OEB 173 - Comparative Biomechanics

Spring 2016: MWF, 1-2 PM
Oceanography Seminar Rm (2nd Fl) MCZ Agassiz Hall entrance (see map on last page)

Professor: Andrew Biewener (AB; biewener@fas.harvard.edu, office: MCZ Room 1)
Teaching Assistant: Mary Salcedo (MS; maryksalcedo@gmail.com, office: Pierce 405)

Class Schedule:

Date	Prof	Class topic	Assignment due
M Jan 25	AB	**Lect #1:** Introduction to biomechanics: jumping right in! **Reading**: Physics review sheets (if needed)	
W Jan 27	AB	**Lect #2:** Terrestrial locomotion 1: Ground reaction forces & CoM mechanics linked to moving with limbs. **Reading**: Biewener - Ch 3	
F Jan 29	AB	**Lect #3:** Terrestrial locomotion 2: Inverse dynamics & joint moments; legged robotics & remote sensing of field locomotion.	
M Feb 1		**Lect #4:** Muscle 1: Mechanics of force production. **Reading:** Schmidt-Nielsen – Ch 10 (p 402-425) (Problem Set 1 posted)	
W Feb 3	AB	**Lect #5:** Muscle 2: Motor control of movement.	
TBD	**AB & MS**	**LAB/ACTIVITY 1: Terrestrial Locomotion: kinematics & force plate recordings** (NWL 258)	
F Feb 5	**MS**	**Discussion 1:** Lecture topics #1-5 & Problem Set 1	
M Feb 8	AB	**Lect #6:** Biological materials and properties: stress, strain & stiffness. **Reading:** Vogel – Ch 4 (p 65-67); Ch 15; Ch 16 (p 325-334, 341-351) & Wainwright – Ch 2 (p 6-15)	Problem Set 1
W Feb 10	AB	**Lect #7:** Biomaterials continues & Fracture (Composite Material Design) **Reading:** Vogel – Ch 16	
F Feb 12	**MS**	**SEMINAR 1:** (Paper Discussion) Terrestrial locomotion & muscle mechanics	

M Feb 15		**NO CLASS**	
W Feb 17	AB	**Lect #8:** Fracture & Viscoelasticity 1: Time-dependent properties of materials. **Reading:** Vogel – Ch 17 (Problem Set 2 posted)	Lab Report ACTIVITY 1
F Feb 19	**MS**	**Discussion 3:** Lecture topics #7 & 8 & Problem set 2	
M Feb 22	AB	**Lect #9:** Viscoelasticity 2 Wainwright - Ch 2 (p 25-39)	
M Feb 22	**AB & MS**	**SEMINAR 2:** (Paper Discussion) Biological materials and their functional roles.	
W Feb 24	AB	**Lect #10:** Biological structures: shape, stress distributions and scaling. **Reading:** Vogel – Ch 18	Problem Set 2
F Feb 26	**MS**	**Discussion 4:** Lecture topics #9&10	
M Feb 29	AB	**Lect #11:** Complex structures; safety factors & optimal design. **Reading:** Vogel – Ch 25 (p 497-501); Alexander (1981); Further reading: Currey – Ch 10 (Problem Set 3 posted)	
M Feb 29	**AB & MS**	**LAB/ACTIVITY 2: Biomechanics of complex structures & safety factors - Instron materials testing** (Pierce Hall)	
W Mar 2	AB	**Lect #12:** Whole body mechanics: bone, cartilage & tendon loading. **Reading:** Biewener – Ch 6	
F Mar 4	**MS**	**Discussion 5:** Lecture topics #11&12 & Problem Set 3	Lab Report ACTIVITY 2
M Mar 7	AB	**Lect #13:** Forces of flow I: energy, momentum & Bernoulli's eq. **Reading:** Vogel – Ch 5 & 6	Problem Set 3
M Mar 7	**AB & MS**	**SEMINAR 3:** (Paper Discussion) Vertebrate limb mechanical advantage (scaling & musculoskeletal stress) HMNH Mammal Hall	**TBD**
W Mar 9	AB	**Lect #14:** Forces of flow II: pressure, drag & Reynolds number. **Reading:** Vogel – Ch 7	

F Mar 11	**MS**	**Discussion:** Lecture topics #13&14	
Mar14-18		**Spring Break**	
M Mar 21	**Guest** G Clifton	**Lect #15:** Lift: force coefficients and circulation. **Reading:** Vogel – Ch 12 (Problem Set 4 posted)	
W Mar 23	**Guest** G Clifton	**Lect #16:** Soaring & gliding **Reading:** Vogel – Ch 12	
F Mar 25	**AB & MS**	**Discussion 5:** Lecture topics #15&16 & Problem Set 4 **Poster Topics - Initial Discussion**	Lab Report ACTIVITY 3
M Mar 28	AB	**Lect #17:** Thrust and flapping flight **Reading:** Vogel – Ch 13	Problem Set 4
M Mar 28	**AB & MS**	**SEMINAR 4:** (Paper Discussion) Pressure, lift and drag in steady flow	
W Mar 30	AB	**Lect #18:** Unsteady force production in flight	
F Apr 1	**AB &MS**	**COMSOL Fluid Mechanics Activity 3 (SEAS lab area)**	
M Apr 4	Rob Wood SEAS	**Lect #19:** Aerial biorobotics (Guest)	
W Apr 6	AB	**Lect #20:** Swimming: aquatic locomotion at high Re numbers. **Reading:** Vogel – Ch 13	
F Apr 8	**MS**	**Discussion 6:** Lecture topics #19&20	
M Apr 11	AB	**Lect #21:** Locomotion at low Reynolds numbers **Reading:** Vogel – Ch 11	Poster Topic Due
M Apr 11	**AB & MS**	**SEMINAR 5:** (Paper Discussion) Unsteady fluid locomotion (flight & swimming)	
W Apr 13	George Lauder OEB	**Lect #22:** Fish swimming and biorobotics (Guest)	
F Apr 15	**AB & MS**	**ACTIVITY 4 - Locomotion in fluids (or move to 4/18)**	
M Apr 18	AB	**Lect #23:** Internal flows: Vessels & flow of blood, mucus etc. (Problem Set 5 posted)	
M Apr 18		**Alternate date for ACTIVITY 4 - Locomotion in fluids**	

W Apr 20		**Lect #24:** Locomotion at the air:water interface. **Reading:** Vogel – Ch 14	
F Apr 22	**MS**	**Discussion 8:** Lecture topics #24 & 24; Problem Set 5	Lab Report ACTIVITY 4
M Apr 25	**AB**	**Lect #25:** Mystery Lecture (Plant biomechanics: prey capture and spore ejection?)	Problem Set 5
M Apr 25	**AB & MS**	**SEMINAR 6:** (Paper Discussion) Unsteady fluid locomotion – (swimming & circulation)	
W Apr 27		No Class in lieu of CFS Laboratory Field Trip & Lunch or Dinner	
Tue May 3 (11	**AB & MS**	CFS Laboratory Field Trip, Poster Session; Lunch or Dinner (Reading period) **11A-5P**	**Poster Presentation**
Th May 5		(Exam period begins)	