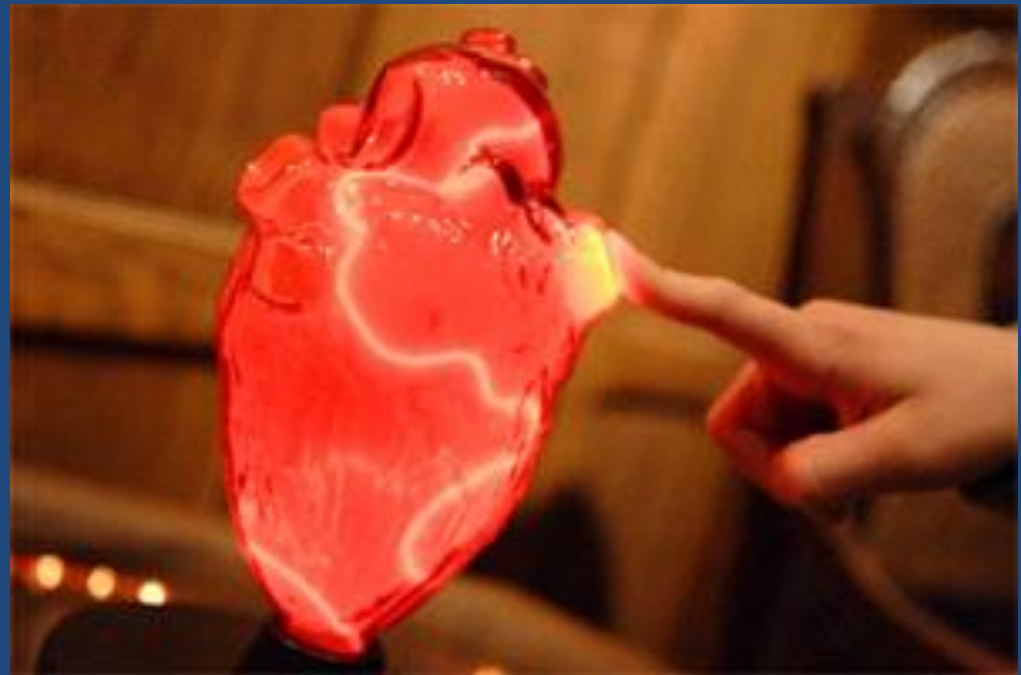


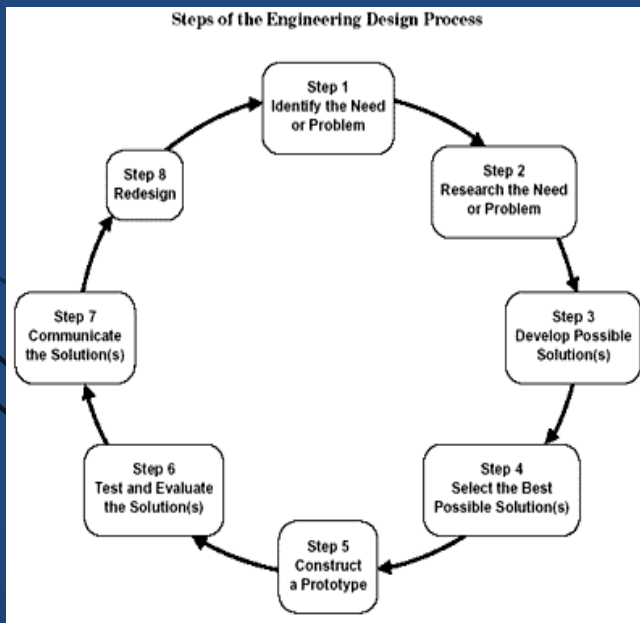
Bioelectricity and Cardiac Function



The Strongest Pump of All

The Importance of Engineering

- Examples of engineering are around you everywhere
- Engineers follow a problem solving process that anyone can use:



engineering
design
process

Five main steps →

The Engineering Design Process

Five main steps:

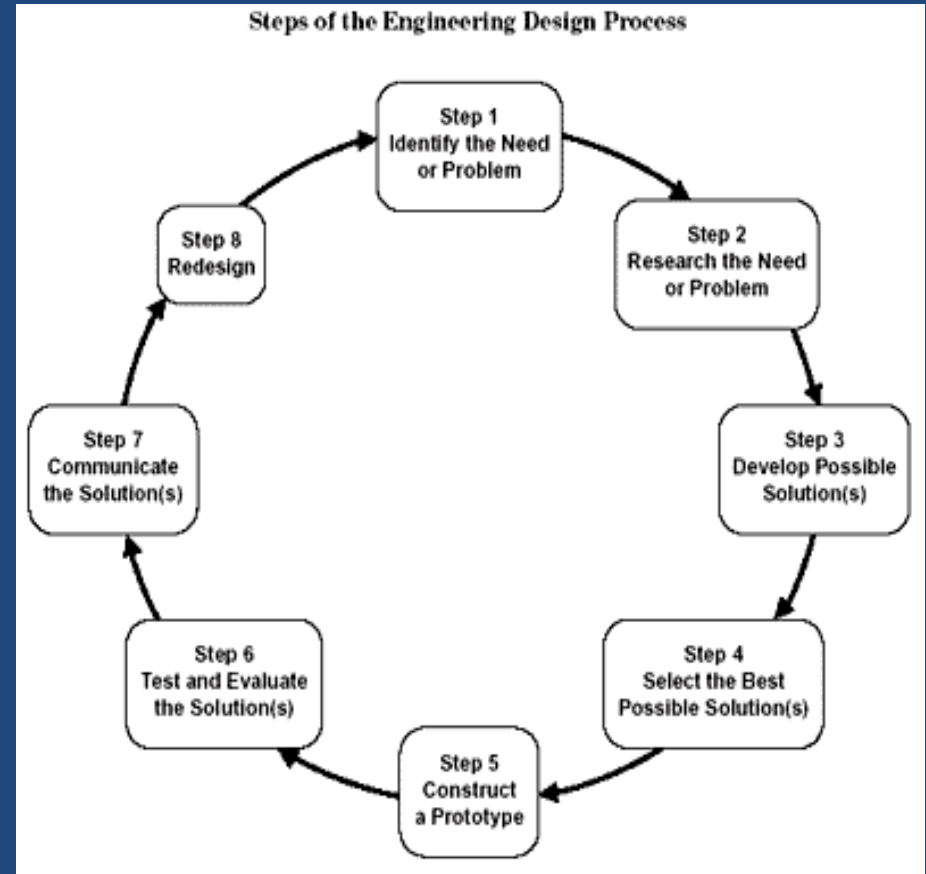
Problem identification

Research

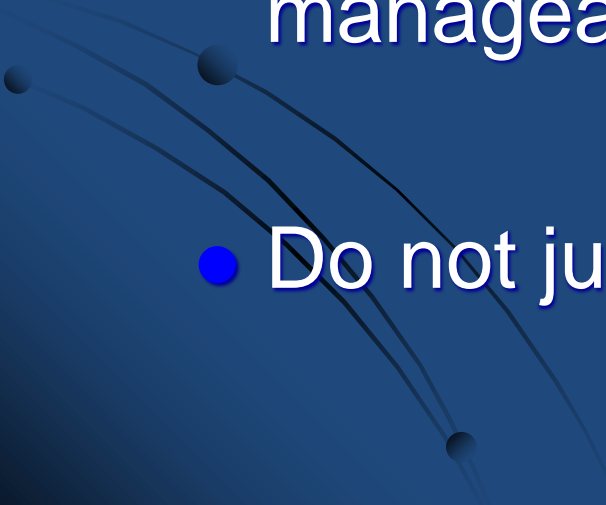
Solution design

Implement & test

Iteration & improvement



So easy, anyone can do it

- No problem is out of your reach
 - Break down the problem into manageable pieces
 - Do not jump to conclusions
- 

What IS the Problem?

- It can be anything you want to investigate
- A 100% right answer does not exist; rather, many possible solutions exist
- Your challenge is to find the best solution for the situation

Researching the Problem

- Takes time and patience
- Look at ways other people have tried to answer the problem or similar problems
- Look at solutions to similar problems
- See what can be improved upon in *your solution*

Your Design Solution

- Use research to help you
- **Brainstorm** — make it original & creative
- Even if it is wrong (or does not work as you ultimately want), find something to learn from it
- Then modify it (again and again... = **design iterations**) to improve it

Testing & Improvement

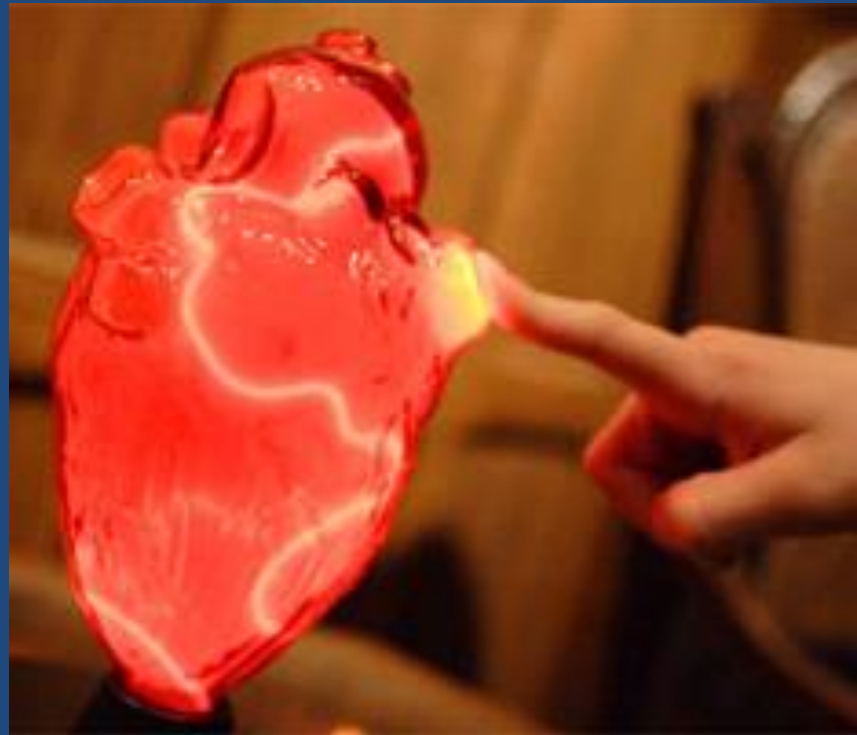
- Check your solution for accuracy
- Test to get data
- Analyze your data to see how well it fixed the problem
- Keep improving the design until it is an acceptable solution = **iterations**

Importance of Heart Bioelectricity

- **Cardiovascular disease** is the leading cause of death in the U.S.
- **Technologies** need to be improved and invented **to help people with this disease**
- Before you can design a solution, you need to **understand how the heart works**

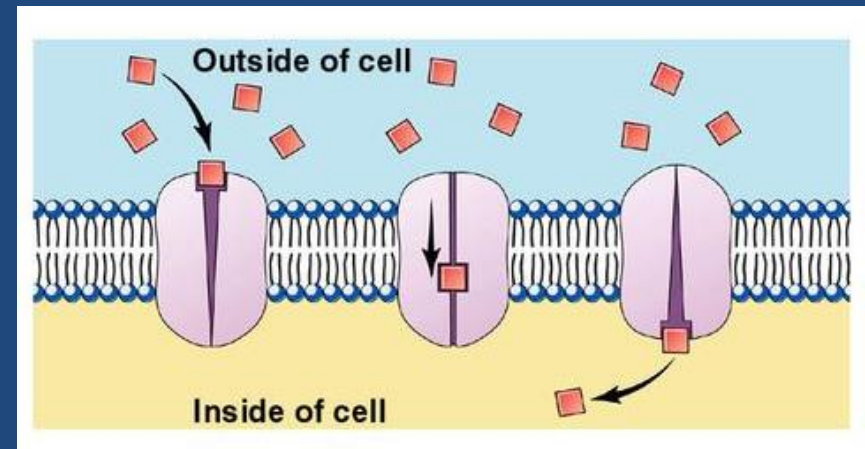
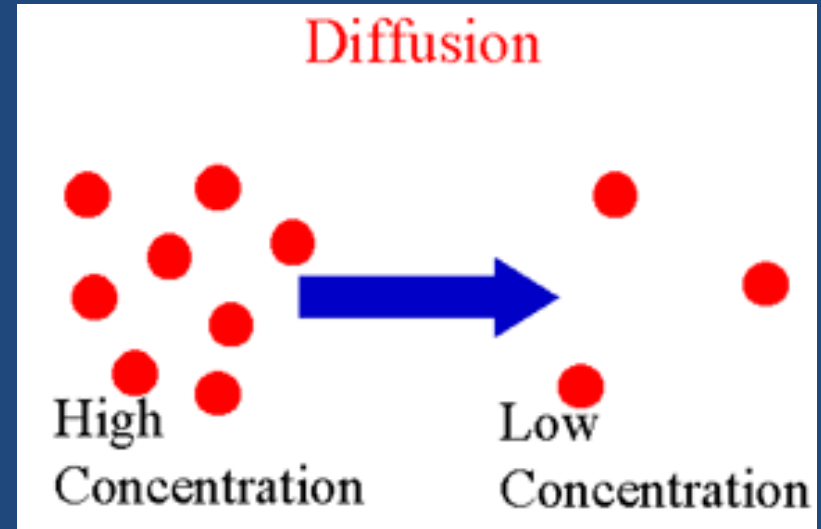
What makes your heart pump?

- Your heart works off an electrical current
- This current is produced by your body
- ...somewhat like a water pump that is powered by electricity



Diffusion

- Potassium and sodium ions
- Each has a +1 charge
- They move across the cell's membrane through diffusion



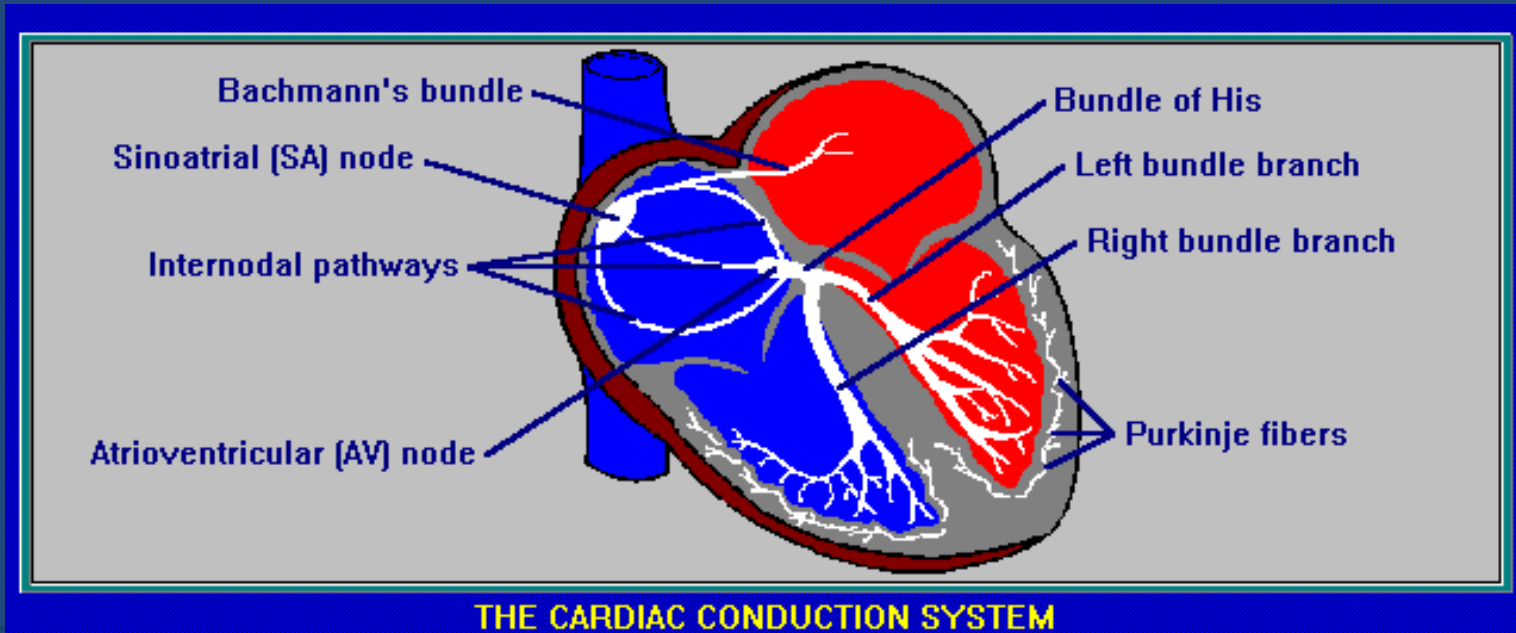
Generating Action Potentials

- The diffusion of the Na^+ and K^+ ions generates an electrical current
- These are the same ions, or electrolytes, in Gatorade
- This is the science behind why Gatorade can be helpful for high-performance athletes

What do action potentials do?

- Give your body the ability to send messages
- These electrical messages are sent throughout the body to tell muscles to contract and relax
- Without the varying concentrations of the ions, your cells could not send these messages

Action Potentials in the Heart

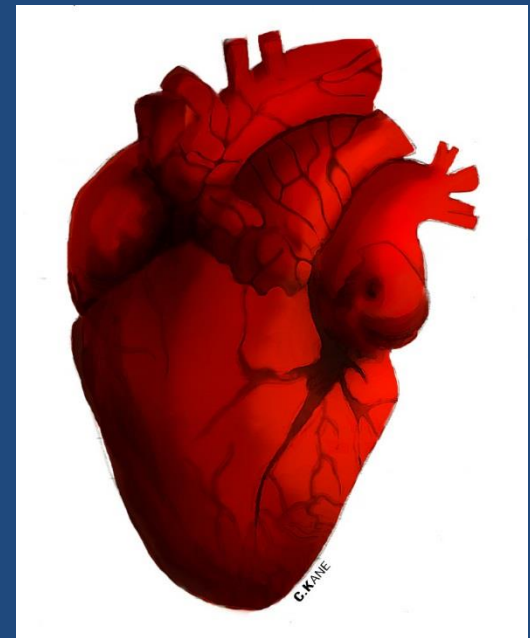


- Millions of cells in your heart do this at once
- Creates a current
- Occurs first in SA node of the heart, at the top
- Goes to the bottom of your heart to pump blood to your body

RECAP: How the heart pumps

Electrical signals called **action potentials** are created from the change in concentration of sodium and potassium ions

- The signals tell the muscles to contract
- They start at the top of the heart and push the blood to the bottom of the heart
- Then they continue to the bottom of the heart to push the blood to the body



DEMO: Water balloons...

(that's right, water balloons!)

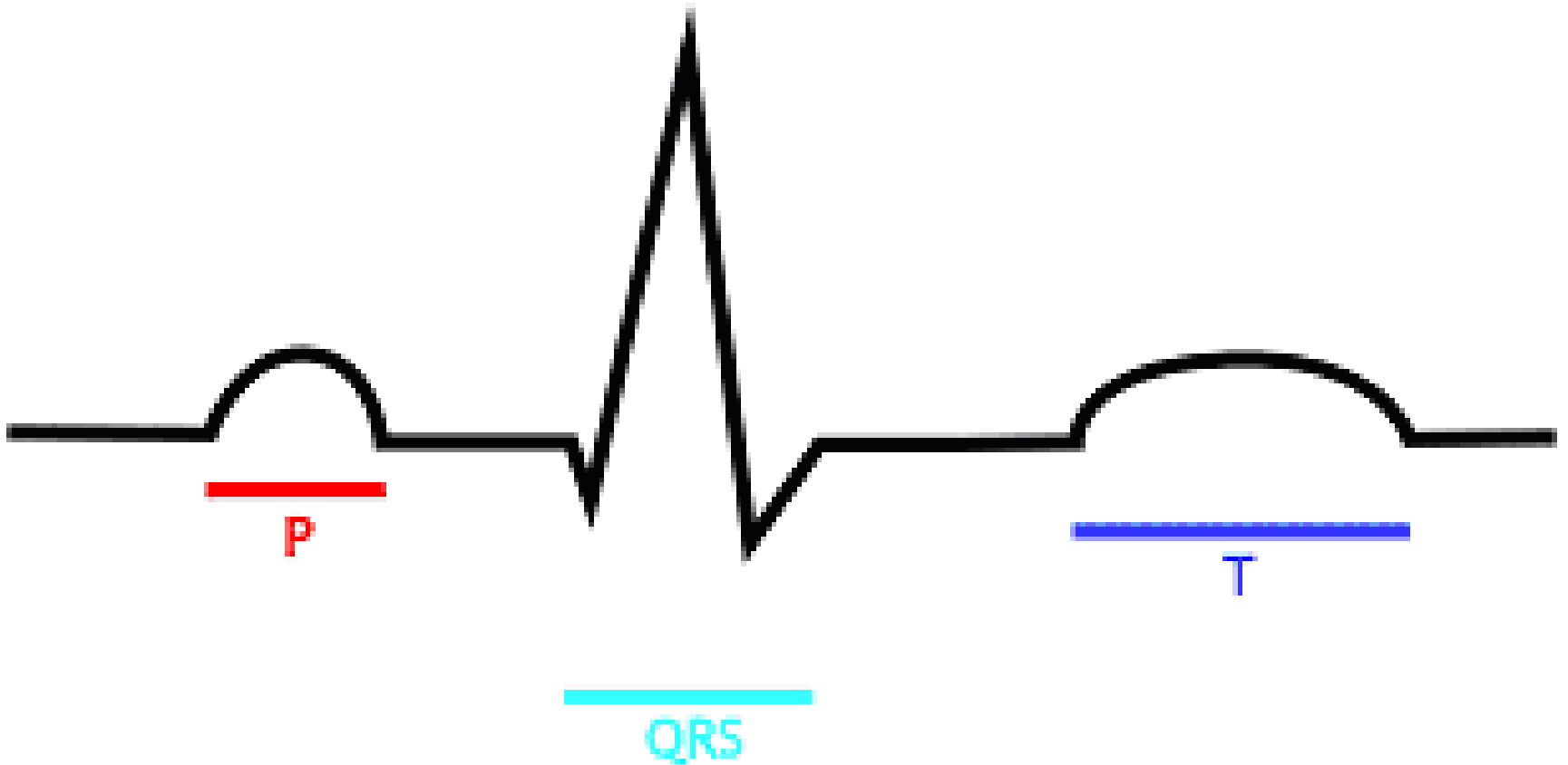
Imagine a water balloon represents your heart:

- Squeeze the top
 - > all the water goes to the bottom
- Squeeze the bottom
 - > all the water goes to the top



This is what happens with the **electrical currents** in your heart; they **tell the muscles to squeeze**, and that's how the blood moves.

The Electrical Wave Form



Class Discussion Question

Problem: A person does not produce enough electrical current to make his/her heart pump correctly.

Challenge Question:
How could you, as engineers, solve this problem?



Engineering Design Solutions?

- Current technologies include **pacemakers**
 - A surgically inserted device that shocks the heart to make sure it beats correctly



- *What are your ideas?*

Engineers need to think outside the box
to find innovative solutions
to everyday problems!

