

Instructor Guide

Cardiac Action Potentials

1.1 Target Audience & Class Size

Audience: Medical Students

Class Size: A small class of no more than 10 students. (This class is designed for 8 students.)

1.2 Course Goal

The cardiac action potential course goal is to educate medical students for the purpose of identifying types of cardiac action potentials. Diagram and explain the phases of nonpacemaker and pacemaker cardiac action potentials and explain the importance of the action potential refractory periods.

1.3 Learning Objectives

1. Describe the purpose and types of cardiac action potentials and which cells they arise from.
2. Diagram and explain the phases of nonpacemaker cardiac action potentials.
3. Explain and state the importance of action potential refractory periods.

1.4 Course Lessons and Activities

- **Lesson 1** is an e-learning module taken as pre-work before class. This module provides an overview of CAP, the phases of nonpacemaker/pacemaker and refractory periods. Students will complete the Cardiac Action Potentials Medical Case Study Handout as part of lesson 1.
- In **Lesson 2**, students watch the video pacemaker action potential from USMLE Rx, then write a page discussion post on the LMS class board summarizing the patient's case in the video and what occurred with the pacemaker action potential.
- **Lesson 3** is the first lesson of the in-class portion. Students are asked to spend 2 minutes writing what happens during an action potential.
- **Lesson 4** allows students to break into groups. Each group is asked to write a type of cardiac action potential, the cells that they arise from, and the purpose of their type.
- In **Lesson 5**, students remain in groups and diagram their group's CAP, label the phases and explain what occurs in each phase.
- In **lesson 6**, students explain and discuss the importance of action potential refractory periods.
- **Lesson 7** allows students to apply their knowledge to a real-world patient case scenario.
- **Lesson 8** is distributed as a post-class online assessment to evaluate.

Lesson	When	Content or Activity Title	Medium	Time
1	Pre-work	Cardiac Action Potential	e-learning	20 mins
2	Pre-work	Pacemaker Action Potential Video Discussion	Video & Discussion	20 mins
3	In class	What happens during an Action Potential?	Group Activity	10 mins
4	In class	Types of Cardiac Action Potentials & purpose	Group Activity	10 mins
5	In class	Diagram the Phases of Nonpacemaker & Pacemaker CAP's	Group Activity	10 mins
6	In class	Importance of Action Potential Refractory Periods	Group Activity	20 mins
7	In class	Applying Cardiac Action Potential to a Patient Case Study	Cased-Based Learning	10 mins
8	Post class	Assessment	Scholar RX	10 mins

1.6 Course Materials

Lesson 1: Cardiac Action Potential (Pre-work)

[Articulate Rise Course Link.](#)

Lesson 2: Pacemaker Action Potential Video & Online Discussion

[Pacemaker Action Potential Video Link](#)

[Cardiac Action Potential Medical Case Study Link](#)

Lesson 3: What Happens during an Action Potential?

[Instructor PowerPoint \(Slide 2\)](#)

Lesson 4: Types of Cardiac Action Potentials, their cells and purpose

[Instructor PowerPoint \(Slide 3\)](#)

Lesson 5: Diagram Phases of Nonpacemaker & Pacemaker Cardiac Action Potentials

[Instructor PowerPoint \(Slide 4 & 5\)](#)

Lesson 6: Importance of Action Potential Refractory Periods

Larger Index Cards

[Instructor PowerPoint \(Slide 6\)](#)

Lesson 7: Applying Cardiac Action Potential to a Patient Case Study

[Instructor PowerPoint \(Slide 7\)](#)

Lesson 8: Assessment

2.1 Lesson Plan

Lesson 1: Cardiac Action Potential

The first lesson of this course is an e-learning Articulate Rise course.

- I converted the Scholar Rx brick content into an interactive Rise course.
- <https://neumeierexamples.s3.us-east-2.amazonaws.com/cardiac-action-potentials-scorm12-yqF6ocoJ/scormcontent/index.html#/>

This e-learning SCORM package would be uploaded to the LMS and assigned to students and lesson 1 pre-work.

Lesson 2: Pacemaker Action Potential Video & Discussion

In the second lesson, students watch the video Pacemaker Action Potential by Arjun Iyer from UISMLE Rx.

Students need to take notes and complete the Potential Action Medical Case Study form, [click here to view it.](#)

The Potential Action Medical Case Study Form will be used in class for a case-based study.

After students watch the video, they need to write a 3 to 5 paragraph summary on what happened to the patient's case and what occurred with the pacemaker action potential in the patient's case.

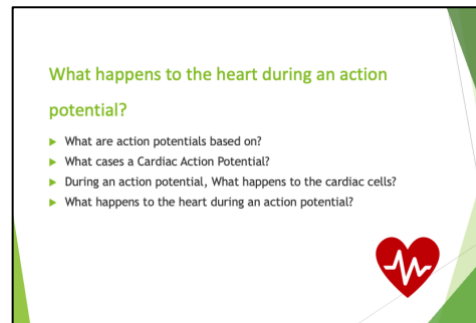
The summary should be posted to the online class discussion board and students need to reply to at least 2 other students' writings or posts by the start of class.

Potential Action Medical Case Study	
Take notes on the case study at the beginning and end of the Pacemaker Action Potential video. Complete the information in the fields below this will be use in class.	
Objectives	
List and describe the key objectives of this case study:	
Objective 1:	
Objective 2:	
Objective 3:	
Patient Information Table	
Attribute	Details
Age	
Gender	
What are the complications?	
Vitals	
BP	
Temperature	
Oxygen Saturation	
Respiratory Rate	
Heart Rate	
EKG Reading	
What do you identify	
How do you manage these symptoms	

Lesson 3: What Happens during an Action Potential?

In this lesson, students write individually for 5 minutes on: “What happens to the heart during an action potential?”

- Students pair with a partner.
- They discuss their answers and compare/contrast:
What is the same?
What is different?
What did they miss?



Slide 2, instructor ppt

Student Answer:

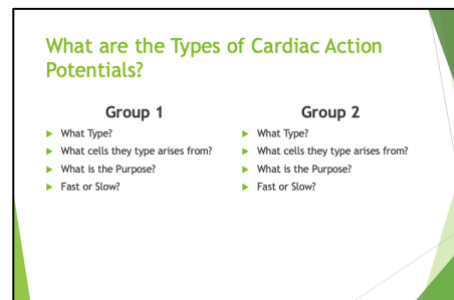
When an action potential travels across the cell membranes of cardiac cells, it is called a cardiac action potential.

During an action potential, the cardiac cells will contract and at the same time the signal will move on to the neighboring cardiac cells. This ensures that the entire heart undergoes a coordinated contraction.

Lesson 4: Types of Cardiac Action Potentials, their cells and their purpose

In this lesson, students are divided into groups to define CAP types, cells and the purpose of each type.

- Group 1 is asked to go to the whiteboard and write 1 type of CAP: nonpacemaker.
- Group 2 is asked to write the other type of CAP: pacemaker.
- Have groups use different color markers.
- Ask student 1 from group 1 to write 1 cell that a nonpacemaker CAP arises from: atrial myocardium.
- Student 2 of group 1 writes the other cell: ventricular.
- Student 3 of group 1 is asked to write the purpose of the nonpacemaker CAP.
- Student 4 of group 1 is asked to write the speed of the nonpacemaker CAP: fast.



Slide 3, instructor ppt

- After group 2 is finished, student 1 of Group 2 writes 1 cell the pacemaker CAP arises from: Sinoatrial.
- Student 2 of group 2 writes the other cell that the pacemaker CAP arises from: Atrioventricular.
- Student 3 of group 2 writes the purpose of the pacemaker CAP.
- Student 4 of group 2 writes the speed of the nonpacemaker CAP: slow.

Lesson 5: Diagram the Phases of Nonpacemaker & Pacemaker Cardiac Action Potentials

In this lesson, group 2 will diagram and explain the phases in nonpacemaker action potential and group 1 will diagram and explain the phases of the pacemaker action potential.

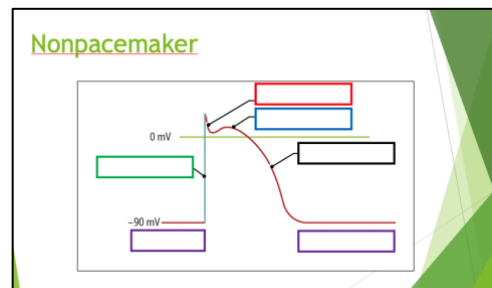
Students remain in groups.

****Note:** The instructor can use slide 4 & 5 of the instructor PowerPoint.

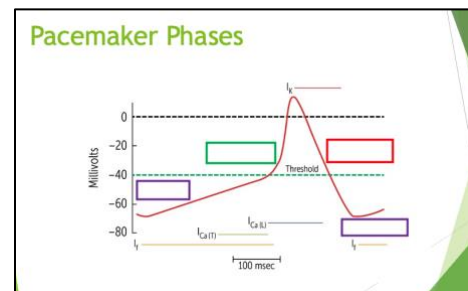
- After diagrams are drawn by both groups, have each individual student of group 2 label the phases and explain what occurs in that phase.
- Student 1 of group 1 labels Phase 4 & explains
- Student 2 of group 1 labels Phase 0 & explains
- Student 3 of group 1 labels Phase 2 & explains
- Student 4 of group 1 labels Phase 3 & explains

****Note:** Students may ask another student in their group for help when explaining.

- Then group 1 will label the phases of the pacemaker CAP and explain
- Student 1 of group 2 labels Phase 4 & explains
- Student 2 of group 2 labels Phase 0 & explains
- Student 3 of group 2 labels Phase 3 & explains
- Student can help



Slide 4, instructor ppt



Slide 5, instructor ppt

Student Answers:

For group 1, Student 1 labels Phase 4 in the **purple** box. Student 1 explains that Phase 4 is at the resting potential as K channels remain open and Na channels are closed. Student 2 labels Phase 0 in the **green** box and explains that Phase 0 is rapid depolarization as the cell interior becomes less negatively charged. Student 3 labels Phase 1 in the **red** box and explains that early repolarization is caused by a rapid K efflux. Student 4 labels Phase 2 in the **blue** box and its the plateau phase, explaining it is caused by calcium channels with a minor K efflux.

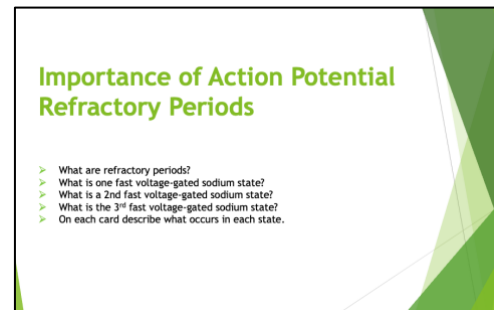
For group 2, student 1 labels Phase 4 in the **purple** box and explains how this is gradual depolarization. Student 2 labels Phase 0 in the **green** box and explains how depolarization is caused by Ca influx after reaching the threshold. Student 3 labels Phase 3 in the red box and explains how repolarization is caused by the delay outward K current.

Lesson 6: Discuss the Importance of Action Potential Refractory Periods

In this lesson, groups will work together to share their thoughts on the importance of the action potential refractory periods.

Each group gets a stack of index cards. Each student takes 5 cards and writes an answer to these questions on the individual cards:

1. What are refractory periods?
 2. What is 1 voltage-gated sodium state?
 3. What is a 2nd voltage-gated sodium state?
 4. What is 3rd voltage-gated sodium state?
 5. On each card describe what occurs in each state.
- After writing their individual answers, students should compare cards with their group and select the best answers.
 - Then they are asked to present findings to the class.
 - 10 mins work time
 - 10 mins presentation time or (5 mins group)



Slide 6, instructor ppt

Lesson 7: Applying a Pacemaker Action Potential to the Patient's Case

In this lesson, students apply their knowledge and discuss as a class what happened in the patient's case and what occurred with the pacemaker action potential.

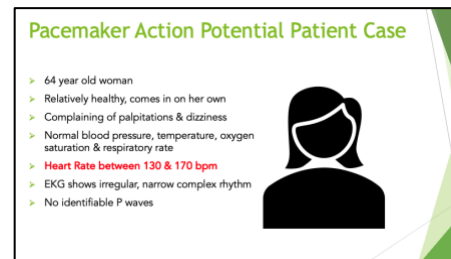
Students return to their seats.

Students are asked to get the [Potential Action Medical Case Study](#) form that was completed from the Pacemaker Action Potential Video.

Students should compare their sheet notes with the sheet from slide 7.

This instructor asks these questions and opens the class up for discussion on these topics:

- What happened to the patient?
- What caused the symptoms?
- What occurred with the pacemaker action potential in this case?
- What happened to the sinoatrial node?
- What happened to the atrioventricular (AV) node?
- What was occurring in the nonpacemaker cardiac action potential with this patient?
- What was happening to nonpacemaker cells?



Slide 7, instructor ppt

Note: I do not know the answers to this but would want to work with a SME or instructor to design this activity out in more detail.

Lesson 8: Post Class Assessment

For the post course assessments, students take a short assessment on the content.

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The assessment would be created in the Canvas LMS.