

# 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.

Printable Lecture Page ([http://php.med.unsw.edu.au/embryology/index.php?title=Foundations\\_Lecture\\_-\\_Introduction\\_to\\_Human\\_Development&printable=yes](http://php.med.unsw.edu.au/embryology/index.php?title=Foundations_Lecture_-_Introduction_to_Human_Development&printable=yes))



Dr Mark Hill

## Aims

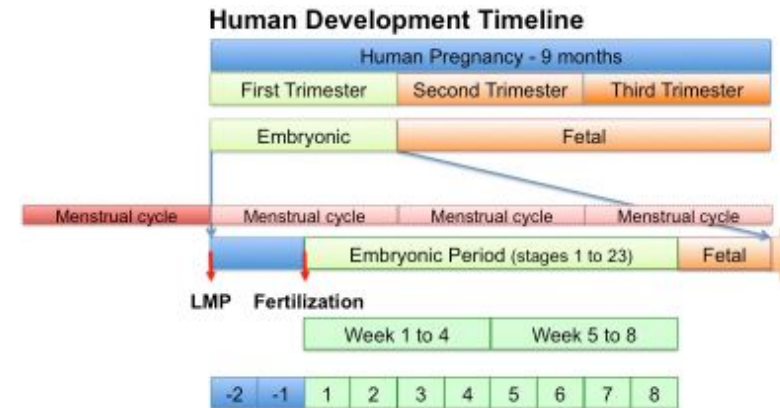
1. Purpose of learning embryology
2. Basic facts about early human development
3. Appreciate differences between the conceptus, embryo and fetus
4. General understanding of the term "critical periods" of development

**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

## Human Development Timeline



- Quicktime movie
- Quicktime version
- Flash version
- Annotated movie

## 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?

## The Developing Human: Clinically oriented embryology

**Citation:** The developing human : clinically oriented embryology 8th ed. Moore, Keith L; Persaud, T V N; Torchia, Mark G Philadelphia, PA : Saunders/Elsevier, c2008.

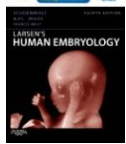
--Mark Hill 09:47, 17 April 2012 (EST) **This textbook currently not available online 2012.**

## Larsen's human embryology

**Citation:** Larsen's human embryology 4th ed. Schoenwolf, Gary C; Larsen, William J. (William James). Philadelphia, PA : Elsevier/Churchill Livingstone, c2009.

The following chapter links only work with a UNSW connection and can also be accessed through this UNSW Library connection ([http://searchfirst.library.unsw.edu.au/primo\\_library/libweb/action/search.do?vid=UNSW&fn=search&vl\(freeText0\)=UNSW\\_SFX1419000000047996](http://searchfirst.library.unsw.edu.au/primo_library/libweb/action/search.do?vid=UNSW&fn=search&vl(freeText0)=UNSW_SFX1419000000047996))

- Chapter 1 - Gametogenesis, Fertilization, and First Week (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10001-6>)
- Chapter 2 - Second Week: Becoming Bilaminar and Fully Implanting (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10002-8>)
- Chapter 3 - Third Week: Becoming Trilaminar and Establishing Body Axes (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10003-X>)
- Chapter 4 - Fourth Week: Forming the Embryo (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10004-1>)
- Chapter 5 - Principles and Mechanisms of Morphogenesis and Dysmorphogenesis (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10005-3>)
- Chapter 6 - Fetal Development and the Fetus as Patient (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10006-5>)
- Chapter 7 - Development of the Skin and Its Derivatives (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10007-7>)
- Chapter 8 - Development of the Musculoskeletal System (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10008-9>)
- Chapter 9 - Development of the Central Nervous System (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10009-0>)

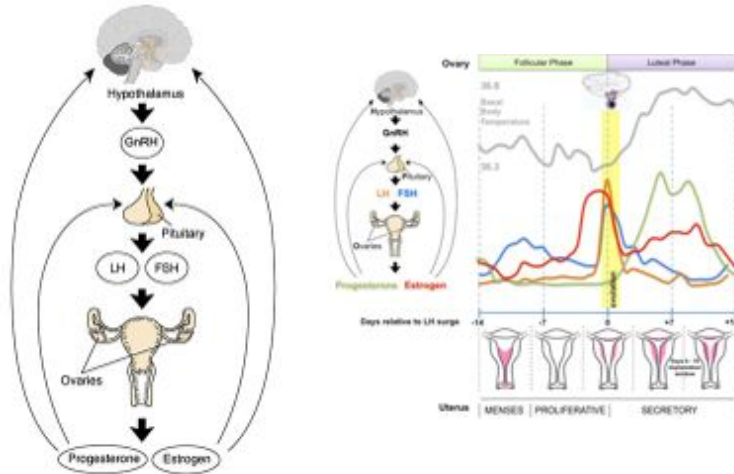


- Chapter 10 - Development of the Peripheral Nervous System (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10010-7>)
- Chapter 11 - Development of the Respiratory System and Body Cavities (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10011-9>)
- Chapter 12 - Development of the Heart (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10012-0>)
- Chapter 13 - Development of the Vasculature (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10013-2>)
- Chapter 14 - Development of the Gastrointestinal Tract (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10014-4>)
- Chapter 15 - Development of the Urogenital System (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10015-6>)
- Chapter 16 - Development of the Pharyngeal Apparatus and Face (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10016-8>)
- Chapter 17 - Development of the Ears and Eyes (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10017-X>)
- Chapter 18 - Development of the Limbs (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10018-1>)

- 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

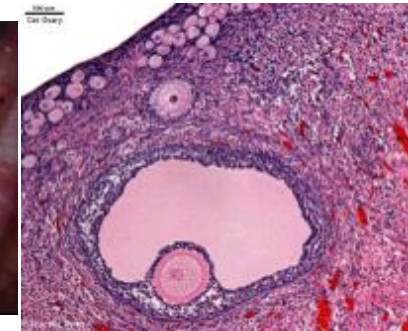


## Male

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

## Ovary

- Paired organs
- lying in the peritoneal cavity



## Ovulation

- ovulation is the release of the egg (oocyte) at about the middle of the menstrual cycle

Links: More Embryology Textbooks

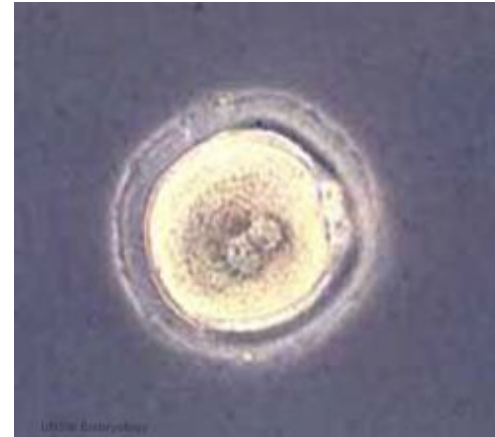
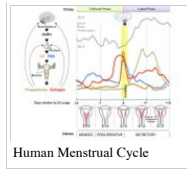
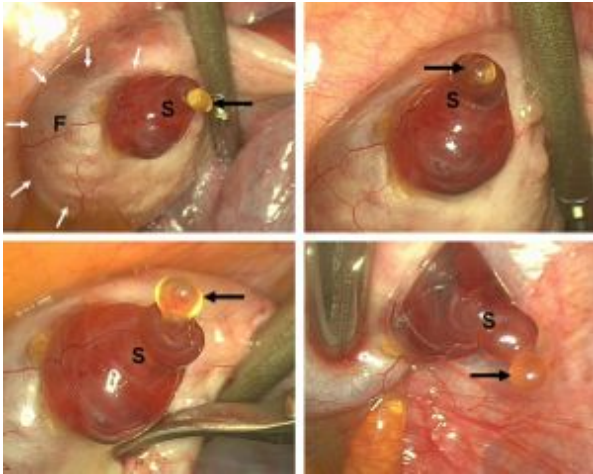
## Four Basic Tissue Types

Tissues and organs of the body consist of combinations of 4 basic tissue organisations:

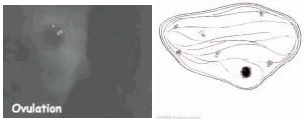
1. Epithelial
2. Connective
3. Muscular
4. Nervous

- Where do they come from?
- How do they develop?

## Human Reproductive Cycle

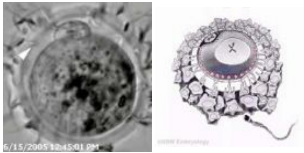


### Human ovulation



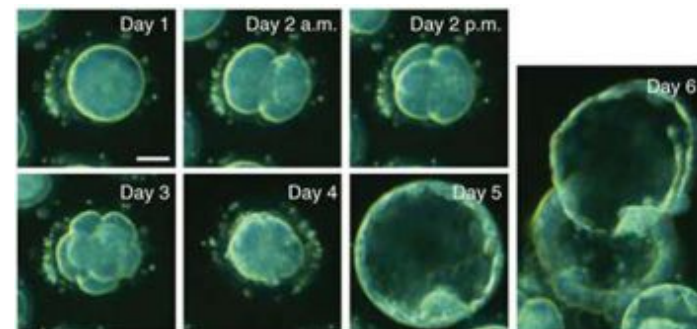
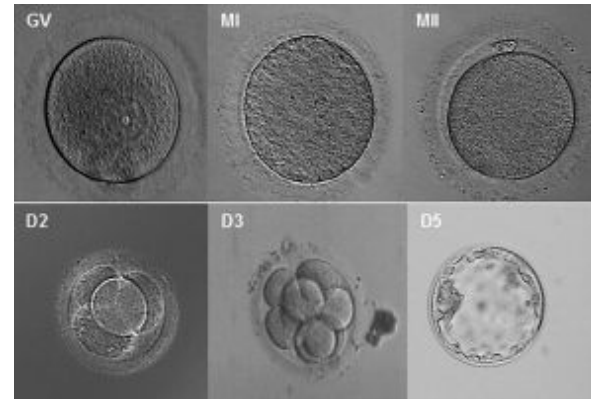
### Fertilization

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



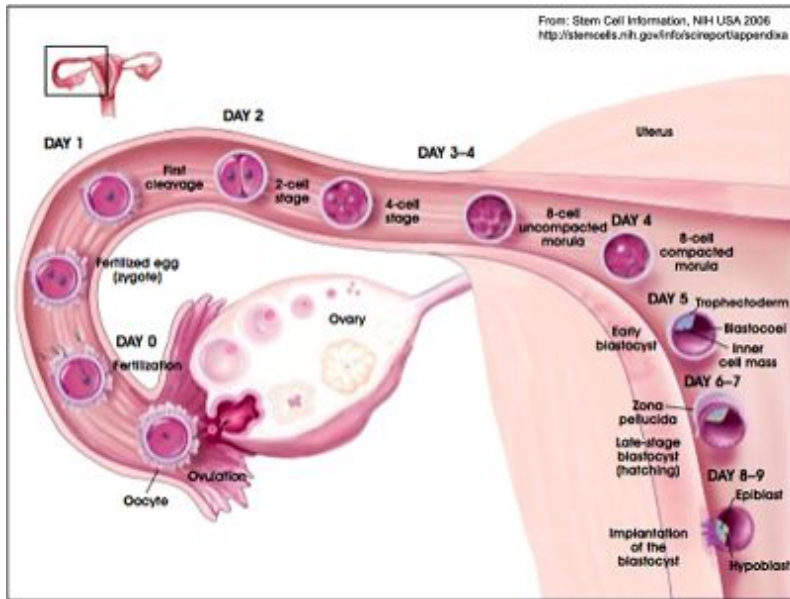
### Early Development

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



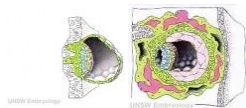
## Week 1 Development

- 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>)

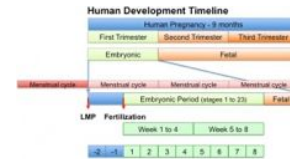
### Gestation Calculation

- 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 Naegele (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 - tubal 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

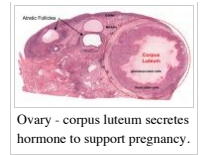
- interaction between implanting conceptus and uterine wall (endometrium)
- The uterine lining following implantation (Decidua)
  - forms 3 distinct regions, at approx 3 weeks
  - Decidua Basalis - implantation site
  - Decidua Capsularis - enclosing the conceptus
  - Decidua Parietalis - remainder of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

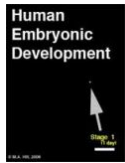
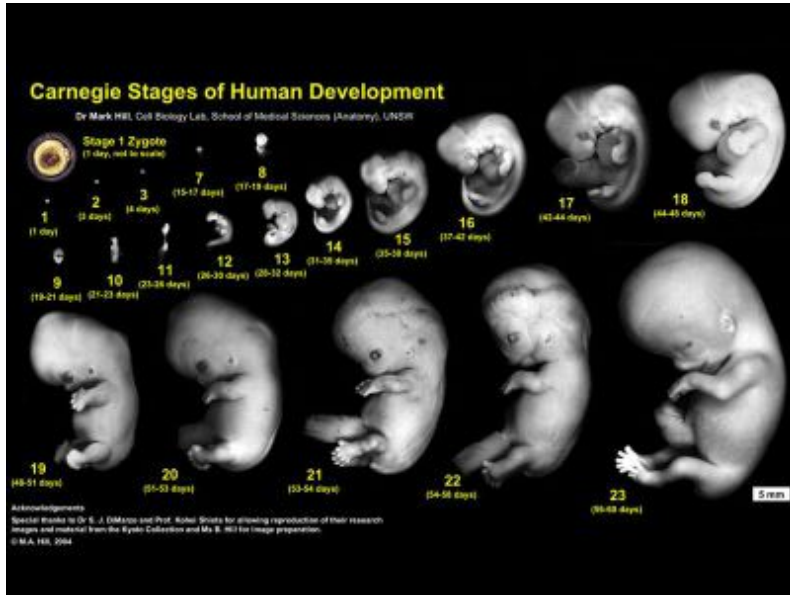
## Placenta

- 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

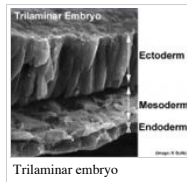
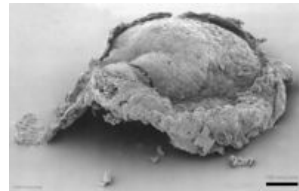
- 3 Key processes commence

#### 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)

- Ectoderm (epithelium)
- Mesoderm (connective tissue)
- 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

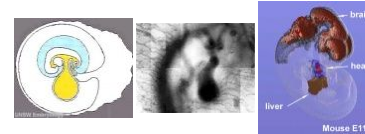
### Neuralation

- segmentation of the ectoderm
- separates the neural tissue from the skin (epidermis)



### Week 4

- heart formation (cardiogenesis)
- first functioning organ

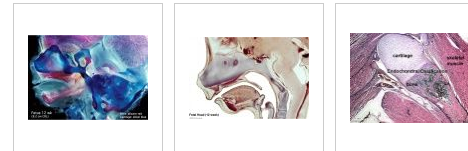


### Week 4-8

- early development of the other organs, tissues and limbs

### Week 9 - 38

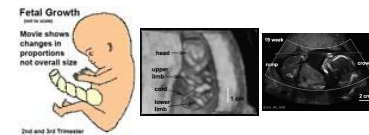
- Fetal Period** - Second and Third Trimester
- Continuing growth and differentiation of organs formed in embryonic period
  - some organs have a later development - neural, genital, respiratory, bones
  - some continue to develop after birth - neural, genital, respiratory, bones
- growth in size, length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



Fetal Head 12 cartilage and bone formation (12 week)

Fetal Head head structures and the brain (12 week)

Fetal knee region

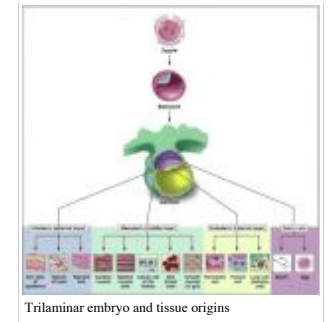


### Birth

- birth (parturition) is a complex physiological process between the fetus and mother
- thought to be initiated by the fetus

#### Maternal Birth Stages

- Dilatation
- Expulsion
- Placental
- Recovery



Trilaminar embryo and tissue origins

## 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

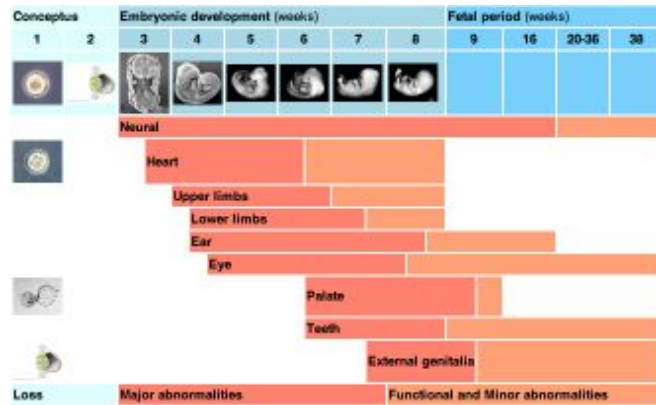
## Critical Periods of Development

### Abnormal Development

Three main causes:

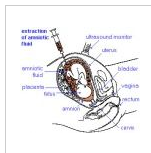
1. Genetic
2. Environmental
3. Unknown

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

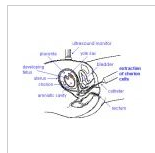


### Diagnosis

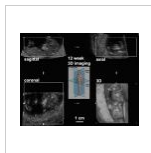
- Prenatal diagnosis - number of different techniques (non-invasive, invasive) for determining normal development
- Neonatal diagnosis (APGAR test, Guthrie test)
- Maternal diagnosis - often pregnancy will expose maternal health problems



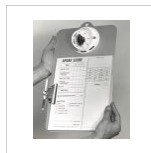
Amniocentesis



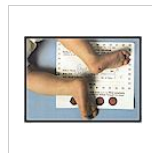
Chorionic Villus Sampling



Ultrasound



APGAR scoresheet



Guthrie card



Xray congenital dislocation hip



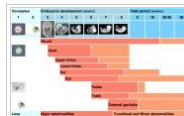
Birth (stage 1)  
Historic teaching model of birth



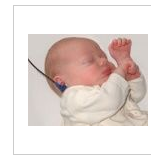
MRI Birth



Newborn infant (perinatal period)



Human critical periods of development



Newborn hearing test

Finished!

## Revision Notes

- You don't need to know everything today, this is an introduction.
- Use the glossary to help understand new terms.
- Don't confuse "germ cell layers" (ectoderm, mesoderm, endoderm) with "germ cells" (egg, spermatozoa).
- Remember the difference between "clinical weeks" (last menstrual period) and "embryonic weeks" (from ovulation/fertilisation, 2 weeks later).
- With abnormalities
  - think about the types of prenatal diagnostic techniques that are now available
  - the 2 major types (genetic and environmental)
  - the effect of maternal age/health/lifestyle.

## Textbooks



Moore, K.L. & Persaud, T.V.N. (2008). *The Developing Human: clinically oriented embryology* (8<sup>th</sup> ed.). Philadelphia: Saunders.

- Chapter 1 - Introduction to the Developing Human



Schoenwolf, G.C., Bleyl, S.B., Brauer, P.R. and Francis-West, P.H. (2009). *Larsen's Human Embryology* (4<sup>th</sup> ed.). New York; Edinburgh: Churchill Livingstone.

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- Chapter 1 - Gametogenesis, Fertilization, and First Week (<http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10001-6>)

Hill, M.A. (2011) *UNSW Embryology* (11<sup>th</sup> ed.). Sydney:UNSW.



- Menstrual Cycle | Oocyte | Spermatozoa | Meiosis | Mitosis
- Fertilization | Zygote | Morula | Blastocyst | Implantation
- Week 1 | Week 2 | Week 3
- Lecture - Fertilization | Lecture - Week 1 and 2

 Foundations Practical - Introduction to Human Development

## 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

Dr Mark Hill 2012, *UNSW Embryology* ISBN: 978 0 7334 2609 4 - UNSW CRICOS Provider Code No. 00098G

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Categories: Medicine | Foundations