

# HST.090 Cardiovascular Pathophysiology Syllabus

## Spring 2019

**Course Directors:** Elazer R. Edelman  
([ere@mit.edu](mailto:ere@mit.edu))  
Steven P. Keller  
([spkeller@mit.edu](mailto:spkeller@mit.edu))

**Course Instructors:** Brian Y. Chang  
([bychang@mit.edu](mailto:bychang@mit.edu))  
Aditya S. Kalluri  
([askallur@mit.edu](mailto:askallur@mit.edu))

**Course Assistants:** Fiona Macleod ([macleodf@mit.edu](mailto:macleodf@mit.edu))  
Max Olender ([molender@mit.edu](mailto:molender@mit.edu))

**Course Staff Contact:** [hst090staff@mit.edu](mailto:hst090staff@mit.edu)

**Anonymous Feedback:** <http://goo.gl/jdGSsz>

**Course Website:** <https://canvas.hms.harvard.edu>

### Description:

HST 090 builds on Anatomy (HST 010) and Pathology (HST 030) to introduce the student to the physiology, pathology, and pathophysiology of the heart and vascular system. Structure-function relationships, the application of physics and engineering to cardiac physiology, molecular mechanisms, and clinical correlates will be thoroughly discussed in the context of normal and abnormal cardiovascular states.

The course is held at MIT in **4-270** on Mondays (8:30-12:00), Wednesdays, and Fridays (11:00-12:30) from February 4<sup>th</sup> to May 17<sup>th</sup>. The course is built around weekly laboratory or case sessions that will introduce concepts that will be further reinforced in the subsequent lectures that week. Weeks without a case or lab will have an **exam-style** problem set with reading questions that are to be completed **independently**.

There are seven labs and five cases of varying complexity and length. Each case and lab requires significant preparation by the course staff. As such, it is expected that the students come prepared. Students will have online access to all material prior to each session and will be expected to (1) complete the readings and review the protocol/case in detail, (2) independently research some detail of the lab/case, and (3) submit answers for any included questions. A student will receive a 0 if found to have not been prepared for a session.

### Philosophy:

Students are expected to learn how to think about and address problems in cardiovascular medicine and research. The course is designed to help students develop a broad, integrative picture of cardiovascular structure, normal function, pathophysiological mechanisms, pathology, clinicopathological correlations, and treatment modalities. Understanding general concepts and mechanistic underpinnings are strongly emphasized over memorization of the specifics or lists of diseases, genes and molecules of signaling pathways, and pharmacologic treatments.

**Students are expected to spend a significant amount of time learning and thinking about material before class.** The case, lab, and lectures are geared toward more complex questions and issues. **Students must be prepared to answer and discuss questions and fully participate.**

### Class Organization:



The course is built around the weekly Monday laboratory or case sessions that will introduce concepts that will be further reinforced in the subsequent lectures that week. In most weeks, the topics in the case or lab are new and will be further discussed on the Wednesday and Friday lectures. **Consequently, preparation for these Monday sessions is critical!** Please complete any reading and questions ahead of time.

### *Lab Sessions*

Laboratory sessions include experiments to introduce cardiovascular concepts, pathology sessions to allow students to study and discuss specimens, and a mammalian laboratory to demonstrate the cardiovascular system in a live animal. Laboratory and case sessions are **mandatory** and take place on Mondays except for the mammalian lab. The beginning of these labs will have a short introductory lecture with time to ask any questions. The lab will take the remainder of the class day and will conclude with a brief overview and conclusion by one of the course instructors. Before the lab, students are expected to review the protocol, complete the pre-lab reading assignments, and submit answers to the pre-lab questions. After the lab, students will complete a report that: (1) briefly summarizes the lab, (2) includes any data that is collected, (3) discusses the data and any interesting findings, and (4) answers the post-lab questions. This report will be due on the Friday of the same week. **Reports can be worked on collaboratively but are submitted individually.**

The OPTIONAL mammalian laboratory is scheduled from 8:30 - 5:00 on either May 1<sup>st</sup> or 3<sup>rd</sup>. There is no lecture on the day you are not in this lab. More information about the Mammalian Lab will be posted separately.

### *Case Sessions*

Case sessions will not only introduce an underlying pathology that will be discussed in the following lectures, but also basic engineering and physiologic concepts that are applied clinically in that case. There will be five cases this semester that introduce new topics or reinforce fundamentals from prior sessions or lectures. Prior to the class it is expected that each student thoroughly reviews the case and attempts to independently research any new or unknown concepts. Please come to each session prepared to discuss the details of the case and the included questions. A brief summary of the case and an attempt at all the questions should be submitted online prior to the case session. This will be graded on effort and insight rather than correctness.

The case session will take place in the normal lecture hall and will be led by a single faculty preceptor who may randomly call on students to help guide the class. During a case session, the class will be periodically split into smaller groups that will work together to answer graded questions about the case. Often, these questions will go beyond technical problems to include ethical quandaries and other practical applications. Instructors and TA's will circulate between the groups to facilitate discussions and answer any questions.

After completing the session, each group will have time to meet to discuss the case and post-case review questions; instructors and TA's will be circulating to provide guidance. After this discussion period, the faculty preceptor will lead a case review by calling on students from different groups to answer these questions to help review and synthesize the entire case. After each case section **students will individually write a case report** including details of the case, conclusions, and answers to the case questions. There is no set format for this case report, however it must include details that are not included in the disseminated slides. Please include interesting topics that were discussed in the reviews or lectures that week. This report will be due on the Friday of the same week.

### *Problem Sets*

Two weeks have no Monday lab or case session. For these weeks an exam-style problem set will be due on Friday. **These problem sets must be completed individually.** While problem sets are completed without collaboration, other resources may be used if properly cited.

### *Mammalian Laboratory Report*

The mammalian laboratory report consists of two sections. A set of predictions will be due the day of the

laboratory and graded. A final mammalian laboratory group report is due on May 14<sup>th</sup> with figures due on May 9<sup>th</sup>. More details will be provided in the mammalian laboratory preparation session.

### **Class Polling and Participation:**

We will use a cloud-based polling software (Poll Everywhere) that enables students to use their electronic devices to answer preparation questions and lecture questions in real time so that instructors can obtain rapid feedback on student comprehension. Responses will be recorded for each student to evaluate participation and anonymously collated to display class performance as a whole. Please register for a free account based on the instructions posted on Canvas.

### **Evaluation:**

Course preparation and report components will initially be graded on a 0/0.5/1 basis. **The reading for the course is significant so it is important to keep up to date each week.** Furthermore, questions in labs, cases, and problem sets are meant to stimulate thought and to direct reading; while some questions may be found directly in the text, others are intended to encourage critical thinking and synthesis of key concepts. Attempts for all questions should be submitted in the appropriate format based on the corresponding session.

Preparation	20%
Reports	40%
Problem Sets	15%
Final Examination	25%

Attendance and participation in all lectures and laboratories are mandatory to pass HST 090. PASS / FAIL. Please talk to a member of the course staff if you are going to miss a class. The designation of HONORS will be determined by quality of classroom participation.

### **Examinations:**

There will be no midterm examination. A final examination will be held on May 22<sup>nd</sup>.

## **Course Topics Overview:**

- I. Anatomy and Physiology
  - a. Anatomy
  - b. Cardiac Cycle
  - c. Metrics of Cardiac Function
  - d. Excitation Contraction Coupling
  - e. Electrophysiology
  - f. Congenital Heart Defects
- II. Hemodynamics
  - a. Blood Pressure
  - b. Hemodynamic Monitoring
  - c. Exercise Physiology
- III. Pathology
  - a. Pericardial Disease
  - b. Atherosclerotic Disease
  - c. Ischemic Disease
  - d. Peripheral Vascular Disease
  - e. Heart Failure
  - f. Arrhythmias
  - g. Valvular Disease
  - h. Pulmonary Vascular Disease
- IV. Translational Topics
  - a. Pacemakers and Defibrillators
  - b. Interventional Cardiology
  - c. Anticoagulation
  - d. Women's Health
  - e. Transplantation

A more detailed schedule and specific lecture sequence can be found on the course website.

**Resources:***Required Reading:*

1. Lilly, Leonard. (2010). Pathophysiology of Heart Disease. 5<sup>th</sup> or 6<sup>th</sup> Ed. Lippincott Williams & Wilkins. \*\* ISBN 978-1605477237 (5th) or 978-1-4511-9275-9 (6th)

*Suggested Reading:*

1. Koeppen Bruce M., Stanton Bruce A. (2009). Berne & Levy Physiology. 6th or 6e Ed. Mosby Inc. \*\* ISBN 978-0-323-04582-7 (6<sup>th</sup>) or 978-0323073622 (6e)
2. Kumar, Vinay. Fausto, Nelso. and Abbas, Abul. (2009). Robbins & Cotran Pathologic Basis of Disease. 8<sup>th</sup> Ed. W. B. Saunders Company. \*\* ISBN 978-1416031215

*Optional References:*

1. Opi, Lionel H. (1998). The Heart: Physiology, from Cell to Circulation. 3<sup>rd</sup> Ed. Lippincott, Williams, & Wilkins Publishers.
2. Braunwald, Eugene. (2012) Heart Disease: A Textbook of Cardiovascular Medicine. 9<sup>th</sup> Ed. W. B. Saunders Company.
3. Levy, Matthew, and Pappano, Achilles. (2007). Cardiovascular Physiology. 9<sup>th</sup> Ed. Mosby- Yearbook Incorporated.
4. The Department of Medicine, Washington University School of Medicine. (2010). The Washington Manual of Medical Therapeutics. 33rd Ed. Lippincott, Williams, & Wilkins Publishers.

The course website contains information pertinent to the course, additional readings not found in the textbooks, lecture slides, problem sets, cases, and other useful handouts (usually in .pdf formats).

Although all HST graduate and medical students should be familiar with the Canvas website, we realize that some students may not immediately have access. Please talk with the course teaching assistants or other staff if you have difficulty accessing the course website.