Nova Southeastern University
College of Osteopathic Medicine

Course Name:	**Medical Physiology I – Fall 2014**
Course Number:	**COM 5061**
Graduating Class:	**2018**
Discipline:	**Basic Science**
Course Type:	**Required**

Course Detail
Class/Semester: M1 Fall 2014
Course Registration Number (CRN): 22850
Dates: August 14, 2014 - December 12, 2014
Contact hours: 47
Credit hours: 3
Location: Steele Auditorium

Examinations:
In-Class Quiz, 8AM-9AM, 8/28/14
Examination 1, 9AM-11AM, 09/22/14
Examination 2, 8AM-10AM, 11/10/14
Examination 3, 9AM-11AM, 12/12/14

Course Director:
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Prerequisites
Matriculation into NSUCOM M1 curriculum

Syllabus
Syllabus is subject to change.

Course Description

This course reviews the physiological functions and regulation of the major human organ systems. Topics covered in the first semester include cell physiology, membranes and membrane transport mechanisms, electrophysiology, muscle physiology, the autonomic nervous system, and cardiovascular physiology.

Core Competency

This course addresses the applicable core competency of medical knowledge.

Course Goals

Upon the successful completion of this course the student will be able to describe the physical and chemical factors and processes responsible for maintenance of cell function, the development of electrical excitability, the contraction of muscle and the functioning of the autonomic and cardiovascular systems.

Examination and Grading Policy

This course adheres to the examination policy as stated in the NSU-COM student handbook except as modified below.

Examinations will be administered using ExamSoft (SofTest-M for iPad). Students must bring their own fully charged iPad equipped with the SofTest-M app for use at each quiz and exam. Examinations will be composed of 1-5 multiple choice questions from each lecture hour and/or reading assignment. The lecturers reserve the right to utilize other formats. There will be three examinations, each worth 100 points and weighted equally. All examinations are held in Steele Auditorium, unless you are notified of a different location. Students are required to take each examination at the scheduled time. During the examinations students are NOT permitted to use, or have in their possession, calculators, cell phones, MP3 players or any other electronic device that sends, receives, or stores information, other than the iPad used to take the examination. The use of any unapproved device by a student during the exam will result in a grade of zero for the exam and further disciplinary action as determined by the College of Osteopathic Medicine. Examinations will not be returned to students.

Quizzes: Quizzes will be posted on the course Blackboard site or on ExamSoft. **You should check the course Blackboard site regularly for announcements.** You will be sent an email notice that a quiz is available and the quiz deadline. The quiz deadline will usually be one week after posting. You are required to complete the quiz by the deadline. If you do not complete the quiz by the deadline you will receive a score of 0 for that quiz, no exceptions!!! The quiz deadline will be posted on the course Blackboard announcements. **Please remember to save your answers before submitting the quiz. Students forgetting to save answers before submitting the quiz, or submitting a quiz without answers, will receive a score of 0 for that quiz.** You are expected to answer the quiz questions on your own, using the textbook readings and lecture notes. Most quizzes will be worth 10 points, and the number will be posted in the quiz announcement. The Total Quiz Grade will be 10% of your final grade for the course. The Total Quiz Grade will be calculated as follows:

Total Quiz Grade = [(number of points correct on quizzes) / (Total possible quiz points)]

The course grade is calculated as follows:

Course Grade = {[(% exam 1 + % exam 2 + % exam 3) / 3] x 0.9} + (Total Quiz Grade x 0.1)

The passing grade for the course is 70%.

Make-up Examinations /Reexaminations/ Remediation

Students who miss an examination must notify the Course Director in writing using their NSU email within 24 hours of the missed examination or they will not be given a make-up examination, and will receive a grade of zero for the missed examination. Students must complete the make-up examination within 10 business days of the missed examination.

Reexaminations will not be given in this course.

Students who fail the course and who are deemed eligible for remediation by the College of Osteopathic Medicine will be given a remediation examination. The date and time of the remediation examination is determined by the College of Osteopathic Medicine. If the student scores a 70% or better on the remediation examination, their course grade will be changed to 70E.

Attendance

The attendance policy of the College of Osteopathic Medicine applies to this course. Students are expected to attend all lectures given in the course.

Course & Instructor Evaluation

Evaluation by the students of the course and instructors shall be carried out at the end of the course. The results will be presented to the Academic Curriculum Committee.

Resources

Required Textbooks

1. Boron, WF and Boulpaep, EL. Medical Physiology: A Cellular and Molecular Approach. Updated Second Edition. Saunders; 2012. ISBN: 978-1-4377-1753-2
   ebook link Medical Physiology: A Cellular and Molecular Approach

Other Required Resources: A TurningPoint Response Devise (iPad, Smart phone or "Clicker") should be brought to all lectures.

Graded course assessments (quizzes and exams) will be administered using ExamSoft (SofTest-M for iPad). Each individual student is responsible for maintaining appropriate iPad and software configurations for this purpose. It is the student's responsibility to ensure functionality (hardware, wireless network access, battery charge, etc) prior to each assessment. Students should contact ExamSoft at support@examsoft.com or 1-866-429-8889 for issues and technical support.

Recommended Textbooks:

1. Barrett, K.E., Barman, S.M., Boitano, S., Brooks, H.L. Ganong's Review of Medical Physiology. 24th Edition. McGraw-Hill Medical/Lange; 2012. Ganong's Review of Medical Physiology. 24th Edition
2. Levick, JR. An Introduction to Cardiovascular Physiology. 4th ed. Oxford University Press; 2003
3. Koeppen, BM, and Stanton, BA. Berne & Levy Physiology. 6th ed. Mosby; 2008 Berne & Levy Physiology
4. Klabunde, RE. Cardiovascular Physiology Concepts. Book & CD, Lippincott Williams & Wilkins; 2004
5. Mohrman, DE, Heller, LJ. Cardiovascular Physiology 6th ed. McGraw-Hill/Appleton & Lange; 2006
6. Blaustein, MP, Kao, JPY, and Matteson, DR. Cellular Physiology and Neurophysiology. 2nd Edition. Elsevier/Mosby; 2012.

Independent Assignments

Additional readings may be added at any point in the course. Selected readings from the primary literature or other sources may be provided to supplement or replace the textbook readings. There may be weekly reading assignments. It is the student's responsibility to read the assigned material prior to attending class. Course content will be delivered using a variety of teaching and learning methods including lectures, in-class and online discussions, assigned readings, self-study modules, and assignments. Class meetings will consist predominantly of lectures and informal open discussions.

Blackboard: http://Blackboard.nova.edu will be utilized to provide and supplement course materials; to conduct online discussions; and to provide links to resources. (Students are encouraged to complete the Blackboard Tutorial and Quiz within the first week of the course). All course handouts and information will be available to students through Blackboard. Handouts will not be provided in class. All course materials will be provided in Adobe Portable Document Format. Adobe Acrobat Reader and Power Point Viewer can be downloaded free at:
http://www.adobe.com/products/acrobat/readstep2.html, and
http://www.microsoft.com/downloads/details.aspx?familyid=048dc840-14e1-467d-8dca-19d2a8fd7485&displaylang=en.

Course announcements will be made either in class, on Blackboard, or NSU email. Students are responsible for accessing and responding to all information disseminated.

Faculty

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COURSE SCHEDULE

Name	Location	Date	Start Time	End Time	Instructor
1. Introduction to Medical Physiology/Cell Membranes and Diffusion	Steele Auditorium	8/14/14	9:10	10:00	Taraskevich
2. Osmosis	Steele Auditorium	8/14/14	10:10	11:00	Taraskevich
3. Protein Mediated Transport	Steele Auditorium	8/21/14	9:10	10:00	Taraskevich
4. Transepithelial Transport	Steele Auditorium	8/21/14	10:10	11:00	Taraskevich
5. Ion Permeation & Equilibria	Steele Auditorium	8/26/14	8:10	9:00	Taraskevich
In-Class Quiz	Steele Auditorium	8/28/14	8:00	9:00	
6. Resting Potential	Steele Auditorium	9/2/14	1:10	2:00	Taraskevich
7. Action Potential Production	Steele Auditorium	9/2/14	2:10	3:00	Taraskevich
8. Action Potential Conduction	Steele Auditorium	9/9/14	8:10	9:00	Taraskevich
9. Neuromuscular Junction	Steele Auditorium	9/10/14	10:10	11:00	Taraskevich
10. Molecular Basis of Skeletal Muscle Contraction	Steele Auditorium	9/10/14	11:10	12:00	Taraskevich
11. E-C Coupling in Skeletal Muscle	Steele Auditorium	9/11/14	10:10	11:00	Taraskevich
12. Skeletal Muscle Mechanics and Energy Sources	Steele Auditorium	9/15/14	10:10	11:00	Taraskevich
13. Smooth Muscle	Steele Auditorium	9/15/14	11:10	12:00	Taraskevich
14. Synapses between Neurons	Steele Auditorium	9/18/14	9:10	10:00	Taraskevich
15. Neurotransmitters	Steele Auditorium	9/18/14	10:10	11:00	Taraskevich
Examination I	Steele Auditorium	9/22/2014	9:00	11:00	
16. Autonomic Nervous System I	Steele Auditorium	9/26/14	1:10	2:00	Zagvazdin
17. Autonomic Nervous System II	Steele Auditorium	9/29/14	8:10	9:00	Zagvazdin
18. Autonomic Nervous System III	Steele Auditorium	10/3/14	1:10	2:00	Zagvazdin
19. Cardiovascular System Overview	Steele Auditorium	10/3/14	2:10	3:00	Mayrovitz
20. Cardiac Output and Distribution	Steele Auditorium	10/8/14	11:10	12:00	Mayrovitz
21. Vascular Structure and Function	Steele Auditorium	10/9/14	9:10	10:00	Mayrovitz
22. Blood Flow, Pressure and Resistance I	Steele Auditorium	10/9/14	10:10	11:00	Mayrovitz
23. Blood Flow, Pressure and Resistance II	Steele Auditorium	10/14/14	9:10	10:00	Mayrovitz
24. Vascular/Cardiac Compliance and Mechanics I	Steele Auditorium	10/14/14	10:10	11:00	Mayrovitz
25. Vascular/Cardiac Compliance and Mechanics II	Steele Auditorium	10/17/14	8:10	9:00	Mayrovitz

26. Cardiac Electrical Activity I	Steele Auditorium	10/17/14	9:10	10:00	Mayrovitz
27. Cardiac Electrical Activity II	Steele Auditorium	10/20/14	9:10	10:00	Mayrovitz
28. Cardiac Electrical Activity III	Steele Auditorium	10/20/14	10:10	11:00	Mayrovitz
29. Cardiac Electromechanical Activity	Steele Auditorium	10/21/14	8:10	9:00	Mayrovitz
30. Determinants of Cardiac Pump Function	Steele Auditorium	10/28/14	8:10	9:00	Mayrovitz
31. Cardiac Cycle	Steele Auditorium	10/30/14	11:10	12:00	Mayrovitz
Examination 2	Steele Auditorium	11/10/14	8:00	10:00	
32. Cardiac Pressure-Volume Loops	Steele Auditorium	11/4/14	8:10	9:00	Mayrovitz
33. Cardiac Sounds and Murmurs	Steele Auditorium	11/13/14	9:10	10:00	Mayrovitz
34. Cardiac Pump Failure and Hemodynamics	Steele Auditorium	11/13/14	10:10	11:00	Mayrovitz
35. Arterial Pressures	Steele Auditorium	11/17/14	1:10	2:00	Mayrovitz
36. Arterial Pulse Propagation and Reflection	Steele Auditorium	11/20/14	9:10	10:00	Mayrovitz
37. Microcirculation	Steele Auditorium	11/20/14	10:10	11:00	Mayrovitz
38. Lymphatic and Venous System Function	Steele Auditorium	11/4/14	1:10	2:00	Mayrovitz
39. Peripheral Vascular Controls I	Steele Auditorium	11/4/14	2:10	3:00	Mayrovitz
40. Peripheral Vascular Controls II	Steele Auditorium	11/4/14	8:10	9:00	Mayrovitz
41. Cardiovascular Controls and Reflexes I	Steele Auditorium	11/4/14	9:10	10:00	Mayrovitz
42. Cardiovascular Controls and Reflexes II	Steele Auditorium	12/1/14	1:10	2:00	Mayrovitz
43. Cardiac-Vascular Coupling and Interactions	Steele Auditorium	12/1/14	2:10	3:00	Mayrovitz
44. Features of Specific Circulations I	Steele Auditorium	12/2/14	10:10	11:00	Mayrovitz
45. Features of Specific Circulations II	Steele Auditorium	12/2/14	11:10	12:00	Mayrovitz
46. Clinical Correlations 1-3	Steele Auditorium	12/4/14	9:10	10:00	Mayrovitz
47. Clinical Correlations 4-6	Steele Auditorium	12/4/14	10:10	11:00	Mayrovitz
Examination 3	Steele Auditorium	12/12/2014	9:00	11:00	

The instructors reserve the right to amend the syllabus and course schedule as required. All changes will be posted on the course Blackboard website, and announced in class.

COURSE OBJECTIVES

*Each lecture has a reading assignment, in addition to the handouts, listed before the lecture objectives. All chapters assigned in the reading assignments for each lecture are from Boron, WF and Boulpaep, EL. Medical Physiology: A Cellular and Molecular Approach. Updated Second Edition. Saunders; 2012. ISBN: 978-1-4377-1753-2. Page numbers in eBooks may differ slightly from the assigned page numbers.

1. **Introduction to Medical Physiology/Cell Membranes and Diffusion**
   Handouts & Boron Text:Chapters 2 & 5*
   1. describe the composition and functions of the cell membrane.
   2. explain the translocation of substances across the cell membrane by the processes of exocytosis.
   3. describe the various forms of endocytosis.
   4. describe the process of diffusion and net diffusion.
   5. explain the various factors that influence the rate of diffusion.
   6. explain Fick's Law of Diffusion.
   7. explain how the permeability coefficient is used in Fick's Law of Diffusion.

2. **Osmosis**
   Pg. 132-139
   1. define osmosis.
   2. use the appropriate form of Van't Hoff's Law to determine the osmotic pressure of a solution.
   3. differentiate between osmotic pressure and tonicity.
   4. explain the role of the reflection coefficient in determining effective osmotic pressure.

3. **Protein Mediated Transport**
   Pg. 116-132
   1. define carrier mediated transport.
   2. list the properties common to all protein-mediated transport systems.
   3. differentiate between the various types of mediated transport based on their properties.

4. **Transepithelial Transport**
   Pg. 141-145
   1. explain the properties of epithelia that allow for unidirectional transport.
   2. differentiate between transcellular and paracellular pathways.
   3. describe the basic mechanisms utilized in transepithelial transport.
   4. explain how epithelia can absorb or secrete depending on the arrangement of channels and transporters in the apical and basolateral membranes.

5. **Ion Permeation & Equilibria**
   Chapter 6
   1. describe the properties of ions in solution.
   2. explain how ions cross membranes.
   3. discuss the factors affecting ion channel selectivity.
   4. describe the various types of ion channels based on their gating mechanisms.
   5. discuss the asymmetric distribution of ions across biological membranes and its consequences.
   6. describe the forces acting on ions.
   7. explain electrochemical equilibrium for an ion.
   8. use the Nernst Equation to determine the equilibrium potential of an ion.

6. **Resting Potential**
   Ch. 6
   1. describe the generation of the membrane potential.
   2. explain how ion gradients are maintained.
   3. discuss the consequences of changing ion permeabilities on membrane potential.
   4. discuss the consequences of changing ion concentrations on membrane potential

7. **Action Potential Production**
   Pg. 156-160; 179-206
   1. describe the passive electrical properties of biological membranes.
   2. explain electrotonic conduction.
   3. describe the electrical events underlying the generation of an action potential.
   4. describe the properties of the voltage-gated channels that produce the action potential.

5. explain the origin of the absolute and relative refractory periods.
6. describe how the refractory periods affect action potential generation.
7. explain the meaning of all-or-none response in regard to the action potential.
8. explain the meaning of overshoot of the action potential.
9. describe how neurotoxins and local anesthetics alter the activity of voltage-gated channels.
10. list the properties of the four major types of voltage-gated potassium channels.

8. **Action Potential Conduction**

Pg. 206-211; 316-322

1. discuss the properties that determine the rate of action potential conduction.
2. describe conduction in muscles and unmyelinated nerves.
3. describe the processes of myelination in the central and peripheral nervous systems.
4. explain the effects that myelination has on neuronal membrane characteristics.
5. describe the distribution of voltage-gated ion channels in myelinated axons.
6. describe the differences in the action potential and its conduction in myelinated versus unmyelinated axons.
7. discuss the effects of demyelinating diseases on action potential conduction.

9. **Neuromuscular Junction**

Ch. 8

1. describe the components of a synapse.
2. describe the properties of electrical and chemical synapses.
3. describe the structure of the neuromuscular junction.
4. explain the sequence of events that occurs during neuromuscular transmission.
5. discuss the concept of transmitter reversal potential in relation to ion permeabilities.
6. discuss the quantal nature of transmitter release.
7. describe the synthesis, storage, and hydrolysis of acetylcholine (ACh) at the neuromuscular junction.
8. differentiate between failure of neuromuscular transmission from postsynaptic (Myasthenia Gravis) versus presynaptic (Lambert-Eaton syndrome) causes.
9. describe the effects of neurotoxins on synaptic transmission.
10. describe the effects of neuromuscular drugs on synaptic transmission

10. **Molecular Basis of Skeletal Muscle Contraction**

Pg. 237-251

1. describe the composition, structure and anatomical relation of the contractile elements in skeletal muscle.
2. explain the role and source of calcium in excitation-contraction coupling in skeletal muscle.
3. describe the Sliding Filament Theory of muscle contraction.
4. explain the meaning of the Force-Length relationship.
5. explain the meaning of Force-Velocity curves.
6. describe isotonic and isometric contractions.
7. discuss the differences between isotonic and isometric contractions.

11. **E-C Coupling in Skeletal Muscle**

Pg. 237-251

1. discuss the structure and function of the sarcoplasmic reticulum in skeletal muscle.
2. describe E-C coupling in skeletal muscle.
3. describe the energy sources utilized by skeletal muscles.
4. describe the different types of skeletal muscle fibers based on their contraction velocities and metabolic properties.

12. **Skeletal Muscle Mechanics and Energy Sources**

Pg. 260-261, 1250-1251

1. describe the periods occurring during a single muscle twitch.
2. discuss the factors that determine twitch duration.
3. explain summation and tetanus.
4. discuss the influence of internal calcium concentration and series elastic element on the development of tension.
5. describe motor units and their role in the graded contraction of skeletal muscles

13. **Smooth Muscle**

Pg. 253-262

1. describe the histology of smooth muscle.

2. describe the properties of single unit and multiunit smooth muscle.
3. discuss the differences and similarities in contractile mechanisms in smooth and striated muscles including sources of ATP.
4. explain the regulation of intracellular calcium in smooth muscle including its role in tone.

14. **Synapses between Neurons**
Pg. 310-312, 323-330, 345-349
1. define what is meant by an excitatory or an inhibitory transmitter.
2. discuss the structure and properties of neurons as related to postsynaptic integration.
3. describe the mechanisms by which transmitter release is modulated by activity

15. **Neurotransmitters**
Pg. 331-344
1. describe the various classes of neurotransmitters.
2. describe the various neurotransmitter receptor mechanisms and transduction pathways.

16. **Autonomic Nervous System I**
Chapter 14
1. describe the general roles and projections of efferent and afferent divisions of the Autonomic Nervous System (ANS).
2. compare and contrast the major physiological and anatomical features of the efferent divisions of ANS with the somatic system.
3. discuss the reciprocal nature of the sympathetic and parasympathetic systems.
4. identify organs under exclusive control of a single autonomic system.
5. give examples of complimentary actions of both autonomic systems.
6. describe the neurotransmitters of the pre- and postganglionic neurons of the parasympathetic and sympathetic systems.
7. discuss the receptor types found on the pre- and postganglionic neurons of the parasympathetic and sympathetic systems.
8. describe the receptors types found on the target tissue of both the sympathetic and parasympathetic nervous systems.
9. list the major anatomical differences between sympathetic and parasympathetic systems including the location of the pre- and postganglionic neurons and the pathways taken by pre- and postganglionic axons of both systems.
10. describe the differences in both the functional and anatomical aspects of the sympathetic innervation of the skin versus the internal organs.
11. compare and contrast the autonomic innervation of the upper body with that of the lower.
12. describe the function of the cranial nerves with an autonomic component and expected problems caused by their damage and/or abnormal activity.
13. discuss the pharmacologic modulation of autonomic activity, and symptoms associated with the blockade or abnormal stimulation of autonomic receptors.
14. describe the roles of the hypothalamus, medulla, and descending pathways in control of the ANS.
15. discuss the importance of the afferent autonomic pathways in relaying sensory information including that of pain.

17. **Autonomic Nervous System II**
Ch. 14
See objectives for lecture #16.

18. **Autonomic Nervous System III**
Ch. 14
See objectives for lecture #16.

19. **Cardiovascular System Overview**
Chapter 17
1. describe the structure-function features and arrangements of the cardiovascular system (CVS) components and their interrelationships.
2. contrast features and functions of systemic, pulmonary and lymphatic circulations

20. **Cardiac Output and Distribution**
Chapter 17
1. define cardiac output (CO), stroke volume (SV), and heart rate (HR) and be able to relate any two to the third.

2. discuss the concepts of mean arterial pressure (MAP), central venous pressure (CVP), and total peripheral resistance (TPR) and predict how changes in one of these affects the others.
3. explain the effect of changes in vascular bed resistance on cardiac output distribution.
4. describe the relationship between TPR, MAP, CO and CVP and evaluate changes in one given adequate information about the others.

21. **Vascular Structure and Function**
Chapter 19
1. describe main features and function of each vessel type comprising the various vascular segments.
2. describe how mean and pulse blood pressure vary within the circulation.
3. describe the relationship between pressure, flow and resistance in all its forms.

22. **Blood Flow, Pressure and Resistance I**
Chapter 19
1. list factors that affect resistance (R) of a blood vessel and how R changes when these change.
2. compare intravascular pressure (P), perfusion pressure and transmural pressure.
3. compare blood flow (Q) in a blood vessel with blood velocity (U) and their relationship.
4. describe the effect of changes in resistance (R) on blood flow and pressure.
5. contrast laminar with turbulent blood flow and describe conditions that produce turbulent flow.
6. define stenosis and describe its effects on blood pressure, flow and velocity.
7. define shear stress and shear rate in a blood vessel.
8. discuss the concept of velocity profile in a blood vessel.
9. define blood viscosity and explain the factors that effect its value.
10. describe the effect of changes in viscosity on blood flow and pressure.
11. describe and explain the variation in blood velocity within the circulatory system.
12. describe the relationship of shear stress to blood viscosity, blood flow and vessel diameter.
13. describe the effects on blood flow and pressure of series versus parallel vascular arrangements.
14. calculate combined resistances in series and parallel vascular arrangements.
15. explain and apply resistance partitioning to determine Q, and P within a vascular bed or organ.

23. **Blood Flow, Pressure and Resistance II**
See objectives for lecture #22.

24. **Vascular/Cardiac Compliance and Mechanics I**
Chapter 19
1. define compliance and be able to determine its value from graphical representations.
2. contrast the concept of compliance with that of distensibility.
3. describe the factors that influence compliance including how directional changes in any of these factors effects the value of compliance.
4. contrast compliance of arteries with compliance of veins.
5. describe how both resistance and compliance interact to determine MAP (defined above).
6. describe Laplace's law as it applies to heart and blood vessels.
7. contrast the concepts of wall stress vs. wall tension.

25. **Vascular/Cardiac Compliance and Mechanics II**
See objectives for lecture #24

26. **Cardiac Electrical Activity I**
Chapter 21
1. describe the main features, arrangements, pathways and sequence of electrical excitation and conduction in the heart and the types and features of the cardiac action potentials.
2. describe the ionic basis for cardiac fast and slow response action potentials and be able to explain how changes in ionic currents may occur and the effect of these changes on action potential features and cardiac function.
3. explain the following cardiac electrophysiological concepts/terms: rectification, ectopic pacemaker, overdrive suppression, refractory periods, vulnerable periods, arrhythmia, reentry, decremental conduction, reentrant and triggered arrhythmias, conduction block, supraventricular arrhythmias.
4. describe the origin of the electrocardiogram and explain the relationship between its deflections, segments and intervals to underlying electrophysiological events and timing.

27. **Cardiac Electrical Activity II**

See objectives for lecture #26.

28. **Cardiac Electrical Activity III**
See objectives for lecture #26.

29. **Cardiac Electromechanical Activity**
Chapter 22
1. explain the excitation-contraction coupling process.
2. explain the concepts of isometric and isotonic contraction of cardiac muscle.
3. explain the concept of contractility and inotropic state in cardiac muscle.
4. describe the effects of preload, afterload and contractility on cardiac force development.

30. **Determinants of Cardiac Pump Function**
Chapter 22
1. Describe the Frank-Starling 'law of the heart'.
2. Explain the effect of preload, afterload and contractility on stroke volume.
3. Contrast the effects of changes in preload vs. changes in contractility.
4. interpret graphical representations of cardiac function curves.
5. describe the peak isovolumic pressure (PIP) curve in relation to the Frank-Starling mechanism.
6. describe the effect of contractility changes on the PIP curve.

31. **Cardiac Cycle**
Chapter 22
1. describe the cardiac cycle in terms of the cardiac pressure-volume loop and in terms of the temporal relationship between electrical, mechanical and hemodynamic events.
2. determine stroke volume and ejection fraction from either the pressure-volume loop or from ventricular end diastolic and end systolic volumes.
3. explain the concept of myocardial wall stress and its variation during the cardiac cycle.
4. describe the relationship between myocardial wall stress and myocardial afterload.
5. describe factors that increase myocardial O2 demand and clinical indices that correlate with these

32. **Cardiac Pressure-Volume Loops**
Chapter 22
1. interpret pump function changes from cardiac pressure-volume (P-V) loops and PIP curves.
2. relate changes in P-V loops to changes in temporal representations of the cardiac cycle.
3. describe P-V loop changes associated with changes in preload, afterload and contractility.

33. **Cardiac Sounds and Murmurs**
Chapter 22
1. describe the genesis of the cardiac heart sounds and their timing in relation to the cardiac cycle.
2. explain the basis of vascular and cardiac murmurs.
3. describe the type of murmurs and hemodynamic changes associated with aortic and mitral stenosis and aortic and mitral regurgitation.

34. **Cardiac Pump Failure and Hemodynamics**
Chapter 22
1. describe ventricular hypertrophy, factors contributing to its occurrence and its effects on function.
2. describe the hemodynamic changes associated with cardiac valve abnormalities.

35. **Arterial Pressures**
Chapter 23
1. define systolic, diastolic, pulse and mean blood pressures.
2. estimate mean pressure from sphygmomanometry.
3. describe factors that influence mean, systolic and pulse pressure and predict the directional changes in pressures caused by these factors.
4. define essential and isolated systolic hypertension.
5. describe the role of blood volume as a determinant of blood pressure.

36. **Arterial Pulse Propagation and Reflection**
Chapter 23
1. define pulse-wave speed and explain the effects of arterial compliance on its speed.

2. explain the concept of pulse-wave reflections in the arterial system.
3. contrast reflection features of pressure vs. flow waves.
4. describe the factors that affect reflection and the effect of reflection on measured arterial pulses.
5. describe the manner in which arterial pulses vary in different parts of the arterial circulation.
6. define the ankle-brachial index and its significance.
7. describe the pressure and flow pulse changes associated with peripheral arterial disease.

37. **Microcirculation**
Chapter 20
1. describe the components and main functions of the microcirculation and contrast the difference in capillary structure-function among organs.
2. describe the process of transcapillary exchange and the factors that affect it.
3. describe the oxygen carrying capacity of the blood via the Hb-O2 equilibrium curve.
4. describe the concepts of oxygen delivery and uptake.
5. describe the concept of oxygen demand vs. supply and factors that may impact on this balance.

38. **Lymphatic and Venous System Function**
Chapter 20
1. describe the function of lymphatic capillaries and the process of lymph transport.
2. describe and explain the conditions that tend to cause edema and lymphedema.
3. describe and explain the effects of gravity on the venous system.
4. describe the effects of normal and abnormal venous valve function on venous pressures.
5. describe and explain the effects of respiration on venous flows and pressures.
6. describe the venous reservoir function and its significance to venous return and cardiac output.

39. **Peripheral Vascular Controls I**
Chapters 23 & 25
1. describe neural, local and hormonal modulation of vascular caliber and tone.
2. describe vascular smooth muscle (VSM) contraction and vasodilation mechanisms.
3. describe major local control processes including autoregulation, hyperemia and myogenic.
4. describe the basic mechanisms responsible for the modulation of vascular smooth muscle that leads to either vasodilation or vasoconstriction including the roles of the following in these processes: calcium, vascular alpha and beta adrenergic receptors, catecholamines, voltage operated channels, receptor operated channels, shear stress, nitric oxide, and metabolic factors.

40. **Peripheral Vascular Controls II**
See objectives for lecture #39.

41. **Cardiovascular Controls and Reflexes I**
Chapters 23 & 25
1. describe the general framework by which receptors and efferent and afferent pathways modulate primary cardiovascular parameters.
2. describe the negative feedback concept and the role of medullary cardiovascular 'control centers'.
3. describe high pressure baroreceptor reflexes and their responses to changes in blood pressure.
4. describe low pressure receptor reflexes and their response to changes in blood volume or pressure.
5. describe the interaction between high and low pressure reflexes.
6. describe the cardiovascular reflexes associated with peripheral and central chemoreceptors.

42. **Cardiovascular Controls and Reflexes II**
See objectives for lecture #41.

43. **Cardiac-Vascular Coupling and Interactions**
Chapters 23 & 25
1. discuss and be able to graphically represent cardiac function curves and vascular function curves and the significance of their intersection.

2. determine the changes in cardiac and vascular function curves due to changes in vascular compliance, vascular resistance, central venous pressure, blood volume, cardiac contractility, posture, sympathetic activity and cardiac failure.

44. **Features of Specific Circulations I**
Chapter 24
1. describe the phasic features of coronary blood flow.
2. describe the metabolic and autoregulatory aspects of coronary blood flow.
3. describe intramyocardial blood flow and the factors that influence its features.
4. describe the determinants of cerebral blood flow.
5. describe the structure-function aspects of cutaneous circulation.
6. discuss cutaneous blood flow in relation to temperature regulation and blood pressure.
7. describe skeletal muscle blood flow in terms of its extrinsic and intrinsic control.

45. **Features of Specific Circulations II**
Chapter 24
See objectives for lecture #44.

46. **Clinical Correlations 1-3**
Chapter 25
1. discuss the interaction between cardiac and vascular changes that occur with hemorrhage and cardiac dysfunction.

47. **Clinical Correlations 4-6**
Chapter 25
See objectives for lecture #46.