Developmental Biology Lecture Outlines

Lecture 01: Introduction
Course content
- Developmental Biology
- Obsolete hypotheses
- Current theory

Lecture 02: Gametogenesis
Overview
Spermatozoa
- Spermatozoon function
- Spermatozoon structure
- Spermatogenesis
Ova
- Ovum function
- Ovum structure
- Oogenesis

Lecture 03: Fertilization
Overview
Events before fusion
Location of egg
- Penetration of egg envelopes
- Cell fusion
- Events after fusion
Prevention of polyspermy
- Nuclear fusion
- Initiation of development
- Other events
Lecture 04: Cleavage

Overview

Holoblastic cleavage
  Radial
  Spiral
  Bilateral
  Rotational

Meroblastic cleavage
  Discoidal
  Superficial

Lecture 05: Gastrulation

Overview

Mechanisms

Examples
  Sea urchins
  Amphibians
  Birds
  Mammals
Lecture 06: Organogenesis 1

Overview

Mesoderm

Overview
Chordamesoderm
Dorsal mesoderm
Intermediate mesoderm
Lateral plate mesoderm
Examples

Ectoderm

Neurulation
Neural crest cells
Examples

Lecture 07: Organogenesis 2

Endoderm

Digestive tube
Respiratory tube
Other organs
Examples
Lecture 08: Gene Expression in Development

Background
- Housekeeping and luxury genes
- Marker genes
- Abundance classes of mRNA
- Role of gene regulation in development

Maternal RNA
- Overview
- Function
- Abundance and complexity

Activation of zygotic transcription
- Overview
- Timing of activation
- Control of activation
- Mid-blastula transition

Tissue-specific transcription
- Overview
- Timing
- General mechanism
- Examples

Expression at the phylotypic stage
- Background
- Expressed gene set
Lecture 09: Pattern Formation - Overview

Overview

Specification
- Autonomous specification
- Conditional specification
- Syncytial specification
- Experimental definition

Determination
- Underlying mechanisms
- Experimental definition
- Mosaic and regulative embryos

Patterning
- Preformation and epigenesis
- Pattern in egg cells
- Examples of stepwise patterning

Lecture 10: Autonomous Specification

Underlying mechanisms
- Determinants
- Determinant localization
- Evidence and examples

Lecture 11: Conditional Specification 1

Underlying mechanisms
- Signals
- Receptors and signal transduction systems
- Signal interactions

Types of interaction
Lecture 12: Conditional Specification 2
  Evidence and examples

Lecture 13: Regulation of Gene Expression
  Overview
  Hypotheses
    Restriction by gene loss
    Restriction by gene regulation
  Experimental evidence
  Other evidence
  Exceptions
    Sequence loss
    Sequence amplification
  Regulatory mechanisms
Lecture 14: Differential Transcription 1

Introduction
Experimental approaches

Chromatin structure
10nm and 30nm fibre
Chromatin loops
Topological domains
Chromosome territories, chromatin compartments, and fractal globules
Involvement in differential transcription
Experimental evidence and examples

Gene structure

Transcription initiation
General transcription factors
Activator proteins
Repressor proteins
Regulation of binding
Involvement in differential transcription
Experimental evidence and examples

Transcriptional states
Lecture 15: Differential Transcription 2

Overview
Roles of activators and repressors

Transcriptional silencing - DNA methylation
Role in chromatin silencing
Experimental approaches
Examples

Transcriptional activation and silencing - histone modification
Overview
General conclusions
Experimental evidence and examples

IncRNAs
Background
Role in development
Mode of action

Transcriptional activation - chromatin remodelling proteins
Role in chromatin activation
Examples

Maintaining transcriptional states - insulator sequences
Overview
Examples and experimental evidence
Lecture 16: Post-Transcriptional Regulation

Introduction

Selective nuclear processing
  Alternate splicing
  Alternate polyA-addition

Examples

Selective mRNA processing
  Micro RNAs
  Repressors
  Modification of translation factors
  Alteration of polyA tail length

Lecture 17: Cellular Processes in Morphogenesis 1

Overview

Cell division
  Aspects regulated

Frequency of cell division
  Molecular mechanisms
  Developmental examples

Position and orientation of cell division
  Molecular mechanisms
  Developmental examples

Coupling of DNA replication and mitotic cell division
  Molecular mechanisms
  Developmental examples

Types of cell division
  Molecular mechanisms
Lecture 18: Cellular Processes in Morphogenesis 2

**Cell adhesion**
- Overview
- Molecular mechanisms
- Developmental examples

Lecture 19: Cellular Processes in Morphogenesis 3

**Cell shape**
- Overview
- Molecular mechanisms
- Developmental examples

**Cell migration**
- Overview
- Molecular mechanisms
- Guidance mechanisms
- Developmental examples

Lecture 20: Cellular Processes in Morphogenesis 4

**Cell death**
- Overview
- Molecular mechanisms
- Developmental examples
- Regulation of apoptosis
Lecture 21: Development in *D. melanogaster* 1

**Background**
- Life history
- Body plan
- Development

**Oocyte patterning**
- Overview
- Anterior group genes
- Posterior group genes
- Terminal group genes
- Dorsoventral group genes

Lecture 22: Development in *D. melanogaster* 2

**Anteroposterior axis specification**
- Overview
- Gap genes
- Pair-rule genes
- Segment-polarity genes
- Computer modelling of expression patterns

Lecture 23: Development in *D. melanogaster* 3

**Anteroposterior axis specification (continued)**
- Segment identity genes

**Dorsoventral axis specification**
- Overview
- Ventral genes
- Dorsal genes

**Summary**
- Patterning
- Realisator genes
Lecture 24: Sex determination in \textit{D. melanogaster}

\textbf{Background}

\textbf{Initial events}

- Role of X chromosome number
- Expression of \textit{Sxl}

\textbf{Subsequent events}

- Subsequent events in somatic sex determination
- Subsequent events in determination of sexual behaviour
- Subsequent events in dosage compensation

\textbf{Germ-line determination}

- Cell autonomous events
- Signalling from somatic tissues

Lecture 25: Development in \textit{C. elegans 1}

Pending

Lecture 26: Development in \textit{C. elegans 2}

Pending

Lecture 27: Development in vertebrates 1

\textbf{Anatomy of the vertebrate anteroposterior axis}

- Nervous system
- Axial skeleton
- Segmentation

\textbf{Hox genes}

- Background
- Organisation
- Expression
- Regulation
Lecture 28: Development in vertebrates 2

Limb development
  Introduction
  Limb bud initiation

Patterning of the limb bud
  Proximodistal axis
  Anteroposterior axis
  Dorsoventral axis
  Other information
  Evolutionary comparisons

Limb regeneration
  Introduction
  Patterning

Lecture 29: Development in flowering plants 1

Overview

Plant development
  Fertilization
  Embryonic development
  Germination
  Subsequent growth

Developmental mechanisms
  Morphogenesis
  Coordination of development
  Epigenetic regulation

Shoot development
  Shoot apical meristem
Lecture 30: Development in flowering plants 2

Flower development
- Initiation of flower development
- Flower structure
- Whorl patterning
- Dorsoventral patterning

Root development
- Root apical meristem
- Patterning by auxin
- Radial patterning
- Epidermal patterning

Lecture 31: Pending

Pending
Lecture 32: Embryonic Stem Cells

**Background**
- Definition
- Potential applications

**Sources of stem cells**
- Overview
- From embryos
- From adult cells - Yamanaka method
- From adult cells - nuclear transfer

**Reprogramming of cells**
- Overview
- Indirect conversion examples
- Direct conversion examples

**Other applications**
- Modelling diseases
- Other

**Adult stem cells**
- Overview

Lecture 33: Left-Right Asymmetry

**Background**

**Mechanisms**
- Nodal signalling
- Blastomere asymmetry
- Evolutionary history