Foundations Lecture - Introduction to Human Development

From Embryology

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Introduction

Human development is one of the most exciting topics to study not only as a medical student, but also for our fundamental understanding of the human body. Of all health issues in Medicine, fertility and reproduction is a topic that will affect everyone. This lecture is going to take you briefly through key biological concepts in human development, these will later be explored in more detail through the BGD course. I will be using simplified terms in the lecture slides (with developmental term in brackets).

This Lecture is under revision for 2012.

The lecture will be followed by a practical class introducing online resources for independent study and working through similar embryology concepts.


Aims

1. Purpose of learning embryology
2. Basic facts about early human development
3. Appreciate differences between the conceptus, embryo and fetus
4. General understanding of the term “critical periods” of development

Concepts: Fertilization, Early conceptus, Germ layers, Embryo, Tissue origins, Timetable/stages of development, Fetus, Placenta

Background Lectures: Cell Structure (structure and function), Cell Division (mitosis, meiosis, lifespan, cell death), 4 Basic Tissues (Epithelial, Connective, Muscular, Nervous)

Links: 2011 Practical | Embryology Textbooks

UNSW Embryology Online

Original Website (http://embryology.med.unsw.edu.au/) New Website (http://php.med.unsw.edu.au/embryology/)

Using these resources (online navigation, organization and printing) will be covered in the introduction to the associated Practical class.

Textbooks

- There are many different excellent embryology textbooks
- I have included 2 that cover the clinical topics as well. More Textbooks?
Four Basic Tissue Types

1. Epithelial
2. Connective
3. Muscular
4. Nervous

Where do they come from?
How do they develop?

Human Reproductive Cycle

- Meiosis in gonad produces haploid gametes (egg and sperm)

**Female**
- Menstrual Cycle a regular cycle of reproduction (28 days)
- begins at puberty
- release of 1 egg (oocyte) every cycle
- Endocrine controlled (HPG axis)
  - Hypothalamus
  - Pituitary
  - Gonad

**Male**
- continuous production of sperm (spermatozoa)
- begins at puberty
- release millions of spermatozoa

**Ovary**
- Painted organs
- lying in the peritoneal cavity

**Ovulation**
- ovulation is the release of the egg (oocyte) at about the middle of the menstrual cycle
Human Menstrual Cycle

Fertilization
- the process of the 2 haploid gametes (egg and sperm) fusing and combining genetic material.
- conceptus - the entire product of fertilization

Early Development
- occurs during week 1 following fertilization
- lasts menstrual period (LMP) week 3
- mitosis to form solid ball of cells (morula), then hollow ball (blastocyst)
Week 1 Development

- occurs freely floating in uterus

Week 2 Development

- Implantation - initial attachment to uterine wall, and then invasion of the uterine wall.

Pregnancy

Detect Pregnancy

- Clinically can be detected following implantation (week 2)
- Last Menstrual Period (LMP) - today ?? .... Birth Date - January 30, 2011

Calculate a new Birth Date (http://embryology.med.unsw.edu.au/Medicine/Flab14EmbryoCalc.htm)

Gestation Calculation

- First pregnancy (primipara) 274 days, just over 39 weeks
- Subsequent pregnancies (multipara) 269 days, 38.4 weeks

Median duration of gestation assumed from ovulation to delivery

- Historic - Franz Carl Naegle (1777-1851), first rule for estimating pregnancy length
- Current - Ultrasound, the most accurate staging method

Trimesters

- Divide the pregnancy into 3 "blocks" of about 3 months (trimesters)
- First Trimester - embryonic period (organogenesis)
- Second and Trimester - fetal period (growth)

Implantation Sites

Abnormal Implantation

- Ectopic Sites:
  - external surface of uterus, ovary, bowel, gastrointestinal tract, mesentery, peritoneal wall
  - If not spontaneous then, embryo has to be removed surgically
- Uterine - subh pregnancy (most common ectopic)

Normal Implantation

- Uterine body
  - posterior, anterior, superior, lateral (most common posterior)
  - inferior implantation - placenta overlies internal os of uterus (Placenta Previa)

Early Placenta

- interaction between implanting conceptus and uterine wall (endometrium)
- The uterine lining following implantation (Decidua)
  - forms 3 distinct regions, at approx. 3 weeks
  - Decidua Basalis - implantation site
  - Decidua Capitata - enclosing the conceptus
  - Decidua Parietalis - remainder of uterus
- uterine cavity is lost by 12 weeks

Placenta

- Materno/fetal organ
- No exchange of blood
- Many different roles
  - can be "sampled" as part of a prenatal diagnostic test

Embryonic Development

- Embryonic Period - Week 1 to 8 (first trimester)
- Establish the basic structure of organs and tissues (Organogenesis)
- Development and growth of the placenta (Placentation)
Week 3

- 3 Key processes commence

**Gastrulation**
- The formation of the 3 layer embryo (trilaminar embryo)
  - All tissues of the body are formed from these 3 embryonic tissue layers (germ layers)
  - 1. Ectoderm (epithelium)
  - 2. Mesoderm (connective tissue)
  - 3. Endoderm (epithelium)
   - Simplified explanation of the 3 layer contributions

**Ectoderm**
- Forms the central and peripheral nervous system and epithelium of the skin

**Endoderm**
- Forms gastrointestinal tract organs and the epithelium of the gastrointestinal and respiratory tracts

**Mesoderm**
- Forms the body connective tissues: blood, bone, muscle, connective tissue skin, gastrointestinal and respiratory tracts

**Somitogenesis**
- Segmentation of the mesoderm
- Forms the axial body plan

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**Neuralation**
- Segmentation of the ectoderm
- Separates the neural tissue from the skin (epidermis)

**Week 4**
- Heart formation (cardiogenesis)
- First functioning organ

**Week 4-8**
- Early development of the other organs, tissues and limbs

**Week 9-38**
- Fetal period - Second and Third Trimester
  - Continuing growth and differentiation of organs formed in embryonic period
  - Some organs have a later development - neural, genital, respiratory, bones
  - Some continue to develop after birth - neural, genital, respiratory, bones
  - Growth in size, length (Second Trimester)
  - Growth in weight (Third Trimester)

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**Birth**
- Birth (parturition) is a complex physiological process between the fetus and mother
- Thought to be initiated by the fetus

**Maternal Birth Stages**
1. Dilatation
2. Expulsion
3. Placental
4. Recovery
Historic teaching model of birth

Newborn
Newborn (perinatal) needs to activate many systems and establish independent regulation (homeostasis)

- Lung function - Fluid drainage, Gas exchange, muscular activity
- Circulatory changes - Closure of 3 vascular shunts
- Thermoregulation - metabolic rate, fat metabolism
- Nutrition - gastrointestinal tract function, peristalsis
- Waste - kidney function
- Endocrine function - loss of placenta, maternal hormones

Critical Periods of Development

Abnormal Development

Three main causes:
1. Genetic
2. Environmental
3. Unknown

- First trimester most critical
- Different effect depending on time of insult (teratogen)

Diagnosis

- Prenatal diagnosis - number of different techniques (non-invasive, invasive) for determining normal development
- Neonatal diagnosis (APGAR test, Guthrie test)
- Maternal diagnosis - often pregnancy will expose maternal health problems

Textbooks


Glossary Links

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | Numbers | Symbols

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