Foundations Lecture - Introduction to Human Development

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).

2017 Lecture PDF

Australian Population Clock - 24,895,126 [Collapse]

6 April 2018

- one birth every 1 minute and 43 seconds,
- one death every 3 minutes and 16 seconds,
- one person arriving to live in Australia every 1 minute and 1 seconds,
- one Australian resident leaving Australia to live overseas every 1 minute and 49 seconds, leading to
- an overall total population increase of one person every 1 minute and 24 seconds.

These assumptions are consistent with figures released in Australian Demographic Statistics, September Quarter 2017 (cat. no. 3101.0).

Australian Bureau of Statistics Population Clock

Australia and the World (2010)

Population Growth Rate | Fertility Rate | AUS, CHN, IND, IDN, USA | World

Growth

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

Links: 2017 | 2017 PDF | Printable Lecture Page | 2016 | 2015 | 2014 | 2013 | 2012

Other Foundations links [Collapse]

The following lecture, practical and practical support pages for Foundations can be found on this current site.

- Foundations Practical - Histology support
- Foundations Practical - Skin Histology
- **Foundations Lecture - Introduction to Human Development**
- Foundations Practical - Introduction to Human Development

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

Lecture Concepts: Embryology Education Support, Human Reproductive Cycle, First Trimester, Second and Third Trimester, Postnatal Development, Abnormal Development

Lecture Content [Collapse]

1. **Embryology Education Support** - UNSW Embryology Online, Glossary Links, Textbooks
2. **Human Reproductive Cycle** - Female. Male, Ovary, Ovulation, Trimesters

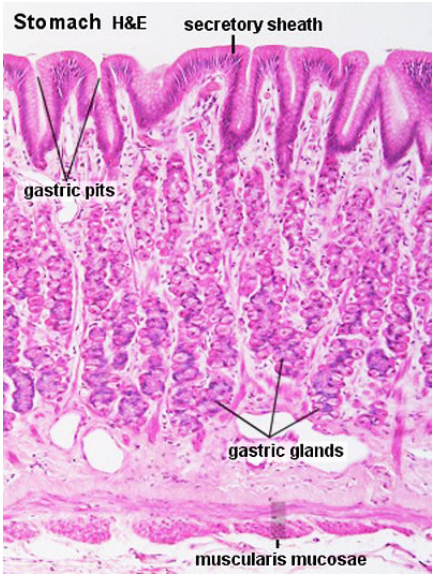
3. **First Trimester** - Fertilization, Week 1, Week 2, Abnormal Implantation, Normal Implantation, Detect Pregnancy, Week 3, Gastrulation, Ectoderm, Endoderm, Mesoderm, Somitogenesis, Neuralation, Week 4, Week 4-8, Placenta
4. **Second and Third Trimester** - Fetal, growth - weight and length
5. **Postnatal Development** - Birth, Maternal Birth Stages, Neonatal, Childhood
6. **Abnormal Development** - Critical Periods of Development, Diagnosis

Links: 2017 Practical | Embryology Textbooks

Four Basic Tissue Types

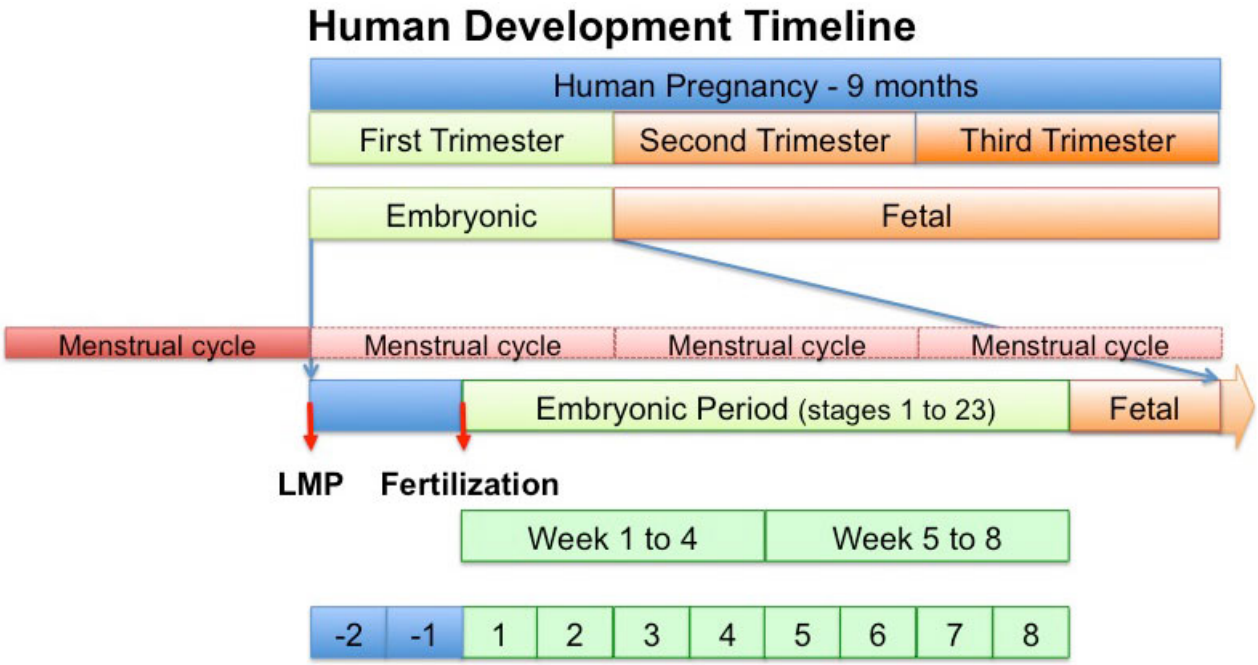
In histology you have heard that tissues and organs of the body consist of combinations of 4 basic tissue organisations:

1. Epithelial 2. Connective 3. Muscular 4. Nervous	• What is the origin of these tissues? • How do they develop? • What are their relationships with each other? • What health issues relate to their normal/abnormal development?



Stomach Wall containing all 4 basic tissues.

Human Development Timeline



concepts animation

Last Menstrual Period (LMP) first day was today -> Birth Date - January 15, 2019 [Collapse]
Gestation Calculation (based upon a normal 28 day cycle) • Historic - Franz Carl Naegele (1777-1851), first rule for estimating pregnancy length • Current - Ultrasound, the most accurate staging method • First pregnancy (primipara) 274 days, just over 39 weeks • Subsequent pregnancies (multipara) 269 days, 38.4 weeks • **GA** - gestational age

Embryology Education Support

UNSW Embryology Online

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

Glossary Links

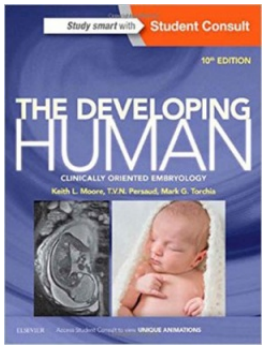
A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T |

U | V | W | X | Y | Z | Numbers | Symbols

Textbooks

- There are many different excellent embryology textbooks
- I have included below embryology textbooks accessible online through the UNSW Library that cover the clinical topics as well.
- As an introduction try the chapter in The Developing Human - Introduction to the Developing Human

The Developing Human: Clinically Oriented Embryology (10th edn) [Collapse]



UNSW Students have online access to the current 10th edn. through the UNSW Library subscription (with student Zpass log-in).

APA Citation: Moore, K.L., Persaud, T.V.N. & Torchia, M.G. (2015). *The developing human: clinically oriented embryology* (10th ed.). Philadelphia: Saunders.

Links: UNSW Embryology Textbooks | Embryology Textbooks | UNSW Library

1. Introduction to the Developing Human
2. First Week of Human Development
3. Second Week of Human Development
4. Third Week of Human Development
5. Fourth to Eighth Weeks of Human Development
6. Fetal Period
7. Placenta and Fetal Membranes
8. Body Cavities and Diaphragm
9. Pharyngeal Apparatus, Face, and Neck
10. Respiratory System
11. Alimentary System
12. Urogenital System
13. Cardiovascular System
14. Skeletal System
15. Muscular System
16. Development of Limbs
17. Nervous System
18. Development of Eyes and Ears

19. Integumentary System
20. Human Birth Defects
21. Common Signaling Pathways Used During Development
22. Appendix : Discussion of Clinically Oriented Problems

Larsen's Human Embryology (5th edn) [Collapse]

UNSW students have full access to this textbook edition through UNSW Library subscription (with student Zpass log-in).

APA Citation: Schoenwolf, G.C., Bleyl, S.B., Brauer, P.R., Francis-West, P.H. & Philippa H. (2015). *Larsen's human embryology* (5th ed.). New York; Edinburgh: Churchill Livingstone.

Links: UNSW Embryology Textbooks | Embryology Textbooks | UNSW Library

1. Gametogenesis, Fertilization, and First Week
2. Second Week: Becoming Bilaminar and Fully Implanting
3. Third Week: Becoming Trilaminar and Establishing Body Axes
4. Fourth Week: Forming the Embryo
5. Principles and Mechanisms of Morphogenesis and Dysmorphogenesis
6. Fetal Development and the Fetus as Patient
7. Development of the Skin and Its Derivatives
8. Development of the Musculoskeletal System
9. Development of the Central Nervous System
10. Development of the Peripheral Nervous System
11. Development of the Respiratory System and Body Cavities
12. Development of the Heart
13. Development of the Vasculature
14. Development of the Gastrointestinal Tract
15. Development of the Urinary System
16. Development of the Reproductive System
17. Development of the Pharyngeal Apparatus and Face
18. Development of the Ears
19. Development of the Eyes
20. Development of the Limbs

Ebook - Kyoto Collection (1st edn) [Collapse]

UNSW students can download this free iBook that describes embryos from the first 8 weeks of development showing whole embryos, histological features, movies and high resolution 3D scans. The iBook also contains a linked glossary with descriptions of embryology terminology, and related terms.

Note - Only available for the Apple iPhone, iPad and laptop and desktop computers. No PC version currently available.

APA Citation: Hill MA. Shiota K. Yamada S. and Ho C. **Kyoto Embryology Collection**. (2016) Apple iTunes. Retrieved from: https://itunes.apple.com/book/id1143922693

Links: iTunes link | Kyoto Collection | Embryology iBooks | UNSW Embryology Textbooks | Embryology Textbooks | UNSW Library

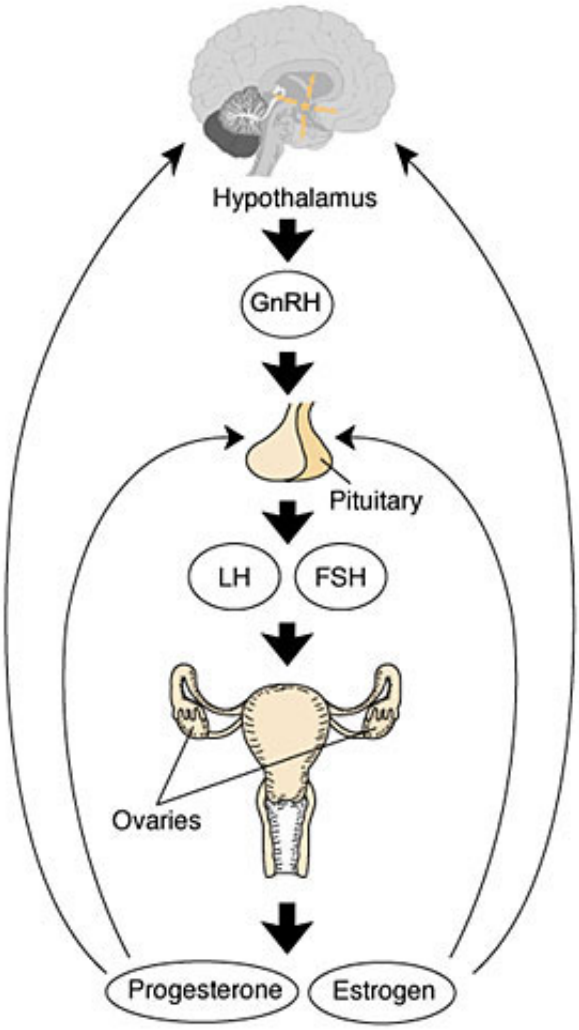
Links: Embryology Textbooks - UNSW | More Embryology Textbooks

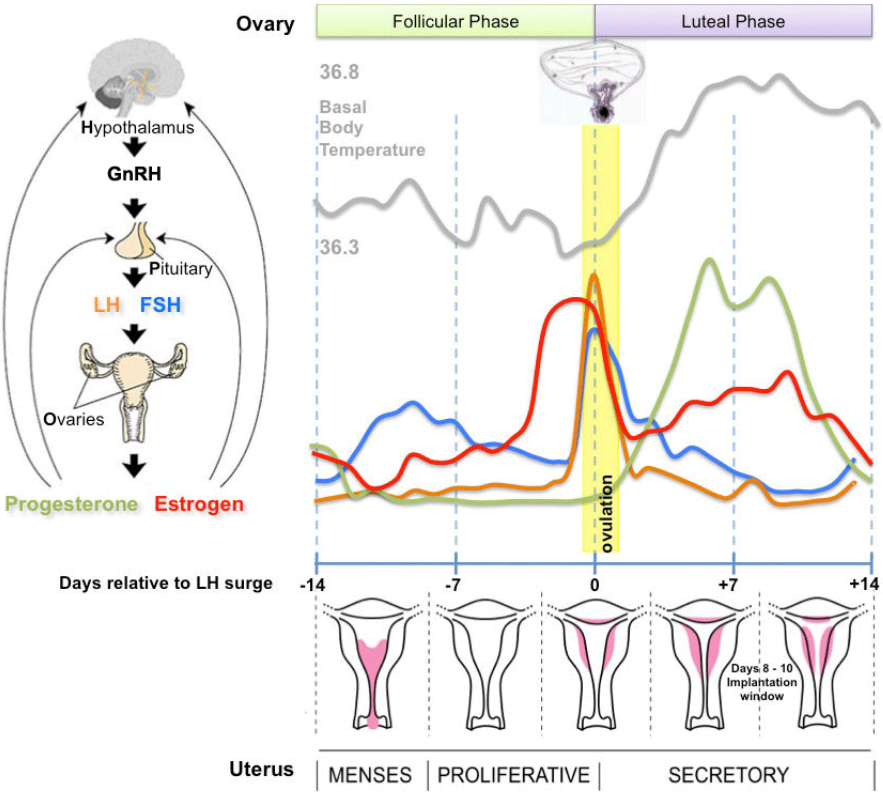
Human Reproductive Cycle

- Meiosis in gonad produces haploid gametes
  - testis the sperm (spermatozoa)
  - ovary the egg (oocyte)
- there are **differences** in when and how gametes are formed in the male and female gonad.

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


Hypothalamus
GnRH
Pituitary
LH
FSH
Ovaries
Progesterone
Estrogen

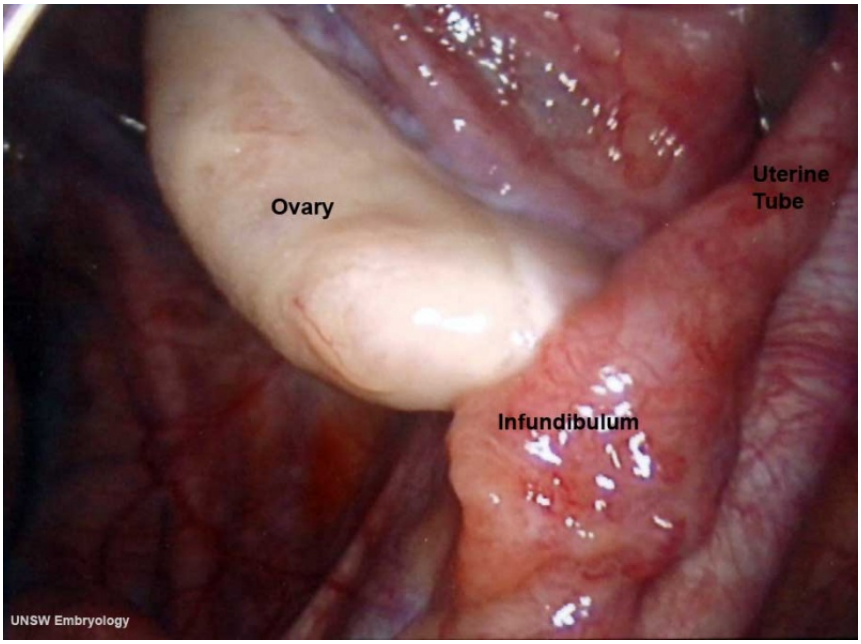

Ovary
Follicular Phase
Luteal Phase
Hypothalamus
GnRH
Pituitary
LH
FSH
Ovaries
Progesterone
Estrogen
36.8
Basal Body Temperature
36.3
ovulation
Days relative to LH surge
-14
-7
0
+7
+14
Days 8 - 10 Implantation window
Uterus
MENSES
PROLIFERATIVE
SECRETORY

Male

- begins at puberty
- continuous production of sperm (spermatozoa, human male 2,000/second)
- release millions of spermatozoa (require activation, capacitation)

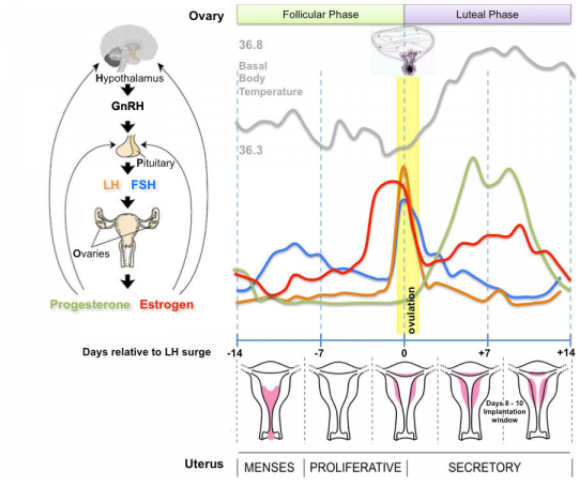
Ovary

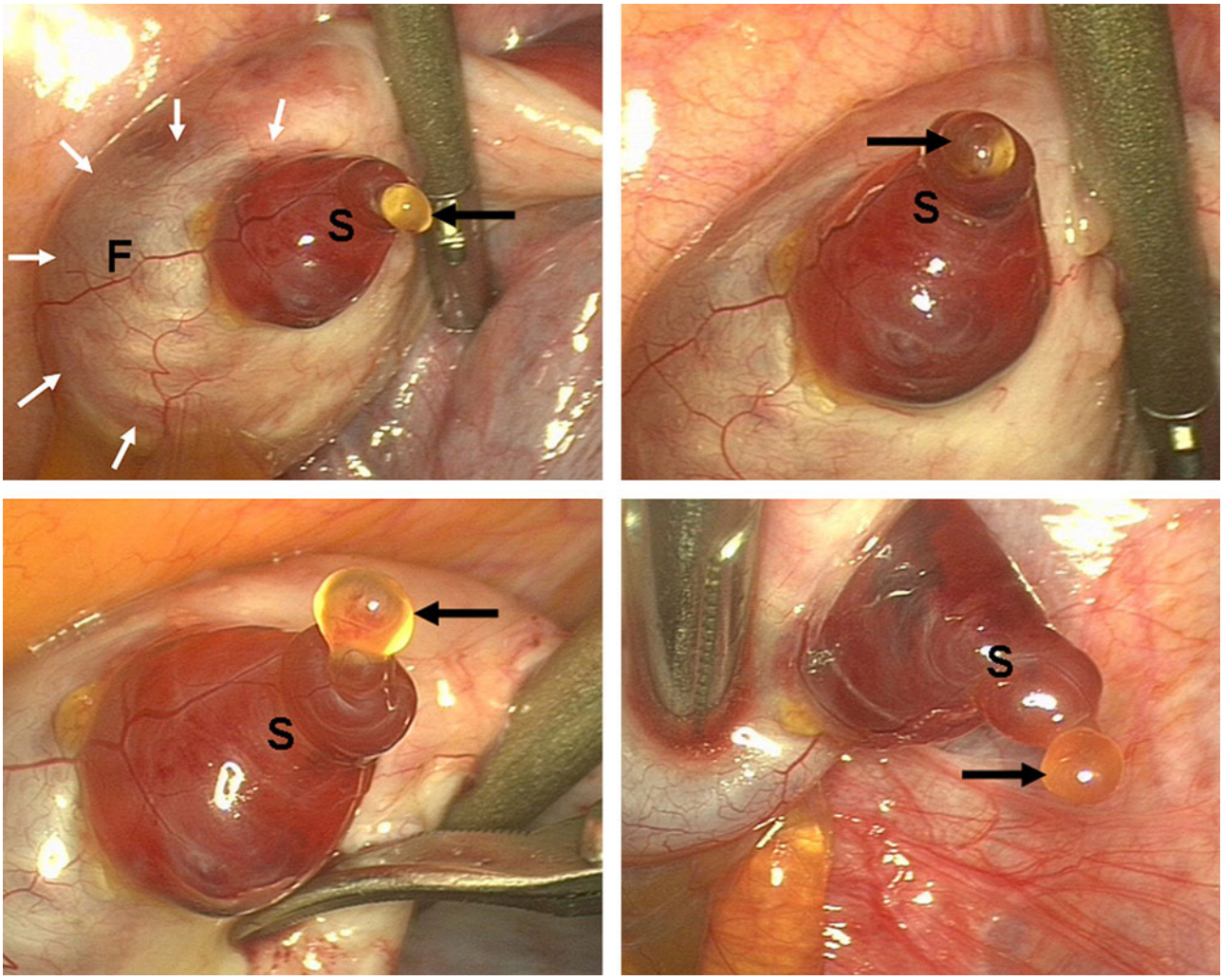
- Paired organs
- lying in the peritoneal cavity



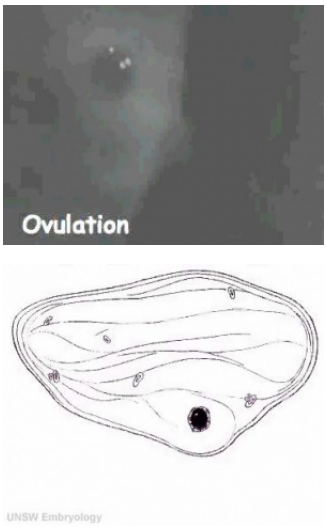
Ovulation

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

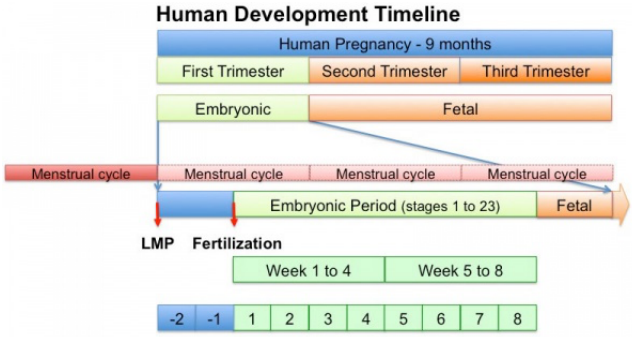




Human ovulation



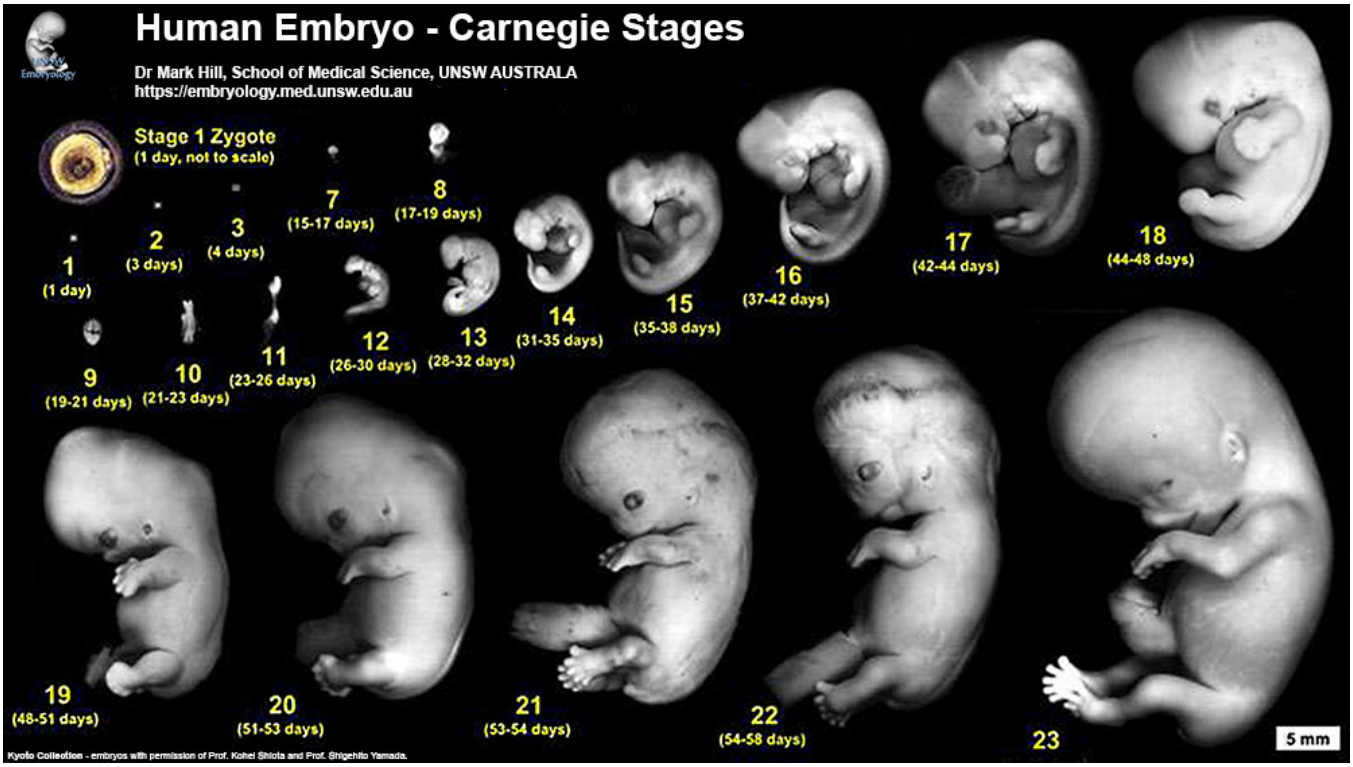
Trimesters

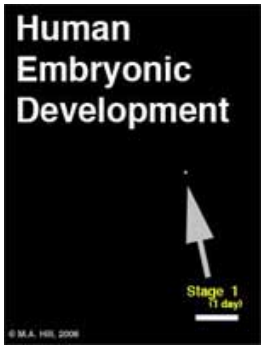


- Divide the pregnancy into 3 "blocks" of about 3 months (trimesters)
- First Trimester - embryonic period (organogenesis)
- Second and Trimester - fetal period (growth)

First Trimester

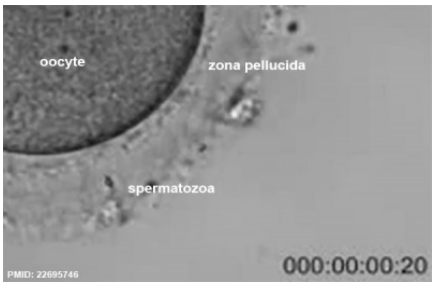
- Embryonic Period - Week 1 to 8 (first trimester)
- Establish the basic structure of organs and tissues (Organogenesis)
- development and growth of the placenta (Placentation)



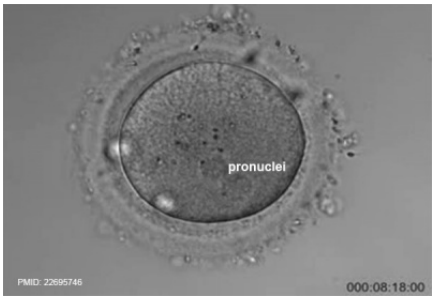


Fertilization

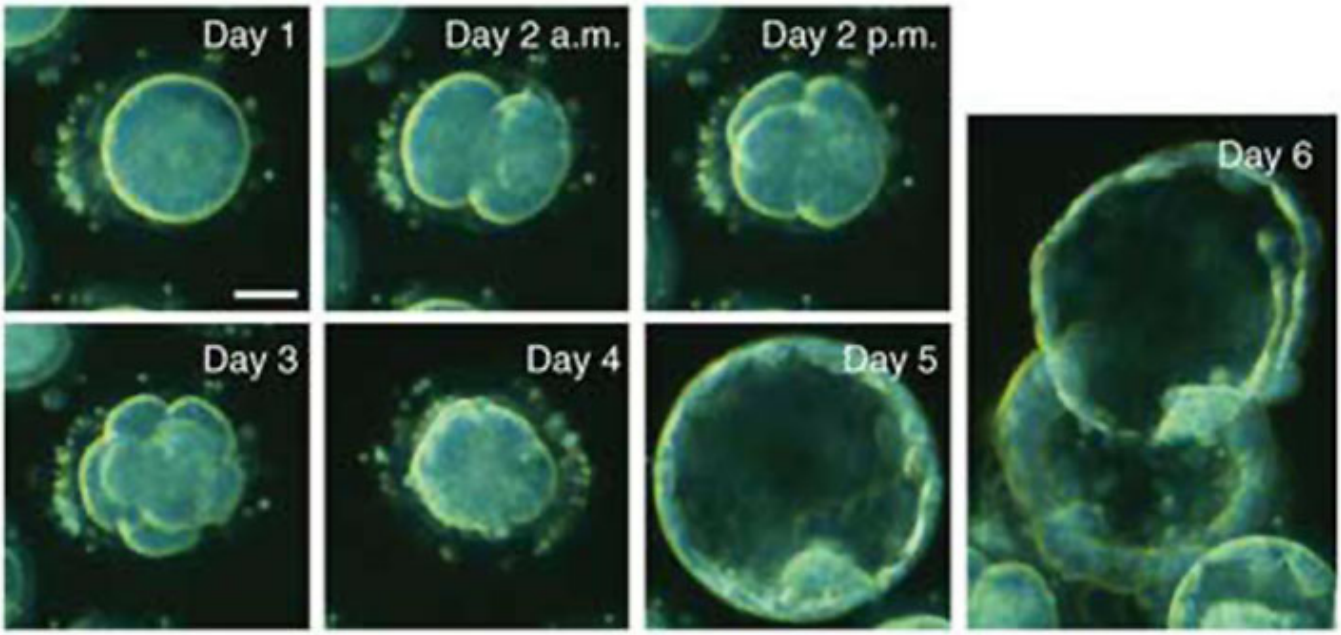
- the process of the 2 haploid gametes (egg and sperm) fusing and combining genetic material.
- **conceptus** - the entire product of fertilisation

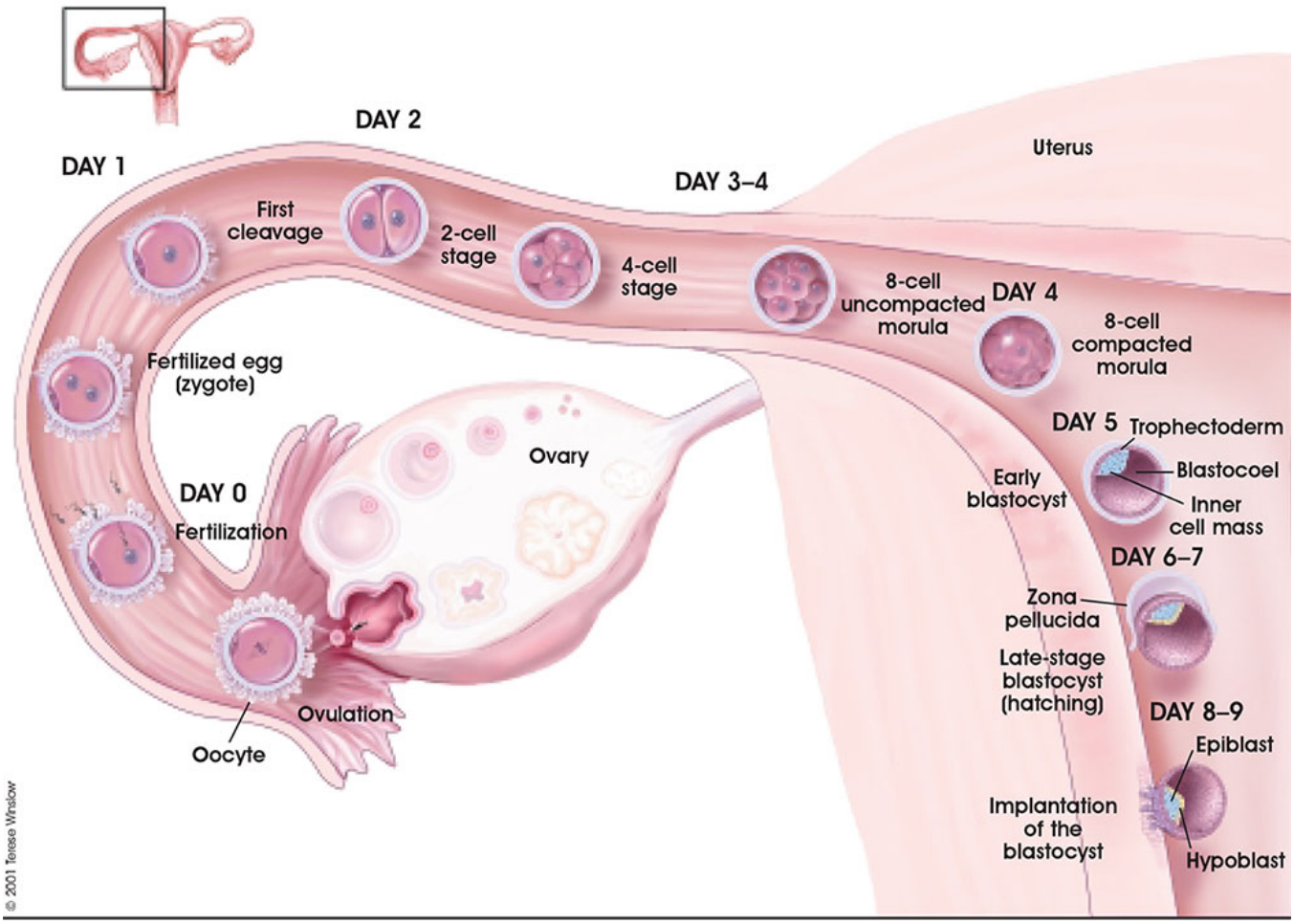


Week 1



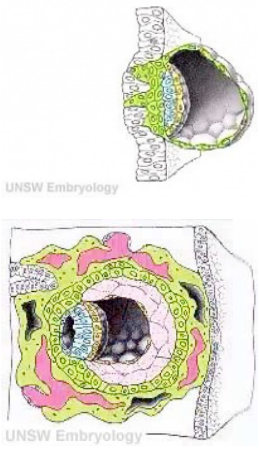
- occurs freely floating in uterus
- occurs during week 1 following fertilization
- last menstrual period (LMP) week 3
- mitosis to form solid ball of cells (morula), then hollow ball (blastocyst)





Week 2

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



Normal Implantation

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

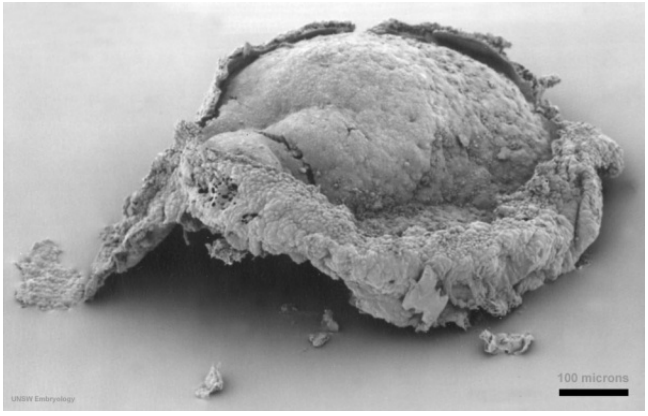
Abnormal Implantation

- 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)

Detect Pregnancy

- Clinically can be detected following implantation (week 2)
- Last Menstrual Period (LMP) - today ? ..... Birth Date - January 30, 2014

Week 3



- 4 Key processes commence

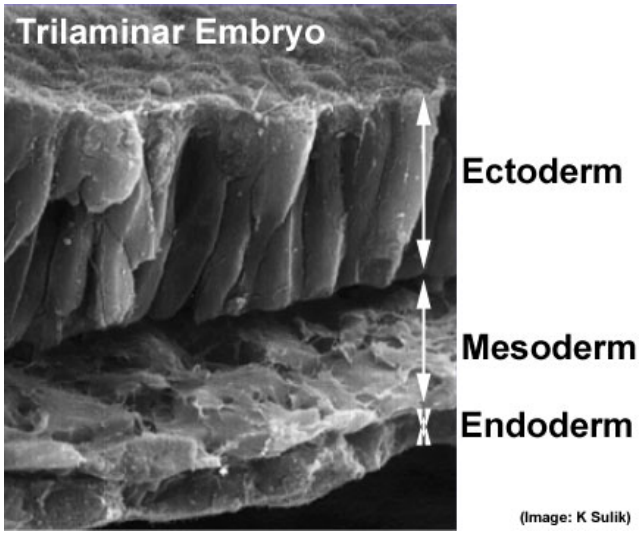
1. Gastrulation

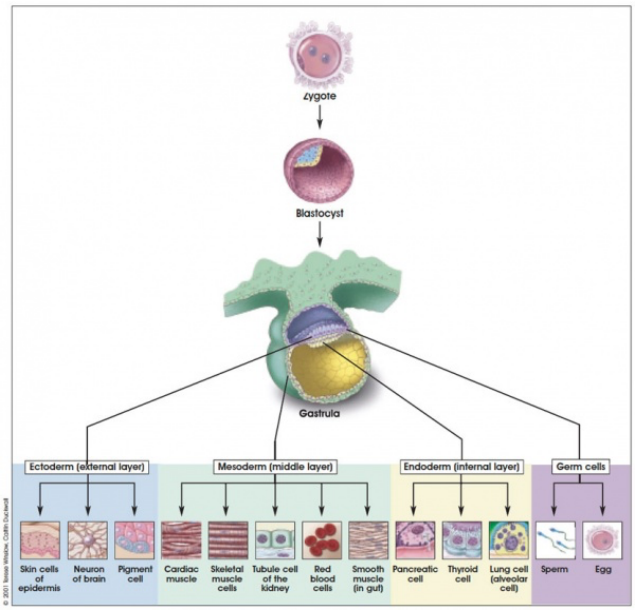
- the formation of the 3 layer embryo (trilaminar embryo)
  - All tissues of the body are formed from these 3 embryonic tissue layers (germ layers)

1. **Ectoderm** (epithelium) - forms the central and peripheral nervous

system and epithelium of the skin

2. **Mesoderm** (connective tissue) - forms the body connective tissues: blood, bone, muscle, connective tissue skin, gastrointestinal and respiratory tracts
3. **Endoderm** (epithelium) - forms gastrointestinal tract organs and the epithelium of the gastrointestinal and respiratory tracts



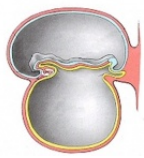


2. Somitogenesis

- segmentation of the mesoderm into **somites**
- forms the axial body plan

3. Neuralation

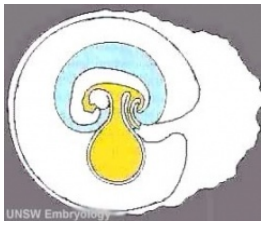
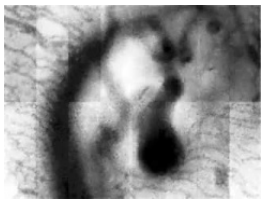
- segmentation of the ectoderm
- separates the neural tissue from the skin (epidermis)



4. Folding

- folding of the whole embryonic disc
- all edges of the disc fold ventrally
  - left and right of the disc come together to form a "tube" of the 3 layers
  - top and bottom of the disc bend to form a "C" shaped embryo.

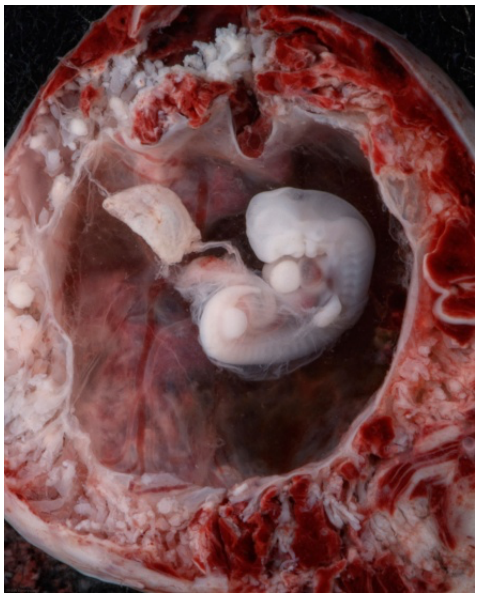
Week 4

Stage 13 - Left Ventrolateral View  **Mobile** | **Desktop** | **Original** Stage 13 | Embryo Slides	• heart formation (cardiogenesis) first functioning organ • extra-embryonic cavities develop  

Week 5 to 8

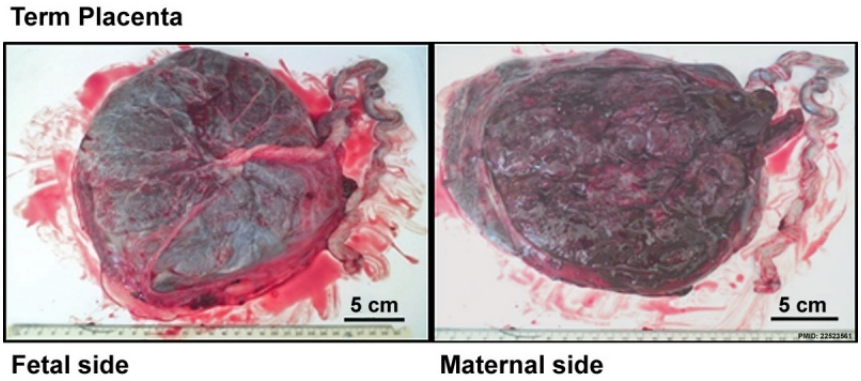
- early development of the other organs, tissues and limbs

Week 5	Week 8			
	Stage 21 - Left Lateral			

Stage 14 - Lateral View 	
Mobile | **Desktop** | **Original**	**Mobile** | **Desktop** | **Original**
Stage 14 | Embryo Slides	Stage 21 | Embryo Slides

Placenta

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



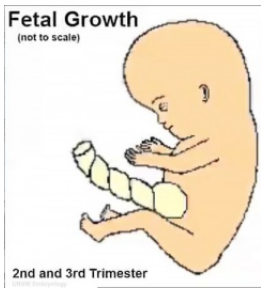
Second and Third Trimester

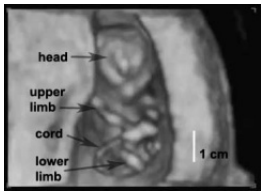
- **Week 9 to 37** - Fetal Development
- Continuing growth and differentiation of organs formed in embryonic period
  - some organs have a later development - neural, genital, respiratory, bones
  - some continue to develop after birth - neural, genital, respiratory, bones
- growth in size, length (Second Trimester)
- growth in weight (Third Trimester)

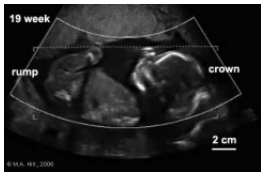
- Fetal Head 12 cartilage and bone formation (12 week)

- Fetal Head head structures and the brain (12 week)

-







Postnatal Development

Birth

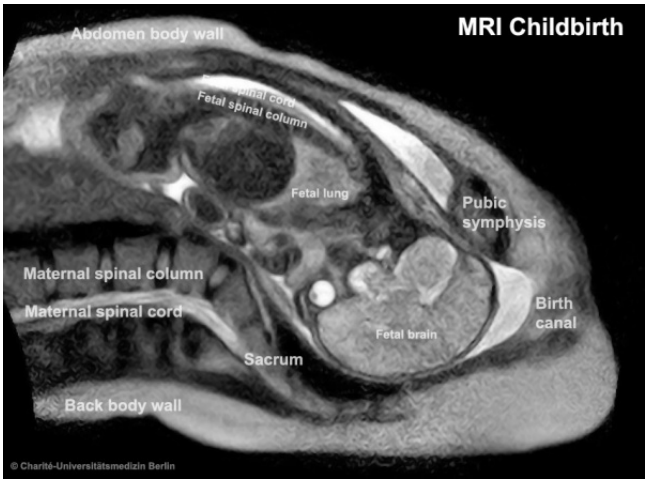
- birth (parturition) is a complex physiological process between the fetus and mother
- thought to be initiated by the fetus

Historic teaching model of birth

Maternal Birth Stages

1. Dilatation
2. Expulsion
3. Placental
4. Recovery

Australian Birth Rate 1998-2007



Newborn

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

- **Lung function** - Fluid drainage, Gas exchange, muscular activity, continued development
- **Circulatory changes** - Closure of 3 vascular shunts
- **Thermoregulation** - metabolic rate, fat metabolism

- **Nutrition** - gastrointestinal tract function, peristalsis, continued development
- **Waste** - kidney function, continued development
- **Endocrine function** - loss of placenta, maternal hormones, continued development

Newborn infant (perinatal period)

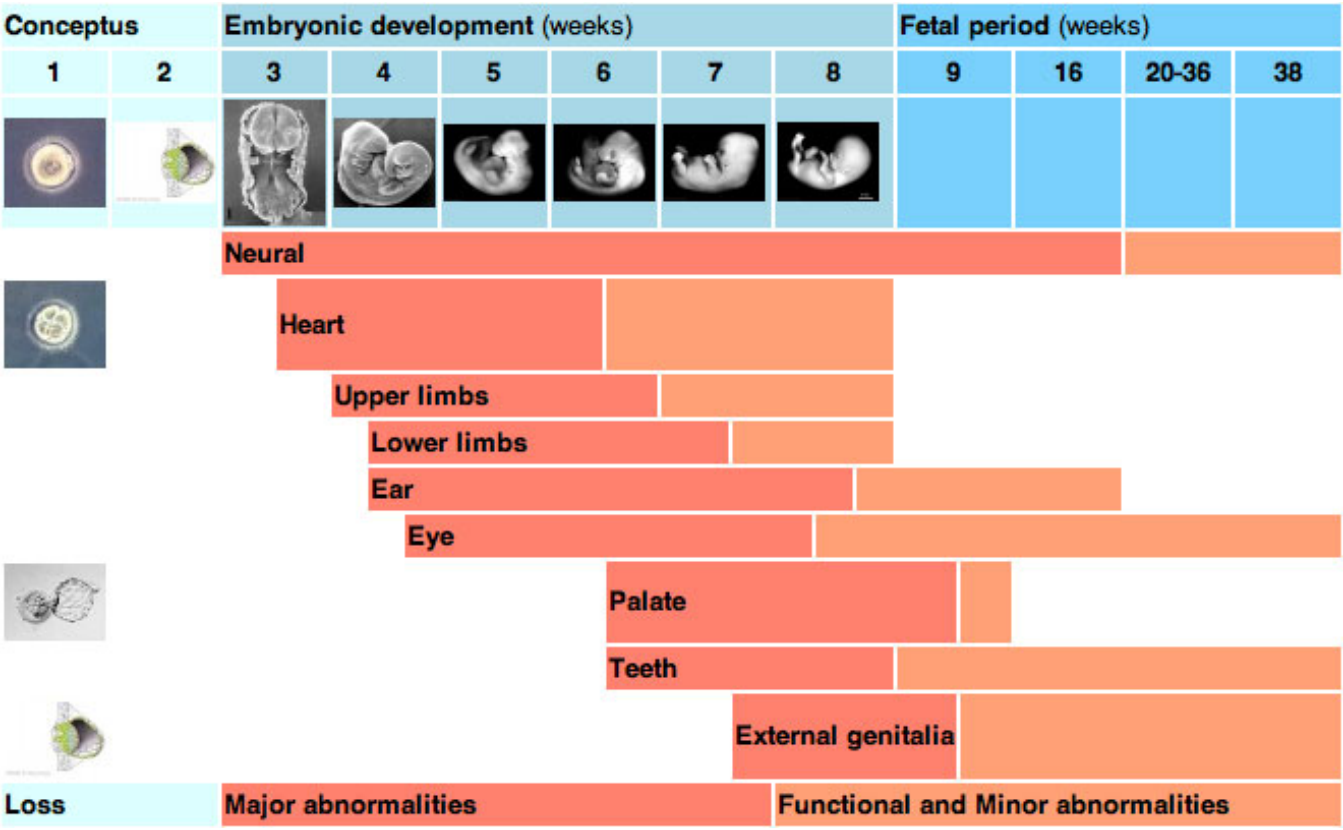
Abnormal Development

Critical Periods of Development

Three main causes:

1. Genetic
2. Environmental
3. Unknown

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



Diagnosis

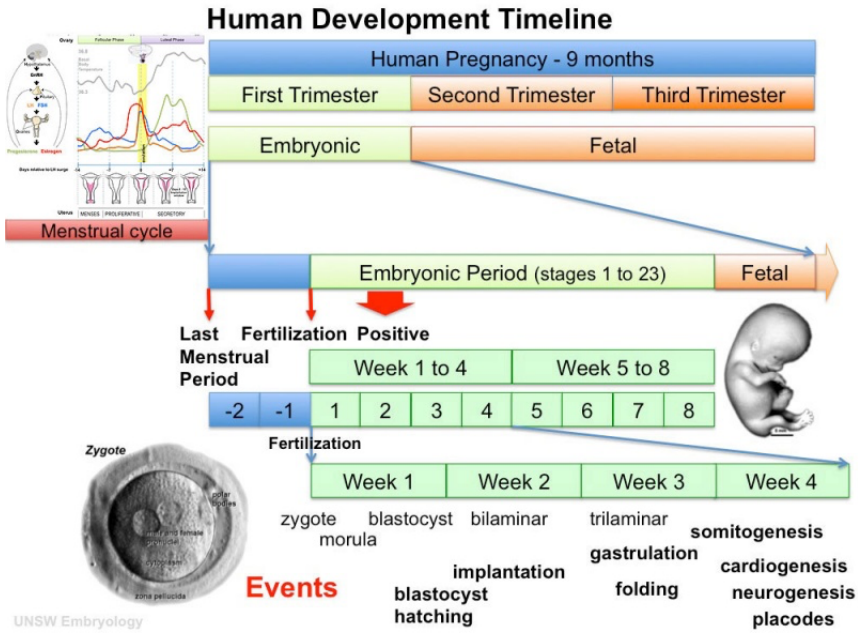
- Maternal diagnosis - often pregnancy will expose maternal health problems
- Prenatal diagnosis - number of different techniques (non-invasive, invasive) for determining normal development
- Neonatal diagnosis - (APGAR test, Guthrie test)
-
- Chorionic Villus Sampling
-
-
-
- Xray congenital dislocation hip
- Newborn hearing test

Finished! Now lets get ready for BGDA

Additional Information

Additional Information - *Content shown under this heading is not part of the material covered in this class. It is provided for those students who would like to know about some concepts or current research in topics related to the current class page.*

Revision Notes



Human development timeline

- 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, spermatazoa).
- Remember the difference between "clinical weeks" (last menstral period) and "embryonic weeks" (from ovulation/fertilisation, 2 weeks later).
- With abnormalities
    - think about the types of prenatal dianostic techniques that are now available

- the 2 major types (genetic and environmental)
- the effect of maternal age/health/lifestyle.

Textbooks

	Hill, M.A. (2018). *UNSW Embryology* (18th ed.) Retrieved April 6, 2018, from https://embryology.med.unsw.edu.au • Menstrual Cycle | Oocyte | Spermatozoa | Meiosis | Mitosis • Fertilization | Zygote | Morula | Blastocyst | Implantation • Week 1 | Week 2 | Week 3 • Science Lecture - Fertilization | Lecture - Week 1 and 2 • Australian Statistics
	**Citation:** Moore, K.L., Persaud, T.V.N. & Torchia, M.G. (2015). *The developing human: clinically oriented embryology* (10th ed.). Philadelphia: Saunders. UNSW Students have online access to the current 10th edn. through the UNSW Library subscription. Links: UNSW Library | NLM ID: 101649439 Chapter 1 - Introduction to the Developing Human
	Schoenwolf, G.C., Bleyl, S.B., Brauer, P.R., Francis-West, P.H. & Philippa H. (2015). *Larsen's human embryology* (5th ed.). New York; Edinburgh: Churchill Livingstone. UNSW students have full access to this textbook edition through UNSW Library subscription (with student Zpass log-in). Read the introduction before Chapter 1.

Foundations Practical - Introduction to Human Development

Glossary Links

Glossary: 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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