

# iCEV Anatomy & Physiology

Knowledge and Skill Statement	Student Expectation	Breakout	ICEV Citation		Lesson Title	New Location
			Narrative/Activity	Type of Citation (New Content/New Citation)		
(4) Scientific and engineering practices. The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:	(A) develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;	(vi) propose solutions supported by data	Narrative	New Content	Communicating Findings in Anatomy and Physiology	Student Handout-Proposing Solutions
(4) Scientific and engineering practices. The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:	(A) develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;	(vii) propose solutions supported by models	Narrative	New Content	Communicating Findings in Anatomy and Physiology	Student Handout-Proposing Solutions
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(5) Scientific and engineering practices. The student knows the contributions of scientists and engineers and recognizes the importance of scientific research and innovation on society. The student is expected to:	(B) relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists and engineers as related to the content; and	(i) relate the impact of past research on scientific thought including research methodology	Narrative	New Content	Impact of Science: Anatomy and Physiology	Student Handout-History of Research Methodology
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# Proposing Solutions

Proposing solutions to anatomy and physiology problems often involves analyzing and interpreting data collected from various sources. A basic approach to utilizing data to propose solutions can include the following processes:

## **Data Collection:**

Gather relevant data from various sources such as research studies, clinical trials, epidemiological surveillance, patient records, and public health databases. The data may include information on pathogens, body system functioning, treatment outcomes, epidemiological trends, and diagnostic test results.

## **Data Analysis:**

Analyze the collected data using appropriate statistical and computational methods. This may involve identifying trends, patterns, associations, and correlations within the data. Use tools such as data visualization techniques, statistical tests, and modeling approaches to gain insights from the data.

## **Identify Patterns & Gaps:**

Look for patterns or trends in the data that may provide insights into the underlying problem. Identify gaps in knowledge or areas where the data is insufficient to fully address the problem. For example, if an elevated heart rate is a concern, analyze the patterns of tachycardia episodes, identify the most common causes, and assess factors contributing to an elevated heart rate.

## **Identify Potential Solutions:**

Based on data analysis, propose potential solutions to address the identified problem. Consider evidence-based interventions, strategies, or innovations aligning with the data findings, scientific ideas, principles and theories. For example, if data analysis reveals potassium levels contribute to tachycardia, propose interventions like electrolyte replacement or the development of electrolyte monitoring systems.

Models can be used to test various functions and treatment options of the human body. Anatomical models help identify relationships between different organs, tissues and systems. Physiological models stimulate physiological processes to allow for the observation and analysis of physiological phenomena in a controlled manner. Computational models can be used to predict or simulate complex physiological phenomena that may be challenging to view. Disease models examine the progression and effects of specific diseases to provide insight into the mechanisms of disease.

Incorporating models into solution design allows researchers to gain a better understanding of the intricate structures and functions of the human body. Additionally, models can be used to assess the performance and cost-effectiveness of different testing approaches. This information can guide decisions on test selection, screening

procedures, and resource allocation. Proposed solutions should be evaluated and validated through real-world studies and trials as well as scientific ideas, principles and theories to ensure their effectiveness and feasibility.

### **Consider Multidisciplinary Approaches:**

Problems related to anatomy and physiology often require multidisciplinary approaches. Collaborate with experts from various fields, such as microbiologists, immunologists, epidemiologists, clinicians, and public health professionals, to develop comprehensive solutions. Incorporate diverse perspectives and expertise to ensure the proposed solutions are well-rounded and effective.

### **Evaluate Feasibility & Impact:**

Assess the feasibility and potential impact of the proposed solutions. Consider factors such as cost, resources, scalability, ethical implications, and the potential for implementation in real-world settings. Conduct cost-effectiveness analyses or modeling studies to evaluate the potential impact of the proposed solutions on disease outcomes or public health.

### **Iterative Approach:**

Proposing solutions based on data is a repetitive process. Continuously gather new data, update analyses, and refine solutions based on emerging evidence and feedback. The field of anatomy and physiology is dynamic, and new insights may lead to further modifications or alternative solutions over time.

Remember, proposing solutions to anatomy and physiology problems requires a rigorous and evidence-based approach. Data analysis plays a crucial role in understanding the problem, identifying potential solutions, and informing decision-making.

# History of Research Methodology

Research methodology is the systematic approach to conducting scientific research. Many components are involved in research methodology such as; research framework, experimental design, sampling techniques, procedures for data collection and analysis, ethical concerns, and reporting.

Research methodology has evolved since the first documented experiments in ancient civilizations. Reflecting on past research is crucial to scientific progress, as this practice provides a foundation for scientific knowledge and establishes opportunities for further research. Most modern research is based on previous studies, either confirming, refuting or addressing variables in prior research.

The evolution of research methodology through time has influenced scientific thought in the following ways: paradigm shifts, methodological advancement, experimental design, and ethical considerations.

## **Paradigm Shifts:**

Throughout time, scientific discoveries have led to fundamental shifts in scientific thought. This is because scientific theories and hypotheses evolve with the accumulation of evidence from past research. With the development of new scientific knowledge, new approaches to research are explored. Major discoveries affecting anatomy and physiology research methodology include:

- Watson and Crick's discovery of DNA structure in 1953 prompted novel approaches in genetics research such as DNA sequencing, gene expression analysis and molecular cloning.
- Germ theory proposed by Pasteur and Koch in the late 19<sup>th</sup> century shifted the focus of medical research from vapors causing illness to microorganisms.
- Darwin proposed the theory of evolution in the mid-1800's, leading to changes in how researchers approached biological concepts. This theory resulted in a focus on fossil records and molecular biology.

## **Methodological Advancements:**

As scientists acquire better means to conduct research, methods for data collection and analysis have evolved. With increased technological capabilities over time, researchers have been able to streamline their research methods. For example, in the 15<sup>th</sup> century, human cadavers were used to explore anatomy and physiology. With the development of X-rays, MRIs and PET scans in the 20<sup>th</sup> century, researchers can learn more about the human body using noninvasive methods. Similarly, the 1983 development of the biological technique polymerase chain reaction (PCR) forever changed the methods researchers use to genotype, clone, sequence, and detect genetic material. The introduction of the Germ Theory in the 19<sup>th</sup> century led to the development of improved microscopes, culturing procedures and staining techniques

to better study and visualize microorganisms.

### **Experimental Design:**

Development of new technologies and advancements in scientific knowledge have brought change to many elements of experimental design. Research methodology has become more rigorous, transparent, and methodologically sound over time.

Researchers began using controls in experimental design as early as 460 BCE. In ancient Greece, Empedocles sought to understand the phenomena of vision and identified the use of one eye or both eyes to see altered the outcome of his observations. As a result, he noted the importance of using controls in an investigation to guarantee valid data. During the Scientific Revolution in the 16<sup>th</sup> and 17<sup>th</sup> centuries, Sir Francis Bacon and Rene Descartes emphasized the use of controls to isolate variables and establish causation. This emphasis is reflected in the first versions of the scientific method published by Bacon in 1620.

The use of randomization is a prominent element of modern experimental design. In the 1920s, mathematician and biologist Sir Ronald Fisher developed the concept of “randomized blocks” to address issues of variability within research. This concept was expanded on by other statisticians exploring the value of randomization. One of the first experiments to successfully implement randomization on human participants was Austin Bradford Hill’s research on tuberculosis treatments. This experiment showcased the power of randomization to evaluate effective treatments. As a result, randomized control trials (RCTs) have become more and more prominent, even serving as the gold standard for medical research. The U.S. Food and Drug Administration (FDA) has incorporated randomization as a standard requirement for evaluating the safety and efficacy of new pharmaceutical products.

### **Ethical Considerations:**

Past cases of unethical research have shaped modern ethical considerations used in research methodology today. Current research methodologies must align with established ethical guidelines and regulations to ensure research participants are protected. The U.S. Public Health Service Syphilis Study at Tuskegee from 1932 through 1972 had a significant impact on medical ethics, research practices, and treatment of research participants. Key changes in research methodology because of the unethical Tuskegee study include:

- Development of regulations to prioritize informed consent as a fundamental requirement for research participation.
- Requirement for institutional review boards (IRBs) for all research involving human subjects. The IRB ensures research protocols meet ethical standards and protect research participants.
- Creation of ethical principles and guidelines to protect the rights, welfare and well-being of human subjects.

### **Current Research Methodologies:**

Current research across many fields has a profound impact on society. Influencing various aspects of daily life and shaping understanding of the world are significant effects of research on society. Modern research methodologies have influenced society by enabling evidence-based decision making, improving health and well-being, and enhancing collaboration.

### **Evidence-Based Decision Making:**

With randomized controlled trials (RCTs) emerging as the gold standard for research methodology in the 20<sup>th</sup> century, researchers have been able to collect credible and trustworthy knowledge. The accumulation of new knowledge with reliable evidence through research is essential for scientific progress and innovation. Society relies on evidence-based knowledge from research to develop government policies, guide interventions and create programs. Data and conclusions from research provide constituents with reliable, valid and replicable information to make informed decisions. The use of rigorous research methodologies allows researchers to develop a comprehensive understanding of environmental, health, social and economic issues. This can be used by the government, organizations, and education networks to solve societal issues, leading to positive societal outcomes.

### **Improved Health & Well-Being:**

Rigorous research methodologies in the medical and health science fields drive advancements in healthcare. Modern methodologies of clinical trials and epidemiological studies contribute to the development of new interventions, treatments and preventative measures. As a result, these advancements are applied to the healthcare field, improving human health and well-being. Additionally, modern research methodologies have allowed researchers to develop novel materials, improve existing systems and create new technologies. As a result, new technologies and innovations are used to improve lives throughout the world.

### **Enhanced Collaboration:**

With an ever-growing knowledge of the world around us, current research methodologies have evolved into an interdisciplinary approach. The collaboration of researchers from different fields of science has become a common practice, as various phenomena require experts from a variety of disciplines. For researchers from different backgrounds to successfully work together, they rely on a common framework for research methodology. The use of the same research guidelines and language allows for the integration of diverse perspectives. As a result, the information provided to society from research is holistic and comprehensive.

# Science Hall of Fame

## Activity Overview:

You are on the nominating committee for the Science Hall of Fame. Your job is to share information and accomplishments for a scientist from the history of anatomy and physiology.

## Directions:

1. Review the **History of Research Methodology Student Handout**.
2. Your instructor will assign you a Hall of Fame candidate.
3. Using all available resources, research the scientist's field, discoveries, accomplishments and impacts they had on the world.
4. Using the information found, create a handout about the scientist using the template provided. Be sure to gather the following pieces of information:
  - Time period the scientist was relevant
  - Country where the scientist was from
  - Major discoveries, innovations and accomplishments
  - Impact the scientist had on society
  - How the scientist impacted research methodology (specific to their field or overall)
5. Include a photo of the scientist in your handout.
6. Create a citation sheet listing all sources used.
7. Be prepared to share your handout with the class in a gallery walk.
8. After the gallery walk, submit your handout to your instructor.

**NAME OF SCIENTIST**

(time period the scientist was relevant)

[Country]

# IMAGE OF SCIENTIST

Major discoveries, innovations and accomplishments:

Impact the scientist had on society: