



## Human Development: An Introduction & Overview

### Course Overview 2011

#### Lecture Schedule

- The course is divided into **in-class lectures** and **on-line self-study** material
- The following material relates to the in-class lecture schedule:**

The first part of the course begins with an overview of development and progresses to the origin and formation of the sex cells. Here we learn about factors (**determinants**) that determine the fate of the future gametes. After an overview of male and female anatomy, the processes of **oogenesis** (females) and **spermatogenesis** (males) is detailed. The fundamental differences in structure and function of sperm and eggs will be discussed. Finally how each of these cells specialize (**differentiate**) at the cellular and molecular levels will be detailed.

#### Part I. From Primordial Germ Cells to Functional Gametes

Date	Lect. #	Title
Sept. 7	1.	Human Development: An Introduction & Overview
Sept. 9	2.	Experimental Techniques in Developmental Biology ( <b>on-line self-study</b> )
Sept. 12	3.	Saga of the Sex Cells
Sept. 14	4.	Life & Death in the Ovary
Sept. 16	5.	Globospermia & ICSI: A Case Report ( <b>on-line self-study</b> )
Sept. 19	6.	Egg Differentiation & Genetic Abnormalities
<b>Sept. 21</b>	7.	<b>1<sup>st</sup> Lecture Test</b>
Sept. 23	8.	Sperm Nuclear Condensation and Male Pronucleus Formation ( <b>on-line self-study</b> )
Sept. 26	9.	Formation of the Male Sex Cells: Male Anatomy & Spermatogenesis
Sept. 28	10.	Formation of the Male Sex Cells: Spermiogenesis
Sept. 30	11.	Creating Transgenic Mice ( <b>on-line self-study</b> )

The **gametes** merge at **fertilization** to begin the processes of development. But this isn't a random encounter with a chance result. Sperm may be guided to the egg and, once there, a series of **intercellular communications** mediated by species-specific molecules guarantee that only the proper sperm will penetrate the egg. Fertilization is a highly controlled process. Often humans want to intervene in the process of fertilization to prevent it, so techniques of contraception have developed. Sometimes things go wrong and fertilization doesn't occur. In such cases, couples (and individuals) may opt for **in vitro fertilization** (IVF) which involves many of the new **Assisted Reproductive Technologies** (ART).

#### Part II. Fertilization & Artificial Reproductive Technologies

Oct. 3	12.	Fertilization: The Sequence of Events
Oct. 5	13.	Fertilization: Intercellular Communication & Signal Transduction

Oct. 7	14.	Study break ( <b>on-line self-study</b> )
<b>Oct. 10</b>	<b>15.</b>	<b><i>Thanksgiving</i></b>
<b>Oct. 12</b>	<b>16.</b>	<b>2<sup>nd</sup> Lecture Test</b>
Oct. 14	17.	Spina Bifida: The lemon sign ( <b>on-line self-study</b> )
Oct. 17	18.	The “ART” of Making Babies

Successful fertilization, in vivo or in vitro, leads to the initiation of early embryonic development that begins with rapid divisions of the **zygote** called **cleavage**. After a period of time the cleaving embryo becomes a multicellular **blastocyst**. The blastocyst can **implant** in the uterine wall to set up the **placental relationship** for further development. The human body is a complex of different organs, tissues and cell types that are arranged in a very precise spatial relationship. During embryonic development the body plan is established through the **morphogenetic movements** of **gastrulation** and **neurulation**. Gastrulation establishes the **primary germ layer: endoderm, mesoderm and ectoderm** in their relative positions while neurulation results in the formation of the neural tube, the precursor of the brain and spinal cord. During these changes the embryo is very susceptible to outside influences. During these **critical periods** agents such as carcinogens and alcohol can cause **birth defects**. Other abnormalities are caused by genetic defects. Various **developmental factors** come into play to regulate the differentiation of cells as exemplified by nerve cell differentiation.

### Part II. From Cleavage to Cell Differentiation

Oct. 19	19.	Early Development I: Cleavage
Oct. 21	20.	Neural Crest: Single Cell Population Produces Many Cell Types ( <b>on-line self-study</b> )
Oct. 24	21.	Early Development: The Blastocyst, Implantation & Extraembryonic Membranes
<b>Oct. 26</b>	<b>22.</b>	<b>3<sup>rd</sup> Lecture Test</b>
Oct. 28	23.	Morphogenesis: Mammary Gland Branching ( <b>on-line self-study</b> )
Oct. 31	24.	Gastrulation: Formation of the Primary Germ Layers
Nov. 2	25.	Neurulation: Making the Brain and Spinal Cord
Nov. 4	26.	Analyzing Genes Involved in Eye Development: ( <b>on-line self-study</b> )
Nov. 7	27.	Critical Periods in Development
Nov. 9	28.	Nerve Cell Differentiation & Developmental Factors

**Cellular and tissue interactions** also mediate the formation of tissues and organs. To understand how **tissues** and **organs** develop and the role of **induction**, we will use two examples. First we will look at **limb development** and the signaling events that occur. Then we will focus on **eye development**. Some special cells, called **neural crest cells**, will separate off and migrate through the body to form nerves, pigment cells and parts of the skull and more. We will finish up by looking at late inductions specifically how hair, teeth and certain glands develop.

### Part III. Induction & Organ Development

Nov. 11	29.	Limb Development: Events & Signal Transduction ( <b>on-line self-study</b> )
<b>Nov. 14</b>	<b>30.</b>	<b>4<sup>th</sup> Lecture Test</b>
Nov. 16	31.	Development of the Eye: A Series of Inductive Interactions
Nov. 18	32.	Limb Development: Hox Genes ( <b>on-line self-study</b> )
Nov. 21	33	The Neural Crest: From Pigmentation to Craniofacial Defects

Nov. 23	34.	Late Inductions: Hair, Teeth and Glands
Nov. 25	35.	Study break
<b>Nov. 28</b>	<b>36.</b>	<b>5<sup>th</sup> Lecture Test</b>

It should be clear that Human Development is a very dynamic and exciting topic. Already you will have been introduced to many new terms and concepts which will become clear as the course continues.

### **On-line Self-study**

- This content is designed to provide the student with new insights not covered in lecture; it is also designed so the student can do some research on their own—it will be tested in the regular scheduled lecture tests.
- The online course content is listed within the lecture schedule to guide students regarding when they should be studying that material
- Students are each solely responsible the on-line self-study material
- This material will not be discussed in lecture or in emails
- Any questions students have must be researched online by them”
- Students can also work together on this material
- The material will be tested based only on what is provided in the on-line self-study material
- Since essentially 1/3 of the course content is on-line self-study material, then approximately 1/3 of each test will focus on this content

**Textbook—Note:** There is no textbook. Any recent developmental biology book or human embryology book can be used such as “Larsen’s Human Embryology, 4<sup>th</sup> Edition, 2009” by G.C. Shoenwolf et al, Elsevier Churchill Livingstone, ISBN 978-0443-06811-9”

**Grading**—this material is available on the course website

**Important Notes**—this material is available on the course website and must be read

**Tests**—Each test will be discussed in lecture about 1 week prior to that test. We will not answer questions about each test except in the lecture when the content is discussed. Emails about tests will not be answered.

## **HUMAN DEVELOPMENT: A FUN TEST Followed by THE NEWS**

**Is This a Man or Woman?**



- It is a man
- Presence of both X+Y chromosomes
- Human Mutation: Person lacks receptors for testosterone
- As a result, the person develops female secondary sexual characteristics

## How Old Is This Person?



- She is 30+ years old
- Turner's Syndrome
- Short Stature
- Webbed Neck
- Infantile Sexual Characteristics; Sterile gonads
- Cause: Monosomy of Sex Chromosomes (XO)

## Male or Female Fetus?



- Could be either one
- This is the "Indeterminate Stage" of genital development
- Male & Female genitalia look same at this stage
- Chromosomal analysis would reveal whether XX or XY
- Lack of Testes Determining Factor (TDF) leads to female form
- Presence of TDF leads to male genitalia

## Understanding the News

**Of Man-Made Mice and Men:** Mice, sheep and more mammals have been cloned. Is human cloning really a possibility? Cloned animals have been shown to age prematurely and develop certain problems, why?

**Two Headed Baby Born in Vietnam:** A baby with two heads was born. How could this happen?

**40,000 Heart Genes Found:** How many genes are there and how do they control how cells and tissues develop? While the human genome has been sequenced there's still some argument about just how many genes we really have and how many are required for the formation of specific tissues and organs.

**Frozen Egg Birth Doubly Successful:** Freezing unfertilized eggs & embryos has involved some problems but freezing fertilized eggs and sperm is easy. Why? Are there developmental defects that result from freezing of human gametes or embryos?

**Sperm-Sifting Technique Helps Select Babies Sex:** How can "Y" sperm and "X" sperm be separated? Can this be effective for selecting the sex of your offspring?

## Overview of Development

**Gametogenesis:** the formation of sperm & eggs

**Fertilization:** fusion of a sperm & egg to form a zygote

**Cleavage:** special, rapid mitotic cell divisions of zygote to form multicellular embryo

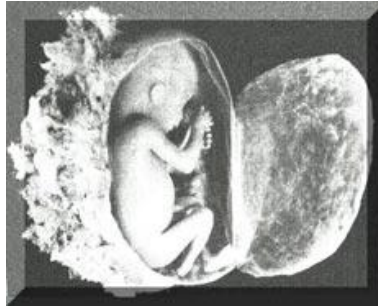
**Morphogenetic Movements:** gastrulation & neurulation initially form primary germ lines establishing cell lineages in appropriate arrangements for further development

**Cell & Tissue Differentiation:** cellular interactions regulate gene activity leading to specialization of cell types

**Pattern & Polarity:** humans have Left-Right, Front-Back, Top-Bottom symmetry that is reflected in the development of tissues and organs

**Growth & Maturation:** The fetus grows as development continues and post-embryonic development is characterized by growth, sexual maturation (leading us back to gametogenesis & fertilization and the life cycle).

**Senescence (aging) and Death:** Are the final developmental events of life leading to the end of the individual.



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