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**Course ID: SCRM 511**

**Title: Developmental Biology and Human Embryology (4 units)**

**Fall - Tues/Thurs 2:00-4:00 PM**

**Location:** Broad CIRM Center 1st floor conference room

**Instructor: Henry Sucov**

**Office:** BCC 511

**Office Hours:** Mon/Wed/Fri 3:00-5:00

**Contact Info:** sucov@usc.edu; tel 323-442-2563

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**Course Description**

This course will survey the anatomical, cellular and molecular processes that underlie development and congenital malformations. The course is primarily oriented to human development and human anatomy, although it incorporates extensive discussion of other species for comparison of similarities and differences. The course is intended primarily for master’s degree students in the Stem Cell and Regenerative Medicine program.

**Learning Objectives**

Students are expected to acquire knowledge and understanding of early development and of the developmental programs that underlie morphogenesis of the major organ systems, the role of stem and progenitor cell types in the development of these organ systems, the etiology of congenital birth defects, principles and examples of teratology, and evolutionary changes in development between species. This course fills a significant gap in, and complements the currently offered courses in the USC Dornsife College of Letters, Arts and Sciences Department of Biological Sciences and in the Keck School of Medicine of USC Department of Stem Cell Biology and Regenerative Medicine.

**Prerequisite(s):** Cell Biology (USC courses BISC 220L, BISC 221L or equivalent if taken at another institution); Molecular Biology (USC courses BISC 320L or equivalent if taken at another institution)

**Co-Requisite (s):** None.

**Concurrent Enrollment:** None.

**Recommended Preparation**: None.

**Course Notes**

None.

**Technological Proficiency and Hardware/Software Required**

None.

**Required Readings and Supplementary Materials**

The Developing Human, K.L. Moore and T.V.N. Persaud, 8th ed (2008); ISBN-13: 978-1416037064; available at USC Bookstore and on reserve at Norris Medical Library.

Developmental Biology, S.F. Gilbert, 10th ed. (2014); ISBN-13: 978-0878939787; available at USC Bookstore and on reserve at Norris Medical Library.

**Description and Assessment of Assignments**

Students are expected to read assigned sections of textbooks or supplemental materials in advance of class. Students will be expected to participate actively in class discussion and will be called on at random to answer questions asked by the instructor. Midterm and final exams will utilize written short essay format questions. There will not be any written materials submitted by students for grading other than associated with the exams, nor oral presentations other than associated with class questions and discussion.

**Grading Breakdown**

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| **Assignment** | **Points** | **% of Grade** |
| Class participation | 15 | 15 |
| Midterm 1 | 25 | 25 |
| Midterm 2 | 25 | 25 |
| Final | 35 | 35 |
| **Total** | **100** | **100** |

**Assignment Submission Policy**

No submitted assignments.

**Additional Policies**

Attendance and reading of the assigned materials prior to each class is expected. Students are expected to participate actively in class and will be called on at random to answer questions posed by the instructor.

**Course Schedule: A Weekly Breakdown**

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| Lecture # | General topic | Specific subjects | Reading |
| 1 | Course intro | Course introduction Overview of human embryology Comparison to other species The cell biology of development Teratology - immediate effects Teratology - 2nd and 3rd generation effects Featured correlate: DES | Moore chapter 1 pp 1-13 (all) Moore chapter 20 pp 471-484 Gilbert chapter 1 pp 12-29 Gilbert chapter 18 pp 635-655 |
| 2 | Oogenesis | Oogenesis in nonmammalian models Concept of maternal information Oogenesis in mammals Spermatogenesis Oocyte maturation and ovulation in mammals Featured correlate: chromosome dysjunction defects | Moore chapter 2 pp 15-28 Gilbert chapter 17 pp 610-624 |
| 3 | Early cleavage | Fertilization Early cleavage in nonmammalian species The maternal to zygotic transition Early cleavage in mammals Featured correlate: in vitro fertilization | Moore chapter 2 pp 31-35 Gilbert chapter 4 pp 107-115 Gilbert chapter 5 pp153-158 |
| 4 | Cytoplasmic localization and early asymmetry | Early specification in nonmammalian species Derivation of the mammalian blastocyst Specification of ICM vs trophoblast Axis formation in nonmammals and mammals Featured correlate: embryonic stem cells | Moore chapter 2 pp 36-40 Gilbert chapter 6 pp 185-212 Gilbert chapter 7 pp 217-225 Gilbert chapter 8 pp 241-270 Gilbert chapter 9 pp 298-314 |
| 5 | Early development | Formation of the amnion and chorion Twins and organization of the extraembryonic membranes Derivation of the epiblast and hypoblast Gastrulation in nonmammalian and mammalian species | Moore chapter 3 pp 43-53 (all) (same parts of Gilbert as above) |
| 6 | Early organogenesis | The notochord and induction of neurulation The notochord and specification of neural tube identity Featured correlate: neural tube closure defects Paraxial mesoderm and somite differentiation Fate of the notochord | Moore chapter 4 pp 55-65 Gilbert chapter 10 pp 333-345 Gilbert chapter 12 pp 415-428 |
| 7 | Intro to neural crest | Specification of neural crest Neural fates of the neural crest Nonneural fates of the neural crest | Gilbert chapter 11 pp 375-393 |
| 8 | Embryonic folding | Lateral folding and formation of the coelomic cavity Ventral folding and specification of fore/mid/hindgut Folding in mouse embryos Featured correlate: omphalocoele The septum transversum and diaphragm | Moore chapter 5 pp 73-79 Moore chapter 8 pp 146-157 (all) |
| 9 | Lung development | Formation of the pleural cavity Lung development Featured correlate: congenital diaphragmatic hernia | Moore chapter 10 pp 198-209 (all) Gilbert chapter 13 pp 478-487 |
| 10 | Midterm 1 |  |  |
| 11 | GI development I | Review of dorsal and ventral mesentery Liver, gall bladder, pancreas, and ducts Featured correlate: diabetes and beta cells Hindgut and endodermal components of the UG system | Moore chapter 11 pp 212-241 (all) |
| 12 | GI development II | Intestinal development Intestinal stem cells | (same as above) |
| 13 | Urogenital development I | Intermediate mesodermMesonephrosFormation of the kidney | Moore chapter 12 pp 244-261Gilbert chapter 12 pp 436-447 |
| 14 | Urogenital development II | Gonadal differentiation Male vs female internal genital differentiation Male vs female external genital development Featured correlate: human hermaphrodites Sex determination in mammals and nonmammalian species | Moore chapter 12 pp 262-283 Gilbert chapter 15 pp 519-545 |
| 15 | The pharyngeal apparatus | Organization of the pharyngeal apparatus Pharyngeal pouch differentiation: thymus, parathyroids, UB body Featured correlate: DiGeorge syndrome | Moore chapter 9 pp 159-175 (Gilbert chapter 13 pp 478-487 from above) |
| 16 | Head and neck development | Pharyngeal muscle and cartilage Mx, Mn, and FNP contributions to the head and face Formation of the palate and nasal cavities Featured correlate: cleft palate Formation of the tongue Development of the ear | Moore chapter 9 pp 176-195 Moore chapter 18 pp 433-436 |
| 17 | Vasculogenesis and hematopoiesis | Vasculogenic progenitors and differentiation Angiogenesis Hematopoietic stem cells and differentiation Bone marrow niche | Moore chapter 13 pp 285-292 Gilbert chapter 13 pp 460-475 |
| 18 | Cardiac development I | First and second heart fields Atrial septation and inflow tract morphogenesis Neural crest and outflow tract morphogenesis Arch artery reorganization Featured correlate: evolution of the recurrent laryngeal nerve 2 (fish) vs 4 (mammal) chamber circulation and evolution Neonatal transitions in the CV system | Moore chapter 13 pp 292-335 Gilbert chapter 13 pp 450-459 |
| 19 | Cardiac development II | Endocardium and valve formation Epicardium and cardiomyocyte proliferation Epicardium and coronary vasculogenesis Integrated multiorgan developmental systems Featured correlate: heart failure and heart regeneration | (same as above) |
| 20 | Neural development I | Organization of the CNS and PNS Glia Subtypes of sensory and sympathetic nerves Axon guidance and establishment of innervation patterns Featured correlate: Hirschprungs syndrome Spinal reflex circuits | Moore chapter 17 pp 380-418 (all) Gilbert chapter 10 pp 347-358 Gilbert chapter 11 pp 396-407 |
| 21 | Midterm 2 |  |  |
| 22 | Neural development II | Hindbrain specification and differentiation Midbrain and forebrain organization Cerebral differentiation | (same as above) |
| 23 | Limb development | Specification of limb domain Function of the AER DV, AP, and PD axes in the limb Featured correlate: variation in limb morphology | Moore chapter 16 pp 364-379 (all) Gilbert chapter 14 pp 490-516 (all) |
| 24 | Skeletal development | Bone and cartilage progenitors Intramembranous and endochondrial ossification Origins of cranial bones Axial and appendicular skeleton Formation of joints | Moore chapter 14 pp 338-356 (all) Gilbert chapter 12 pp 432-436 |
| 25 | Skeletal and smooth muscle development | Review of somite differentiationSkeletal muscle subtypesMuscle regeneration via satellite cellsSmooth muscle differentiation | Moore chapter 15 pp 357-363 (all)(Gilbert chapter 12 pp 415-428 from above) |
| 26 | Skin and hair development | Review of ectoderm/epidermis and dermis specification Epidermal differentiation Formation of hair follicles Skin stem cells Melanocytes Featured correlate: melanoma Additional glands of the skin | Moore chapter 19 439-456 (all) Gilbert chapter 10 pp 367-372 |
| 27 | Eye development | Induction of the lens and cornea Differentiation of retinal neurons Origin of retinal pigmented epithelium Featured correlate: macular degeneration | Moore chapter 18 pp 420-430 Gilbert chapter 3 pp 79-81 Gilbert chapter 10 pp 359-367 |
| 28 | The evolution of developmental programs | Historical views of comparative embryology How variation can be achieved Examples of variation in developmental modules between species Integration of multiorgan morphogenesis | Gilbert chapter 20 pp 689-716 (all) |
| 29 | Special topic: Epithelial-mesenchymal transformation in embryonic development | General description Gastrulation Heart valve morphogenesis Neural crest delamination Cancer | (Review sections of Gilbert previously assigned: chapter 3 pp100-102, chapter 13 pp 457-460, chapter 11 pp 375-380) |
| 30 | Special topic: Cell-cell communication in embryonic development | Formation of the inner cell mass Notochordal secreted factors BMPs and TGFbs Gradients | (Review sections of Gilbert previously assigned: chapter 3 (all), chapter 9 pp 298-314) |
| FINAL |  | **Date:** For the date and time of the final for this class, consult the USC *Schedule of Classes* at [www.usc.edu/soc](http://www.usc.edu/soc). |  |

**Statement for Students with Disabilities**

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. Website and contact information for DSP: http://sait.usc.edu/academicsupport/centerprograms/dsp/home\_index.html, (213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX) [ability@usc.edu](mailto:ability@usc.edu).

**Statement on Academic Integrity**

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one’s own academic work from misuse by others as well as to avoid using another’s work as one’s own. All students are expected to understand and abide by these principles. *SCampus*, the Student Guidebook, ([www.usc.edu/scampus](http://www.usc.edu/scampus) or <http://scampus.usc.edu>) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

**Emergency Preparedness/Course Continuity in a Crisis**

In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies.