplasmosis, parasite infection from cattle, sheep, pigs, cats
    – Especially in second and third trimesters
    – Brain damage in fetus, vision impairment/blindness, seizures, miscarriage, stillbirth, death of fetus
    – 9 out of 10 appear normal at birth
    – Avoid raw meat or very rare, wash hands and surfaces of raw meat, peel and wash raw fruits and vegetables, avoid cat feces and areas of cat feces, wear gloves
Prenatal Development: Environmental Influences (cont)

- Maternal factors
  - Stress
    - Unusual stress during pregnancy at elevated risk of malformations: cleft lip, cleft palate, heart malformations
  - Major stress during 24\(^{th}\) – 28\(^{th}\) week may influence development of autism
  - Age
    - Miscarriage and stillbirth rises with age
      - 90% of pregnancies in women over 45 end in miscarriage
      - Donated ova to older women have younger outcomes
      - Down syndrome increases as do other chromosomal abnormalities

Miscarriage rates as a function of maternal age.
Prenatal Development: Environmental Influences (cont)

• Maternal factors
  – Outside environmental hazards
    • Air pollution
    • Chemicals
    • Radiation particularly between 8 – 15 weeks
    • Extreme heat and humidity
    • Chemicals in manufacturing semi-conductor chips
    • Exposure to DDT
    • Insecticides
      – Chlorpyrifos and diazinon cause stunting of prenatal growth
    • Hazardous waste sites
    • Lead, mercury, dioxin, nicotine, ethanol: asthma, allergies, autoimmune disorders such as lupus
    • Chemically contaminated ground water and home pesticide use: childhood cancers, leukemia
    • Routine dental x-rays triple risk of LBW
Prenatal Development: Environmental Influences (cont)

• Paternal factors
  – Abnormal or poor quality sperm:
    • Lead
    • Marijuana
    • Tobacco smoke
    • Large amounts of alcohol
    • Radiation
    • DES
    • Pesticides
    • High ozone levels
  – Male occupations
    – Oil: Prader Willi (same gene contributed by mother on same chromosome = Angelman syndrome)
  – Smoking contributes to secondhand smoke, linked with low birthweight, infant respiratory infections, SIDS, cancer, reduction in head circumference
  – Age
    • Dwarfism
    • Schizophrenia
    • Autism
Monitoring and Promoting Prenatal Development

• Ultrasound (sonogram): noninvasive
  – No known risk

• Amniocentesis: invasive
  – Performed after 15 weeks
  – Results take 1 – 2 weeks
  – Small added risk of fetal loss or injury

• Chorionic villus sampling (CVS): invasive
  – Performed 10 weeks
  – Additional risk of fetal loss or injury than amnio

• Maternal blood test (AFP): noninvasive
  – No known risk
  – False negatives/false positives
Proportion of U.S. Mothers with Late or No Prenatal Care, According to Race or Ethnicity, 2004.
Every hour of every day is an unspeakably perfect miracle.

-- Walt Whitman