ANAT2341 Embryology Introduction: Steve Palmer
Course overview
Course lecturers – specializations and roles

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
<th>Email</th>
<th>Availability; times and location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Convener</td>
<td>Dr Stephen Palmer</td>
<td><a href="mailto:s.palmer@unsw.edu.au">s.palmer@unsw.edu.au</a></td>
<td>By appointment</td>
</tr>
<tr>
<td>Lecturer/tutor</td>
<td>Dr Annemiek Beverdam</td>
<td><a href="mailto:a.beverdam@unsw.edu.au">a.beverdam@unsw.edu.au</a></td>
<td>By appointment</td>
</tr>
<tr>
<td>Lecturer/tutor</td>
<td>Prof Ken Ashwell</td>
<td><a href="mailto:k.ashwell@unsw.edu.au">k.ashwell@unsw.edu.au</a></td>
<td>By appointment</td>
</tr>
<tr>
<td>Lecturer/tutor</td>
<td>Prof Edna Hardeman</td>
<td><a href="mailto:e.hardeman@unsw.edu.au">e.hardeman@unsw.edu.au</a></td>
<td>By appointment</td>
</tr>
<tr>
<td>Lecturer/tutor</td>
<td>Dr Nalini Pather</td>
<td><a href="mailto:n.pather@unsw.edu.au">n.pather@unsw.edu.au</a></td>
<td>By appointment</td>
</tr>
<tr>
<td>Course designer</td>
<td>Dr Mark Hill</td>
<td>Overseas sabbatical</td>
<td>Email via S.Palmer</td>
</tr>
</tbody>
</table>

Steve Palmer 9385 2957
Course overview
Summary, aims and expected outcomes

Credit Points:
6

Summary of the Course
This course will introduce embryological development as a major topic within medical sciences. Students completing this course will have a broad understanding of: human development, some animal models of development and current related research topics. Experts and researchers from within the field contribute to the current course.

Aims of the Course
1. This course will enable students to explore and gain further understanding of embryology through the investigation of development in both humans and animal models with a direct emphasis of their application to emerging research and reproductive technologies.
2. This course will enable students to broadly understand abnormalities in development and current applications to medical research.

Student learning outcomes
At the conclusion of this course the student will be able to:
1. Describe the key events in early and systematic embryological development.
2. Apply developmental theory to abnormalities of development and current medical research techniques.
3. Complete tasks in scientific communication either online, written and by oral presentation.
4. Work in small groups to research a specific topic and deliver a group project.
Course overview
Graduate attributes

The students will be encouraged to develop the following Graduate Attributes by undertaking the selected activities and knowledge content. These attributes will be assessed within the prescribed assessment tasks.

At the conclusion of this course the student will be able to:

1. Investigate embryological development by scholarly enquiry of research literature.
2. Apply developmental theory to anatomical development.
3. Undertake basic research by applying analytical and critical thinking.
4. Create individual and group projects that demonstrate initiative and collaborative work.
## Course overview
### Means of assessment

<table>
<thead>
<tr>
<th>Assessment task</th>
<th>Length</th>
<th>Weight</th>
<th>Learning outcomes assessed</th>
<th>Graduate attributes assessed</th>
<th>Due date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Tasks</td>
<td>Short answer and/or multiple choice</td>
<td>20 %</td>
<td>Critical thinking and initiative, information literacy</td>
<td>Scholarly enquiry of research literature</td>
<td>Throughout the semester</td>
</tr>
<tr>
<td>Group Project</td>
<td>3000 word referenced review with figures and mid-semester oral presentation</td>
<td>30 %</td>
<td>Information literacy and effective communication</td>
<td>Initiative and collaborative work</td>
<td>Mid-semester presentation and week 11 submission of review</td>
</tr>
<tr>
<td>Theory Examination</td>
<td>2 hours</td>
<td>50 %</td>
<td>Engagement with the relevant disciplinary knowledge in its interdisciplinary context</td>
<td>Apply developmental theory to anatomical development</td>
<td>Within the S2 exam period 8th – 26th Nov</td>
</tr>
</tbody>
</table>

**Submission of Assessment Tasks**

Student individual tasks will be set and submitted on a regular basis during laboratories. Oral presentation of group projects will be during weeks 8 and 9. Group project reports are due on the Sunday of week 11. Late submissions will be penalized by 5%/ day late.
Course overview
Means of assessment

Individual assessments - 20% of the final mark – taken during the first 30 mins of laboratory – usually 10 questions – single word answers or multiple choice.

Group project – 30% of the final mark – to be discussed in Lab2

Final exam – 50% of the final mark - 2hr paper – answer 5 questions in a short essay style selected from a list of topics drawn from the lecture material and the textbook chapters.
Course overview

Academic honesty and plagiarism

Plagiarism is using the words or ideas of others and presenting them as your own. Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. With regard to the group project work please note the statement:

"Claiming credit for a proportion of work contributed to a group assessment item that is greater than that actually contributed;"

Academic Misconduct carries penalties. If a student is found guilty of academic misconduct, the penalties include warnings, remedial educative action, being failed in an assignment or excluded from the University for two years. The University has also adopted an educative approach to plagiarism and has developed a range of resources to support students.

For more information see: [http://www.lc.unsw.edu.au/plagiarism](http://www.lc.unsw.edu.au/plagiarism)
## Course overview

## Course schedule


<table>
<thead>
<tr>
<th>Wk No.</th>
<th>Wk Start Monday</th>
<th>Lecture 1 Tuesday 12-1pm Wallace Wurth LG02</th>
<th>Lecture 2 Tuesday 4-5pm Biomedical Theatre E</th>
<th>Laboratory Wed 10am-12 Wallace Wurth G08</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>05 Aug</td>
<td>Fertilization</td>
<td>Week 1 &amp; 2 Development</td>
<td>Lab 1</td>
</tr>
<tr>
<td>3</td>
<td>12 Aug</td>
<td>Embryology Introduction</td>
<td>Week 3 Development</td>
<td>Lab 2</td>
</tr>
<tr>
<td>4</td>
<td>19 Aug</td>
<td>Mesoderm Development</td>
<td>Ectoderm, Early Neural, Neural Crest</td>
<td>Lab 3</td>
</tr>
<tr>
<td>5</td>
<td>26 Aug</td>
<td>Early Vascular Development</td>
<td>Placenta</td>
<td>Lab 4</td>
</tr>
<tr>
<td>6</td>
<td>02 Sept</td>
<td>Endoderm, Early Gastrointestinal</td>
<td>Respiratory Development</td>
<td>Lab 5</td>
</tr>
<tr>
<td>7</td>
<td>09 Sept</td>
<td>Head Development</td>
<td>Neural Crest Development</td>
<td>Lab 6</td>
</tr>
<tr>
<td>8</td>
<td>16 Sept</td>
<td>Musculoskeletal Development</td>
<td>Limb Development</td>
<td>Lab 7 Project Orals</td>
</tr>
<tr>
<td>9</td>
<td>23 Sept</td>
<td>Renal Development</td>
<td>Genital</td>
<td>Lab 8 Project Orals</td>
</tr>
</tbody>
</table>

**Mid-Semester Break 28th Sept – 7th Oct**

<table>
<thead>
<tr>
<th>Wk No.</th>
<th>Wk Start Monday</th>
<th>Lecture</th>
<th>Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>07 Oct</td>
<td>Endocrine Development</td>
<td>Lab 9</td>
</tr>
<tr>
<td>11</td>
<td>14 Oct</td>
<td>Neural</td>
<td>Lab 10</td>
</tr>
</tbody>
</table>

**Group Project is Due for Submission on Sunday 20th October**

<table>
<thead>
<tr>
<th>Wk No.</th>
<th>Wk Start Monday</th>
<th>Lecture</th>
<th>Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>21 Oct</td>
<td>Heart</td>
<td>Lab 11</td>
</tr>
<tr>
<td>13</td>
<td>28 Oct</td>
<td>Fetal</td>
<td>Lab 12</td>
</tr>
</tbody>
</table>

**Study week 2nd – 7th November**

Examinations 8th – 26th November Date TBA
## Course overview

### Online link - Timetable

<table>
<thead>
<tr>
<th>Week</th>
<th>Week Start Monday Date</th>
<th>Lecture 1 Tue 12:00 - 1:00pm Wallace Wurth LG02</th>
<th>Lecture 2 Tue 4:00 - 5:00pm Biomedical Theatre E</th>
<th>Laboratory Wed 10:00am - 12:00pm Wallace Wurth Lab G08</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5 Aug</td>
<td>Fertilization</td>
<td>Week 1 and 2 Development</td>
<td>Fertilization and IVF</td>
</tr>
<tr>
<td>3</td>
<td>12 Aug</td>
<td>Embryology Introduction</td>
<td>Week 3 Development</td>
<td>Introduction to Group Projects</td>
</tr>
<tr>
<td>4</td>
<td>19 Aug</td>
<td>Mesoderm Development</td>
<td>Ectoderm, Early Neural, Neural Crest</td>
<td>Human Genetic Diseases</td>
</tr>
<tr>
<td>5</td>
<td>26 Aug</td>
<td>Early Vascular Development</td>
<td>Placenta</td>
<td>Mouse Models of Human Genetic Disease</td>
</tr>
<tr>
<td>6</td>
<td>2 Sep</td>
<td>Early Endoderm, Early Gastrointestinal</td>
<td>Respiratory Development</td>
<td>Understanding Mechanisms Using Mouse Models</td>
</tr>
<tr>
<td>7</td>
<td>9 Sep</td>
<td>Head Development</td>
<td>Neural Crest Development</td>
<td>Examples of Mouse Models: GTF2IRD1 and YAP</td>
</tr>
<tr>
<td>8</td>
<td>16 Sep</td>
<td>Musculoskeletal Development</td>
<td>Limb Development</td>
<td>Oral Presentation of Group Projects 1</td>
</tr>
<tr>
<td>9</td>
<td>23 Sep</td>
<td>Renal Development</td>
<td>Genital</td>
<td>Oral Presentation of Group Projects 2</td>
</tr>
<tr>
<td></td>
<td>Mid Semester Break 28 Sep - 7 Oct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>7 Oct</td>
<td>Endocrine Development</td>
<td>Integumentary Development</td>
<td>Assisted group work for final report</td>
</tr>
<tr>
<td>11</td>
<td>14 Oct</td>
<td>Neural</td>
<td>Sensory</td>
<td>Assisted group work for final report</td>
</tr>
<tr>
<td></td>
<td><strong>Group Project is Due for Submission at the end of week 11</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>21 Oct</td>
<td>Heart</td>
<td>Stem Cells</td>
<td>Review process of final reports</td>
</tr>
<tr>
<td>13</td>
<td>28 Oct</td>
<td>Fetal</td>
<td>Birth and Revision</td>
<td>Review of lecture coursework and tutorial session</td>
</tr>
<tr>
<td>2 Nov</td>
<td>Study Week</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 to 26 Nov</td>
<td>Examination- TBA</td>
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</table>
Course overview

Expected Resources for students

Textbooks - Either of the textbooks listed below are recommended for this course and page references to both are given in each lecture. There are additional embryology textbooks that can also be used, consult course organizer. Both textbooks are currently accessible online through the UNSW Library connection (links are included in online lecture and practical materials).


Online materials - Supported by the online education site UNSW Embryology:

http://php.med.unsw.edu.au/embryology
Course overview

Other information to be included

- Students are expected to attend all lectures and laboratories and absences require prior arrangement with the course coordinator and/or a medical certificate. See also the UNSW Student conduct policy https://my.unsw.edu.au/student/academiclife/assessment/StudentConductPolicy.html
- Information on relevant Health and Safety policies and expectations as outlined at: http://medicalsciences.med.unsw.edu.au/SOMSWeb.nsf/page/Health+and+Safety
- Theory examination will be a two-hour exam in the examination period semester 2.
- Students should refer to the UNSW website for further advice concerning special consideration in the event of illness or misadventure https://my.unsw.edu.au/student/atoz/SpecialConsideration.html
- Student equity and diversity issues via Student Equity Officers (Disability) in the Student Equity and Diversity Unit (9385 4734). Further information for students with disabilities is available at http://www.studequity.unsw.edu.au/content/Services/Disabilityservices.cfm

Attendance issues:
1. Lecture content is tested during the laboratory of the following week
2. These tests will mainly be on the lecture material but may also be drawn from the appropriate book chapter
3. The tests occur within the first 30mins of the laboratory – so please be on time
4. At least 80% attendance is expected for the laboratories
ANAT2341 Online
Navigating through the web pages
Timetable – provides hyperlinks to all of the course units
For example – The laboratory class 2 – Introduction to group projects
Audio will be made available as it comes through – previous years are also available
Embryology involves learning a new language – use the Glossary
C for Carnegie stages
Carnegie stages are a system of classifying embryonic development based on the external features and related internal changes that affect appearance and growth of the embryo. Note that the stages are not directly dependent on either age or size, but upon the appearance of specific embryonic features. Early human and other species embryos can be classified by these stages. The term “Carnegie stages" are named after the famous USA Institute which began collecting and classifying embryos in the early 1900's.
Human Development Timeline

**Human Pregnancy - 9 months**

- **First Trimester**
- **Second Trimester**
- **Third Trimester**

**Embryonic**

- **Fetal**

**Menstrual cycle**

**Embryonic Period (stages 1 to 23)**

- **Fetal**

**Last Fertilization Positive**

- **Week 1 to 4**
- **Week 5 to 8**

- **Week 1**
- **Week 2**
- **Week 3**
- **Week 4**

- **Zygote**
- **Blastocyst**
- **Implantation**
- **Hatching**
- **Morula**
- **Bilateraral**
- **Gastrulation**
- **Folding**
- **Somitogenesis**
- **Cardiogenesis**
- **Neurogenesis**

- **Placodes**

UNSW Embryology
8 weeks is the end of the *embryonic* period in humans – most of the events we will be looking at during the course will be within the first 8 weeks – this is followed by the *fetal* period.

Overview of the course:
Embryology integrates many different disciplines, anatomy, cell biology, evolution, genetics, cell-signaling, molecular biology, biochemistry.
Anatomical – observation, naming and fate mapping
**Anatomical** – observation, naming and **fate mapping**

Fate mapping – the chick–quail grafting system

Nicole Le Dourin From: *Comparative Embryology*
Gilbert SF.
Using animal models to study mechanisms of human development

The sequence of a gene can be conserved throughout evolution and the function of the protein encoded by the gene can also be highly conserved.

Example 1: Mutation of the mouse *Engrailed* gene leads to a failure of normal cerebellum development in the mouse brain. If a Drosophila fruit fly gene with a similar DNA sequence is substituted, cerebellum development seems normal.

Example 2: By mis-expression of the Drosophila *Eyeless* gene in a fly’s leg it is possible to induce an extra eye (TOP). If a gene with similar sequence from a squid is used (*Pax6*) the same thing happens (BOTTOM).
If we assume that a gene in the human does roughly the same job as it does in other animals – we can use animal models to study genetic disease.

*Caenorhabditis elegans*: nematode worm, external development in egg, transparent, **fate of every cell (about 1000) mapped**, short life-cycle, rapid development, very cheap and easy to keep, **easy to manipulate gene expression (feed them DNA)**, genome sequenced to completion, very poor relevance to human development,

*Drosophila melanogaster*: fruitfly, external development in egg, **excellent for genetics**, short life-cycle, rapid development, easy and cheap to keep, genome sequenced to completion, poor relevance to human development.

*Xenopus laevis*: African clawed frog, external development in egg, easy and moderately inexpensive to keep, short life-cycle, rapid development, very poor for genetics, genome not sequenced due to tetraploidy, **very good for grafting studies and fate mapping**, better relevance to human development.
Animal models continued:

*Gallus gallus*: Chicken, external development in egg, easy and cheap to produce (eggs), relatively rapid development, very poor for genetics, genome sequence incomplete, very good for grafting studies (chick/quail grafting) and fate mapping, good relevance to human development.

*Danio rerio*: Zebrafish, external development in egg, easy and moderately inexpensive to keep, short life-cycle, rapid development, good for transient genetic manipulation, translucent embryo, genome sequenced to completion, good relevance to human development, good all-round model.

*Mus domesticus*: Mouse, internal development in uterus (virtually impossible for grafting studies), very expensive to keep, 20 day gestation, 8 weeks before sexually mature, difficult and expensive genetic manipulation, genome sequenced to completion, excellent relevance to human development,
The nuclei of all somatic cells contain the same chromosomal DNA content and have the potential to make a clone.

**Somatic cell nuclear transfer in frogs and sheep**

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**Viable offspring derived from fetal and adult mammalian cells**

*NATURE* | VOL 385 | 27 FEBRUARY 1997


**Dolly the sheep**

Nucleus from a mammary cell derived from a 6 year old ewe
Q: How do all of the different cell types arise?
A: lineage restriction

The early cell division stages of *Caenorhabditis elegans* embryo and the lineage restriction of the cells
How does lineage restriction work? Cell fate is controlled by molecular switches – transcription factors that control the expression of other genes and thus differentiation.
Developmental transcription factor proteins are expressed in restricted spatial patterns e.g. the Hox proteins

mRNA in-situ hybridization
Production of the inducer from a point source generates a diffusion gradient across a field of cells. If sufficient receptors are activated in the receiving cells to generate a threshold intracellular signal then cell fate is switched.
The 3-dimensional organization of the vertebrate limb bud uses a number of spatial cues.

A wing bud of a chick embryo at 4 days of incubation. The scanning electron micrograph shows a dorsal view. At the distal margin of the limb bud a thickened ridge can just be seen.

The apical ectodermal ridge (AER).

Expression patterns of key signaling proteins and DNA-binding transcription factors in the chick limb bud.

- **Sonic hedgehog**: diffusible morphogen
- **FGF4**: diffusible morphogen
- **FGF8**: diffusible morphogen
- **Wnt7a**: diffusible morphogen
- **BMP2**: diffusible morphogen
- **Notch**: cell-cell signaling
- **En1**: DNA-binding transcription factor
- **Lmx1**: DNA-binding transcription factor
**Cell migration and movement** – mass movements of cell populations relative to others to reorganize shape, e.g. gastrulation and formation of the neural tube.
Morphogenesis by apoptosis of temporary developmental structures e.g. tissue between the digits in the mouse paw

Fluorescent green marker indicates cells undergoing apoptosis
Remember 1st short answer/multiple choice test is tomorrow.

Make sure you have revised notes from the 1st 2 lectures of last week.