Chapter 28: Pregnancy and Human Development

I. Introduction

A. Definitions
1. Oocyte: female gamete (egg)
2. Spermatozoon: male gamete
3. Pregnancy: from fertilization to birth
4. Gestation: the time of development
5. Pre-embryonic period: first two weeks
6. Embryonic period: weeks 3 through 8
7. Fetal period: weeks 9 through birth

II. From egg to embryo

A. Accomplishing fertilization
1. Oocyte: viable for 12 to 24 hours
2. Sperm: viable for 24 to 72 hours
3. Zygote: a newly fertilized egg
4. For successful fertilization to occur:
a. No more than 3 days before ovulation
b. No later than 24 hours after ovulation

B. Sperm transport and capacitation

1. Cervical mucus
2. Phagocytes in uterus
3. Capacitation: takes 6-8 hours

C. Acrosomal reaction and sperm penetration

1. Acrosome reaction: occurs at the egg surface
   a. Diagram:
2. Outer egg coats: *(cumulus, corona, zona)*

   a. Cumulus: *cloud-like layer of sticky material*
   
   b. Corona radiata: *cells that encapsulate the egg*
   
   c. Zona pellucida: *a tough glycoprotein coat directly over the oocyte cell membrane*

3. Block to polyspermy
   
   a. Fast block to polyspermy
      
      1) First sperm cell entry: *Na\(^+\)* caused depolarization
      
      2) Prevents other sperm cell binding
      
      3) Cortical reaction: *caused by Ca\(^{++}\)* from ER
         
         a) Enzymes destroy sperm cell receptors
      
   b. Slow block to polyspermy (continuation of fast)
      
      1) Zona swells: *to throw off remaining sperm*

4. Completion of meiosis II and fertilization

   a. Male and female pronuclei combine
   
   b. Mitotic spindle forms
   
   c. Male and female chromosomes combine
D. Preembryonic development: 1st 2 weeks in utero

1. Cleavage and blastocyst formation
   a. Cleavage: rapid mitosis following fertilization

      1) Morula: forms by 72 hours: 16 cells
         a) By day 5 after fertilization

      2) Blastocyst: a hollow sphere with 2 cell types
         a) Trophoblast: forms the wall of the sphere
         b) Inner cell mass: a cluster of cells against one side of the sphere

2. Implantation of the blastocyst: starts at day 6
a. Blastocyst contacts endometrium: secretes digestive enzymes to burrow into the wall

b. Implantation takes one week
   1) HCG from trophoblast: maintains the corpus luteum

c. Placentation: formation of the placenta
   1) Temporary organ: connecting the developing conceptus to the uterus
   2) Placenta consists of:
a) Decidua basalis

b) Chorion

3) Placental hormones
   a) HCG: *maintains the function of the corpus luteum*
   b) Estrogen and progesterone: *growth and differentiation*
   c) Placental lactogen
   d) Relaxin
   e) HCT (T=thyrotropin)

E. Events of embryonic development: *weeks 3 through 8*
   1. Formation of embryonic membranes
      a. Amnion becomes amnionic sac: *envelops the embryo*
      b. Yolk sac: *no nutritive value in humans*
1) Forms part of the digestive tract
2) Early site of blood cell and B.V. formation
3) Seeds the gonads

c. Chorion: becomes the fetal part of the placenta
d. Alantois: small out-pouch of the yolk sac

2. Gastrulation: occurs during week 3

a. Primary germ layers begin to form
   1) Endoderm: inferior part
   2) Mesoderm: middle layer
   3) Ectoderm: superior part

3. Organogenesis germ layers begin to form organs
   1) Endoderm
      a) Digestive epithelia
      b) Digestive glands
      c) Endocrine glands
      d) Urogenital epithelia
   2) Mesoderm
      a) All muscle tissue
      b) Most connective tissues
      c) Serous membranes
      d) Urogenital organs
   3) Ectoderm
      a) All nervous tissue
      b) Most epithelia
      c) melanocytes

F. Fetal development: week 9 through birth
   1. Fetal circulation
2. **Umbilical arteries:** branches of internal iliacs send blood to the placenta

3. **Umbilical vein:** returns blood from placenta
   a. Some blood to liver then to IVC
   b. Most blood to ductus venosus

4. **Ductus Venosus** empties into IVC

5. **Foramen ovale:** shunt between atria

6. **Ductus arteriosus:** connects pulmonary trunk to aorta
7. **Fetal features** \((c/r = \text{crown/rump length})\)
   
a. **8 wks:** \(c/r = 30 \text{ mm all systems present in rudimentary form}\)
b. **12 wks:** \(c/r = 90 \text{ mm: crude facial features, can detect sex}\)
c. **16 wks:** \(c/r = 140 \text{ mm: eyes and ears in normal positions, face looks human}\)
d. **17-20 wks:** \(c/r = 190 \text{ mm: fetal position due to space}\)
e. **21-30 wks:** \(c/r = 280 \text{ mm: eyes open, nails complete}\)
f. **30-40 wks**

**III. Effects of pregnancy on the mother**

A. **Anatomical:** organs in general become well vascularized

   1. Chadwick's sign: *vagina develops purplish color*
   2. Chloasma: *pregnancy mask*
   3. Uterus
      a. Occupies most of the abdominal cavity
      b. Ribs flare and abdomen widens
   4. Relaxin: *placental hormone causes symphysis pubis to relax and widen*
   5. **Weight gain** avg of about 29 pounds is normal need 300 extra calories/day

B. **Metabolic changes**

   1. Placenta produces hormones
   
      a. Human placental lactogen
         1) Prepares mammary glands
         2) Glucose sparing may cause gestational diabetes
      b. Human chorionic thyrotrhopin: *raises metabolic rate*
C. Physiological changes

1. GI system
   a. Morning sickness
   b. Motility of tract
   c. Heartburn

2. Urinary system
   a. Frequent urination

3. Respiratory system
   a. Estrogen receptors on nasal mucosa

4. Cardiovascular system: most of the changes
   a. Total body water rises
   b. 24%-40% rise in blood volume
   c. Varicose veins

IV. Parturition: birth

A. Initiation of labor (280 days after last menses)

1. Estrogen is at the highest level
   a. Stimulates myometrium
   b. Progesterone antagonist
   c. Braxton-Hicks

2. Oxytocin produced by fetal cells
   a. Causes prostaglandin production
   b. Stimulates strong uterine contractions

3. Stress initiates mother’s hypothalamus
1) Causes maternal OT release
2) Positive feedback started
3) Cervical stretching

4. Prostaglandins and OT necessary
   a. Anti-prostaglandin meds may interfere

B. Stages of labor
   1. Stage 1: Dilation
      a. Peristalsis: from the fundus down
      b. Contraction frequency: increases
      c. Cervix effaces: (thins) and dilates due to pressures
      d. Amnion ruptures: releases fluid (breaking of the water)
      e. Longest part of labor: (6-12+ hrs)
      f. Engagement occurs: Infants head enters pelvis
   2. Stage 2: Expulsion: from full dilation to birth (usually less than an hour)
      a. Strong contractions: every 2-3 minutes
      b. Desire to push
      c. Crowning: occurs when the largest diameter of the infants head is
distending the vulva
   3. Stage 3: Placental: delivery of the placenta, within 15 min. usually

V. Adjustments of the fetus at birth
   A. Taking first breath
      1. CO₂ accumulates: because fetus is no longer connected to the mother
         a. First breath
         b. Surfactant: reduces surface tension in alveoli
         c. Premature infants: do not produce sufficient surfactant
B. Occlusion of fetal vessels and shunts
   1. Umbilical arteries: distal parts become medial umbilical ligaments
   2. Umbilical vein: round ligament of liver
   3. Ductus arteriosus: collapses to become ligamentum arteriosum
   4. Foramen ovale: becomes fossa ovalis

VI. Lactation
   A. Prolactin: stimulates milk production
      1. Colostrum: less lactose, more protein, no fat

   B. Infant sucking stimulates hypothalamus
      1. OT: causes milk let-down

   C. Human milk: has a natural laxative effect

   D. Nursing