VTPP 657: CARDIOVASCULAR PHYSIOLOGY

Course Information:
Current Number: VTPP 657
Term: Fall 2014
Credit hours: 4
Meeting location: VMA 300D
Meeting Times: MWF 11:30-12:20
Textbook: None

Instructor Information:
Christopher Quick, Ph.D.
Telephone number: 979-845-2645
Email address: cquick@tamu.edu
Office hours: TBA

Prerequisites: None.

Course Description (VTPP 657): Physiological considerations of the circulatory system including general and integrative aspects of the heart and blood vessels.

UNIQUE NATURE OF COURSE
This course is designed so that you learn the basics of cardiovascular physiology while performing authentic cardiovascular research. The cardiovascular system exhibits complex, adaptive behavior that emerges from the interaction of its parts. By stepping you through the deductive approach I use to perform research with mathematical models, you will discover for yourself how the behavior of the cardiovascular system arises from a small set of fundamental principles. Occasionally, you will develop an understanding of how the cardiovascular system works that is consistent with what is found in textbooks, and you will have “re-discovered” existing knowledge. More often you will encounter conflict between your understanding (refined by computer simulations based on chemistry, physics, and math) and what is found in textbooks. This conflict is valuable, because you will have discovered new knowledge, and experience cardiovascular physiology as a living science instead of a fossilized history. The first half of the course will focus on discovery, the second half on producing research.

FOCUS ON RESEARCH LEADERSHIP
A rare and missing component of graduate education is training to lead a multidisciplinary team of scientists, many of whom have knowledge and skills you lack. To increase the probability of creating research products and to gain marketable leadership skills, you will have the opportunity to lead a multidisciplinary team of DeBakey Undergraduate Research Scholars. If undergraduate students are not available, you will work in teams of other graduate students.
STRUCTURE OF COURSE

Flipped class: We will use a “flipped class” model in which short video lectures are watched at home and team projects are completed in the classroom.
  • Spend class time doing research
  • Maximize meaningful contact with experts

Team-based approaches: All projects will be performed in teams
  • Lead a team of undergraduates interested in creating research projects
  • Gain marketable leadership skills.

Systems approach with models: You will use established mathematical models to explore how the parts of the cardiovascular system interact, yielding complex, emergent behavior.
  • Use a customized computer lab to model without having to program
  • Simulate diseases, compensatory mechanisms, and clinical interventions

Learning by doing research: We will not “teach” you cardiovascular physiology with a series of lectures. Instead, we will perform real research and in the process learn physiology.
  • Direct your own learning and teach each others
  • Minimize the simple transfer of knowledge from textbook.

Scaffolding the discovery process in phases: The class is divided into four distinct phases, each of which is designed to scaffold the discovery process.
  • Quickly introduce you to the bare minimum knowledge to begin research
  • Transition from training/discovery in first half to production of research in second half
TEAM PROJECTS

PHASE I (2 weeks) BREAK THE CARDIOVASCULAR SYSTEM: Work with a team to explore research-grade cardiovascular models to discover how the mechanical properties of the cardiovascular system interact to yield blood and interstitial pressures, volumes and flows.

1a Predict genesis of disease process: Use concept sensitivity analysis to identify changes in parameters that result in abnormal pressures, volumes, or flows.

1b Define at risk populations: Explore parameter covariance to determine how different baseline parameters cause disparate impact on disease processes.

1c Find nonintuitive results: Identify nonintuitive results by comparing your guess of results prior to simulation to actual simulation results.

Product: A chart tabulating results and a few paragraphs highlighting interesting results.

Phase II (2 weeks) ESTABLISH HOMEOSTASIS: Work with your team to generate hypotheses of how a set of compensatory mechanisms might maintain homeostasis with failure of one component of the cardiovascular system. Each team will be assigned a different type of failure.

2a Discover compensatory mechanisms: Vary parameters to predict physiological processes (or clinical interventions) that result in pressure, flow and volume homeostasis when the component begins to fail.

2b Determine cost of compensation: Determine costs of compensation in terms of effects on blood and interstitial pressures, volumes and flows.

2c Select research strategies: Select a set of strategies to determine whether predictions are correct and/or novel.

Product: A 10-slide conference presentation in PowerPoint highlighting your results.

PHASE III (3 weeks) IDENTIFY DISEASES AND CHALLENGE PARADIGMS: Work with your team to determine if your model predicted established symptoms and treatments of a particular disease (i.e., education) or conflicted with the literature and created new knowledge (i.e., research).

3a Evaluate predictions: Evaluate relevance of model results by identifying physiological mechanisms (or clinical interventions) that would yield the predicted behavior.

3b Evaluate novelty: Evaluate novelty of the your predictions, explanations of observed behavior, and challenges of standard assumptions.

3c List relevant references: Evaluate your knowledge deficit and the knowledge deficit of the scientific community and choose relevant learning materials and scientific references that provide evidence for your arguments.

Product: A project pre-proposal (2 pages and <1 page references) in form of Predoctoral Fellowship Grant arguing your initial results are promising to produce a novel education tool or novel research.

MIDTERM: EVALUATION OF PRE-PROPOSALS: Review, score, and provide written feedback for 3 pre-proposals using American Heart Association evaluation criteria. Projects evaluations will be debated in Counsel. Roughly half will be selected for advancement.

PHASE IV (7 weeks) RESEARCH: With your new team, create a viable research project for the DeBakey Institute and potentially prepare for publication.

4a Create a team: Create a team of experts including undergraduates with specific skills and faculty with relevant interests address the final project.

4b Develop novel research plan: create a novel research plan using mathematical modeling and analysis of previously-reported data.

4c Design a research management plan: Create a plan for a managing a research project, including evaluating and training a future research team.

Product: A 3-page research proposal in style of American Heart Association Predoctoral Fellowship Grant (with an additional 1 page of references). If project advances sufficiently, produce an abstract for submission to a national engineering or life science conference.
GRADING

Team Products (50% total grade). Working in a multidisciplinary team to produce research and communicate the results is half the challenge of cardiovascular physiology research. You are therefore expected to fully participate in developing team products. Projects will be graded by based on whether products were useful and increased the collective knowledge of the class (education) or the collective knowledge of the scientific community (research). The points you receive for a project will be weighted by your relative participation in your team, as indicated by your teammates.

- Team Project I (5 points)
- Team Project II (10 points)
- Team Project III (15 points)
- Team Project IV (30 points)

Providing Constructive Criticism (50% total grade). Critically assessing research products and providing constructive criticism is the other half of the challenge of cardiovascular physiology research. You are therefore expected to participate in the class by rating and providing constructive feedback to the video lectures and the team products. Those receiving constructive criticism will grade you based on the usefulness of your suggestion.

- Provide constructive feedback to video lectures (10 points)
- Provide constructive feedback to team projects (50 points)

Composite Grade. Grading will be based on developing your team’s products (50%) and enhancing the products of the rest of the class (50%). Although it is theoretically possible to earn up to 120 points, the projects can be difficult, and the standards for earning points for participation are high. To compensate for a very real potential for failure when taking risks to create new knowledge, and recognizing that there are multiple ways to achieve excellence in open-ended academic endeavors, you only need to accumulate 90 points to earn an A. If you wish to challenge any particular grade you received from your peers, the instructor will cancel that grade, and the instructor will assign a new grade according the rigorous standards of the scientific community.

- >89 points A
- 80-89 points B
- 70-79 points C
- 60-69 points D
- <60 points F
PARTICIPATION AND FEEDBACK GRADING RUBRIC

Participate in teams (weighting percent effort of team products): Your teammates will assign a percent effort for developing each of the team products. If your personal score for a team product is weighted by your percent effort. Example: Your team received 13 points for the report for Phase III. You are in a team of 3. Your team estimated that you put in 45% of the total effort to create the presentation. Your personal score for the team = 13 points X 0.45/0.33 = 18 points.

Watch lectures (10 points maximum): Submit at least 1 novel question, suggestion or constructive criticism per assigned video. The instructor will assign credit for each video comment based on a simple criterion: Is it clear how post can lead to increased efficiency or effectiveness of video. 2 points per useful comment.

Provide constructive feedback (50 points maximum): Post online constructive suggestions for each of the other teams’ products after each of the four phases, including midterm evaluation. The constructive suggestions to improve the product will be graded by the instructor.

0-2 The suggestions were not useful, the criticisms were not insightful, and there is little evidence that the reviewer actually looked at the team’s product.

3-6 Some of the criticisms were insightful, but there were no useful suggestions that could be implemented if students were asked to rework the product. They would at least know what needs changing.

6-9 The criticisms were insightful and informative, and they should have a good idea what they need to change. The suggestions were useful enough to implement if they were asked to rework the product.

10 The criticisms and suggestions were so useful, there was a significant contribution to the science. The reviewer should get credit as a co-author if the work eventually gets published.

Learning Outcomes: This course is designed to encourage refinement of higher-order thinking skills (Cognitive Process Dimension) applied to higher-order knowledge (Knowledge Domain). The learning outcomes (underlined phrases in TEAM PROJECTS) can be mapped onto Bloom’s revised taxonomy of educational objectives (Anderson and Krathwohl, 2001).
**Attendance Policy:** (See Student Rule 7: http://student-rules.tamu.edu/rule07) “The university views class attendance as an individual student responsibility. Students are expected to attend class and to complete all assignments...If the student is seeking an excused absence, the student must notify the instructor as soon as possible after the absence, but no later than the end of the second working day after the last date of absence.” Extensions to deadlines will only be given for excused absences.

**Classroom Communication:** The university has established a formal process for handling of student grievances associated with any course. If there are major concerns about the conduct of a course, which cannot be resolved by meeting with the Instructor, a Classroom Communication Concerns form should be completed and submitted to the appropriate department head. (This form is available in the VTPP Departmental Office, Room 332, VMA.)

**Aggie Honor Code:** “An Aggie does not lie or cheat or tolerate those who do.” Our conduct in this class should embody the spirit as well as the letter of the Aggie Honor Code. If you have any questions about the code or Honor Council and its Procedures, please consult the “Know the Code” website found at http://www.tamu.edu/aggiehonor.

**Americans with Disabilities Act (ADA) Policy Statement:** The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu.

**Special Note Concerning Individual Student Needs:** Whether or not you are registered with Disability Services, the Instructor has rooms available for those who need quiet to concentrate or flexibility to get up and move around. Attempts have been made to incorporate the principles of Universal Design in classroom activities and online resources (including subtitled videos). Computers are available that can be customized for particular student needs. The Instructor actively welcomes suggestions to make the class accessible, productive, and enjoyable for all students.
EXAMPLES OF FAILURES TO EXPLORE

High blood volume
High pulmonary resistance
High systemic resistance
High right ventricular stiffness
High left ventricular stiffness
Low systemic arterial compliance
Low right ventricular contractility
High pulmonary capillary permeability
Low systemic lymphatic pumping
High heart rate
Low systemic resistance (arterio-venous shunts)
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<td>Description of course</td>
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<td>Video 1&amp;2 Comments 9/5</td>
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<td>Closed loop system</td>
<td>Video 2: time—varying elastance</td>
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<td>Interstitial Fluid Balance</td>
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<td>Report Phase I</td>
<td>Video 4: microvasculature</td>
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<td>9/15-9/19</td>
<td>Predicting Homeostasis</td>
<td>Video 5: modeling methods</td>
<td>Video 5&amp;6 Comments 9/19</td>
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<td>II</td>
<td>9/22-9/26</td>
<td>Predicting Homeostasis</td>
<td>Video 6: balance points</td>
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<td>Report Phase II</td>
<td>Video 7: research fast-track</td>
<td>Video 7&amp;8 Comments 9/19</td>
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<td>Evaluating hypotheses</td>
<td>Video 8: how to make a video</td>
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<td>Evaluating hypotheses</td>
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<td>11/10-11/14</td>
<td>Evaluating Potential Projects</td>
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<td>IV</td>
<td>10/20-10/24</td>
<td>Create something new</td>
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