ANAT2341: lectures overview

EMBRYOGENESIS

Fertilization
Cleavage and Blastocyst Formation
Gastrulation

Organogenesis
(integumentary system, gonadogenesis)

3 weeks

37 weeks

Resources ANAT2341:
http://php.med.unsw.edu.au/embryology/
Larsen’s Human Embryology
The Developing Human: Clinically Oriented Embryology

Dr Annemiek Beverdam – School of Medical Sciences, UNSW
Wallace Wurth Building Room 234 – A.Beverdam@unsw.edu.au
Images of my past
My Travels
Lectures overview

Early embryogenesis

- **3 weeks**
  - Zygote
  - Blastocyst

- **37 weeks**
  - Gastrula
  - Ectoderm (external layer)
    - Skin cells of epidermis
    - Neuron of brain
    - Pigment cell
  - Mesoderm (middle layer)
    - Cardiac muscle
    - Skeletal muscle cells
    - Tubule cell of the kidney
    - Red blood cells
    - Smooth muscle (in gut)
  - Endoderm (internal layer)
    - Pancreatic cell
    - Thyroid cell
    - Lung cell (alveolar cell)
  - Germ cells
    - Sperm
    - Egg
Fertilization

Dr Annemiek Beverdam – School of Medical Sciences, UNSW
Wallace Wurth Building Room 234 – A.Beverdam@uq.edu.au
Fertilization lecture overview

Cell division, mitosis and meiosis

Gametogenesis: oogenesis and spermatogenesis

Fertilization
Cell Cycle

1 fertilized cell produces $10^{14}$ cells

Regeneration vs Quiescence
Interphase vs mitosis
Mitosis vs meiosis
Mitosis

http://php.med.unsw.edu.au/embryology/images/d/dd/Mitosis_01.mp4
Mitosis

Occurs in all cells
Shuts down cellular function
Generation of two genetically identical daughter cells
2n -> 4n -> 2n
Meiosis

Occurs in only in gametes
Generation of genetically different daughter cells
2n -> 4n -> 2n -> n

Wild type meiosis

pairing and recombination

metaphase I

anaphase I

metaphase II

anaphase II

Meiosis I

Meiosis II

Differential segregation into 4 daughter cells
Mitosis vs meiosis
Gametogenesis
Reproductive system

Male
- Testis
- Vas deferens
- Bladder

Female
- Ovary
- Oviduct
- Uterus
- Bladder

Male sex hormones

Estrogen

Glans penis

Glans clitoris

Figure 24-8 part 2 Discover Biology 3/e
© 2006 W. W. Norton & Company, Inc.
Gametogenesis
Reproductive system
Gametogenesis
Spermatogenesis

Male Gametogenesis

Spermiogenesis

- Spermatogonia
- Interphase G¹
- Interphase S
- Prophase I
- Metaphase I
- Anaphase I
- Telophase I
- DNA duplication
- Primary spermatocytes
- Secondary spermatocytes
- Cytokinesis
- Spermatids
- Telophase II
- Anaphase II
- Metaphase II
- Prophase II
- Interphase G²
- Crossing over

Spermatogenesis refers to the process of sperm production in the testes. It is a continuous process and involves several stages, including spermatogonia, interphase G¹, interphase S, prophase I, metaphase I, anaphase I, telophase I, DNA duplication, primary spermatocytes, secondary spermatocytes, cytokinesis, spermatids, telophase II, anaphase II, metaphase II, and prophase II. The process is illustrated with a diagram showing the stages and cell division.
Spermiogenesis

Spermatids develop:
- head: nucleus and acrosome (Golgi)
- midpiece: mitochondria
- tail: flagellum (microtubules)

Capacitation: final step of sperm maturation
Spermatogenesis/spermiogenesis
Oogenesis

Changes in Human Germ Cell Number

- Germ Cells Number (million)
- Fertile (400-500 oocytes)

Birth, Puberty, Menopause
Oogenesis

Female Gametogenesis

- Primordial oocyte
- DNA duplication
- Interphase G
- Interphase S
- Prophase I
- Metaphase I
- Anaphase I
- Telophase II

Meiotic Arrest until fertilization

Meiotic Arrest @ week 12

Primary oocyte generates 1 mature oocyte and 2 (or 3) polar bodies
Oogenesis
Oogenesis

Menstrual cycle
Oogenesis
Zona Pellucida

Produced by granulosa cells and oocyte ZP1, ZP2, ZP3 glycoproteins:
Fertilization process/sperm binding/acrosome reaction
Gametogenesis

Mitotic arrest until puberty
Continuous mitosis followed by meiosis from puberty
1 primary spermatocyte: 4 spermatids (cytoplasmic bridges)
Spermiogenesis in testes

Prophase I arrest prenatally
Metaphase II arrest until fertilization
1 primary oocyte: 1 oocyte, 3 polar bodies
Oogenesis in ovary and oviduct
Gametogenesis

**Female:**
Oogenesis
Ovaries/oviduct
Meiotic arrest at prophase I until puberty
Meiotic arrest at metaphase II until fertilization
1 oocyte per month

**Male:**
Spermatogenesis
Testes
Mitotic arrest until puberty
Maturation of many spermatocytes throughout life
Fertilization

Ejaculation
Capacitation of sperm in female genital tract
Oocyte secretes chemotactic factors

Fertilization takes place in first 1/3 of oviduct
Zona Pellucida induces acrosome reaction
Membrane Fusion:
Cortical granule release: prevention of polyspermy
Oocyte resumes meiosis

Fusion of male and female pronuclei
Mitosis

© 2006 Merriam-Webster, Inc.
Fertilization

http://php.med.unsw.edu.au/embryology/images/5/5f/Fertilization_003.mp4

http://php.med.unsw.edu.au/embryology/images/9/95/Pronuclear_fusion_001.mp4
Fertilization lecture overview

Cell division, mitosis and meiosis

Gametogenesis: oogenesis and spermatogenesis

Fertilization

Resources ANAT2341:
http://php.med.unsw.edu.au/embryology/
Larsen’s Human Embryology
The Developing Human: Clinically Oriented Embryology

Dr Annemiek Beverdam – School of Medical Sciences, UNSW
Wallace Wurth Building Room 234 – A.Beverdam@unsw.edu.au