

# The Scientific Process in Diagnosis

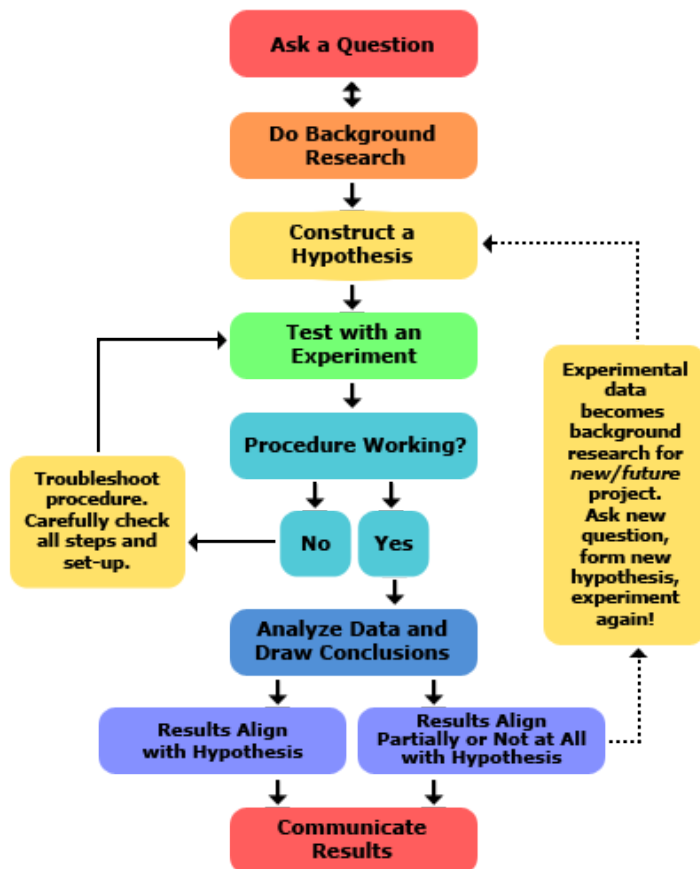
## HASPI Medical Biology Lab 01a

### Background/Introduction

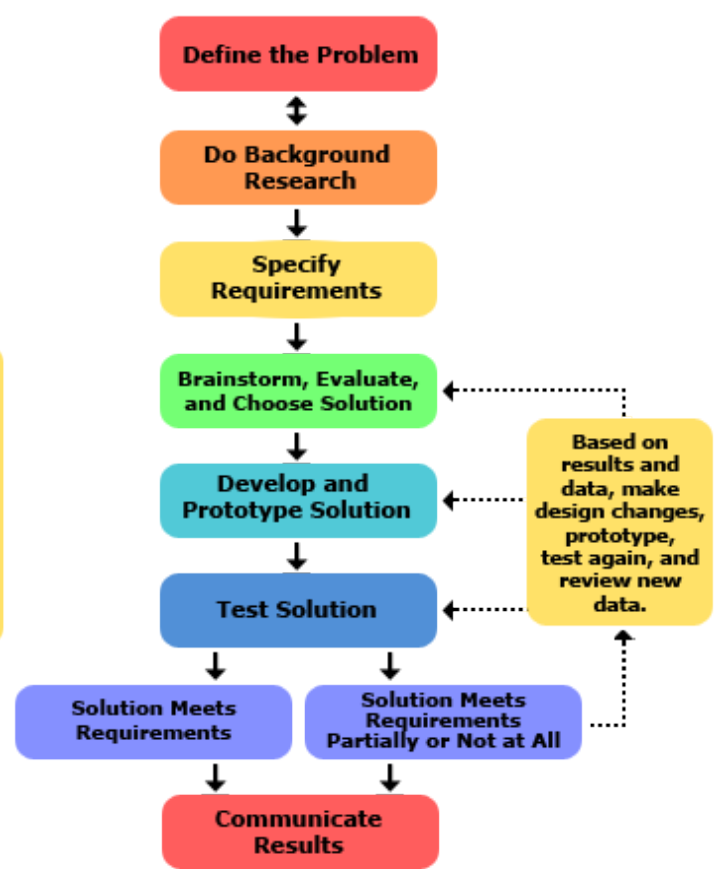
### Science and Engineering

Science is the study of the natural world. The **scientific method** is a process used to study science. While the scientific method is often presented as a linear step-by-step process, it is actually much more complex requiring repeated re-evaluation and adjustments as experiments are being performed. On the other hand, engineering is the creation of new things, often based on the results of scientific experimentation. Engineers use a more creative **engineering design process**. The flow charts below outline the process used in science and engineering.

#### Scientific Method



#### Engineering Method

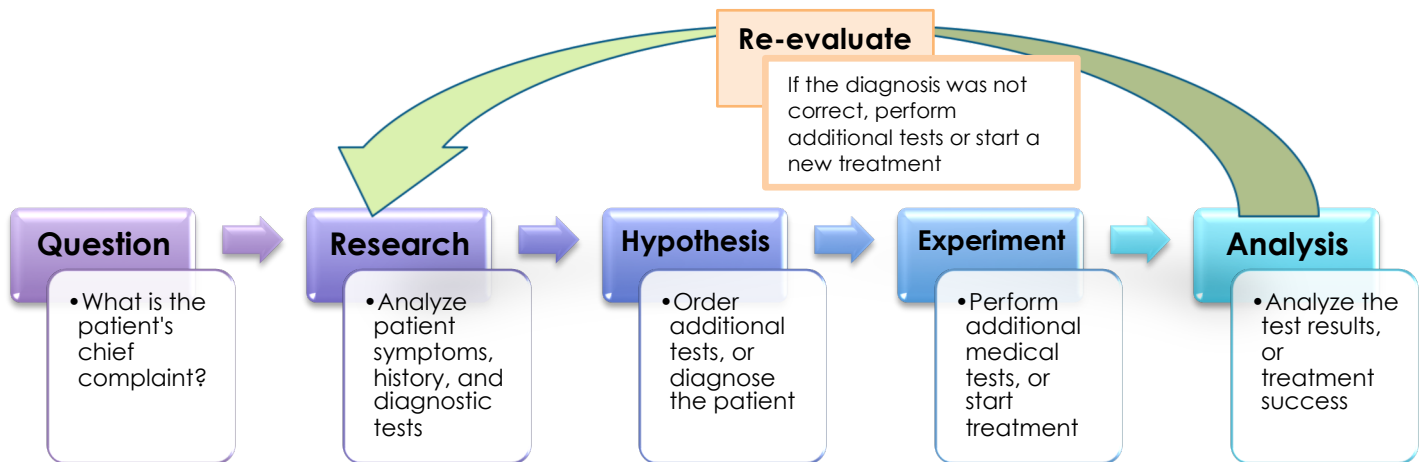


[http://www.sciencebuddies.org/science-fair-projects/project\\_scientific\\_method.shtml](http://www.sciencebuddies.org/science-fair-projects/project_scientific_method.shtml)  
<http://www.sciencebuddies.org/engineering-design-process/engineering-design-process-steps.shtml>

As seen above, scientists use the scientific method to produce testable explanations and theories. They make observations, ask questions, hypothesize answers, and develop/perform experiments in an attempt to provide answers to the questions. Engineers use the design process to produce and test solutions to given problems. Scientists and engineers both contribute greatly to the medical field and healthcare, but in different ways.

## Science and Engineering in Medicine

The scientific process in healthcare is most obviously seen in medical diagnosis. The medical diagnosis is an example of science in action. A patient comes to a healthcare professional with a chief complaint, or health concern, which provides the question. The healthcare professional then analyzes the patient's symptoms, medical history, and condition to determine a diagnosis. The initial diagnosis is considered a hypothesis. To experiment and determine whether the initial diagnosis is correct, the healthcare professional may order additional diagnostic tests or start treatment based on the initial diagnosis. This is considered the experiment. The diagnostic test results, or the treatment results, are then analyzed to confirm or negate the diagnosis. If the initial diagnosis was correct, treatment will be started or continued. If it was incorrect, additional tests or a different treatment will be started. This process repeats until the correct diagnosis for the patient has been determined.



Engineering principles and designs can be seen throughout the medical field. The specific branch of engineering that works within the realm of medicine is called biomedical engineering. Biomedical engineering can be used to produce diagnostic and therapeutic equipment, imaging equipment, tissue and cell lines, prosthetics, and pharmaceutical drugs as a few examples. Medical machines, such as the digital x-ray, surgical robots, and even diabetes monitors are all the result of biomedical engineering. Entire careers can be built around engineering new and existing products that improve healthcare.

## Worldwide Health Issues and Constraints

Worldwide diseases, epidemics, and public health are a very real problem facing the human population. Evaluating a solution to a complex real-world problem, such as how to handle epidemics, is based on prioritized criteria and trade-offs that take into account a range of constraints. Such constraints include cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. As a result, these complex issues do not necessarily have a single solution.

Worldwide disease control frequently encounters these constraints. An example is the prevalence of measles cases in the United States. The measles virus is an extremely contagious disease that can be deadly. The measles vaccination was introduced largely in the 1960s. Before that time, more than 3 million people were infected and an estimated 500 deaths occurred yearly in the U.S. as a result of measles.

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Children are generally required to have the measles vaccination before starting school, and as of the year 2000 measles was considered eliminated in the United States due to widespread vaccination. While the measles virus is essentially eradicated in the U.S., it is still present abroad. When unvaccinated individuals travel abroad, they are at risk of a measles infection.

The simple solution to prevent measles epidemics in the U.S. was widespread vaccination, which has proven to be effective, but additional constraints arose. From 1989-1991, more than 55,000 measles cases were reported. This was attributed to the lack of vaccination among uninsured children; the cost of the vaccination was a constraint. As a result, the U.S. government stepped in to provide vaccinations to uninsured children in 1994.

### Characteristics of Measles

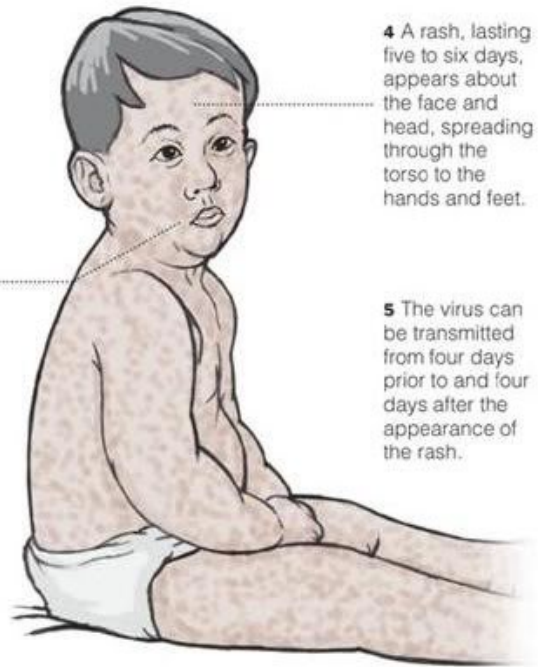
1 The virus is spread by breathing in virus-containing droplets or by touching contaminated surfaces.

2 The virus grows in cells in the back of the throat and lungs. Symptoms appear after 10 to 12 days.

3 Infected person has a fever lasting two to four days, followed by a cough, runny nose and red, watery eyes.

4 A rash, lasting five to six days, appears about the face and head, spreading through the torso to the hands and feet.

5 The virus can be transmitted from four days prior to and four days after the appearance of the rash.



<http://pakmed.net/college/forum/?p=68051>

More recently, the safety and reliability of vaccinations have been questioned. Parents now have the opportunity to exempt their children from childhood vaccinations for social or cultural reasons. This has caused a rise in the number of measles cases. In the first 3 months of 2014, 129 cases of measles were already reported, while the national average per year has been less than 160 cases. As a result of these constraints, experts predict a continued increase in the number of measles cases over the next several years. This one example shows that there are many constraints that must be taken into account in attempting the prevention of future measles and other epidemics.

### Review Questions – answer questions on a separate sheet of paper

1. What is the difference between science and engineering?
2. Compare and contrast the scientific process and the engineering process.
3. Explain how the scientific process is used in a medical diagnosis (outline EACH step).
4. In medicine, why do you think it is important that re-evaluation is part of the scientific process?
5. A patient goes to the doctor complaining of chest pain and shortness of breath. Explain how a doctor would use the scientific process to diagnose the patient.
6. How does engineering impact the medical field? Give at least 3 examples.
7. Worldwide health issues are complex real-world problems. Why is there often not a single solution to these problems?
8. Explain why widespread vaccination for measles has not eradicated the disease.

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## The Scientific Process in Diagnosis

### HASPI Medical Biology Lab 01a



Health and Science  
Pipeline Initiative

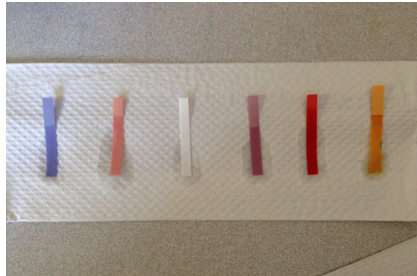
#### Scenario

Complex real-world problems can be solved by breaking them down into smaller, more manageable problems. When diagnosing a patient, it is important to collect patient information, physical exam observations, medical history, and diagnostic tests to determine a diagnosis, and start treatment. In this activity, you will evaluate and diagnose five patients based on the information provided and diagnostic test results. It will be necessary to break down and evaluate the observations and results separately to develop a correct diagnosis.

#### Materials

Glucose test strips	Patient A sample	Paper towels
Electrolytes test strips	Patient B sample	Lab answer sheet
Ferritin test strips	Patient C sample	Diagnostic Test Results sheet
Blood pH test strips	Patient D sample	Patient Information sheets (5)
Liver Enzymes test strips	Patient E sample	Medical Tests & Possible Diagnoses sheets (5)
White Blood Cell test strips	Forceps	

#### Directions

Task		Response
1	Find a partner.	
2	This is a station activity. There are 5 stations representing patient rooms spread throughout the classroom. Each station has information and samples for an ill patient.	
3	Choose a patient station. Look through the "Patient Information" sheet and answer questions 1 & 2 on the lab answer sheet.	
4	Look at the "Diagnostic Tests & Possible Diagnoses" sheet. Four possible diagnoses have been provided, with a description and the diagnostic test results that would occur if the patient has that diagnosis. Answer question 3 on the lab answer sheet.	
5	A patient fluid sample has been provided, along with test sheets for each diagnostic test.	
6	Not all diagnostic tests need to be completed to find a diagnosis. Decide which diagnostic tests you will perform.	
7	To perform each test, remove a test paper from the bag with forceps. <b>DO NOT USE YOUR FINGERS!</b>	
8	Open the patient sample. Using the forceps, dip half of the test paper in the patient sample.	
9	Place the test paper on a paper towel and wait 20-30 seconds before observing the results.	<p><b>Results Example</b></p> 
10	Record any color change in the diagnostic test results table on the lab answer sheet.	
11	Look at the "Diagnostic Test Results" sheet to determine what the color change could indicate.	
12	Using all of the information collected, diagnose your patient in question 4 on the lab answer sheet. Explain what observations or test results led to that diagnosis.	

## Connections & Applications

Your instructor may assign or allow you to choose any of the following activities. As per NGSS/CCSS, these extensions allow students to explore outside activities recommended by the standards.

- THE SCIENCE PROCESS IN MEDICINE:** House M.D. is a television program that has had several seasons on Fox since 2004. House focuses on the diagnostic process for difficult medical cases. Choose any episode of House to watch. As you watch the episode, answer the following questions:
  - What is the episode number and title?
  - What are the patient's symptoms?
  - What information, if any, was found during the physical exam?
  - Is there any medical or family history related to the symptoms?
  - What is the initial (first) diagnosis?
  - How is the patient being treated?
  - Was the treatment effective? If not, what was the next step used by the medical team?
  - How was the diagnosis process similar to the scientific process (observation, hypothesis, experiment, results, re-evaluate the hypothesis)?

- SYMPTOM CHECKER:** Go to the following website:

<http://symptoms.webmd.com/#introView>

The Internet provides a wealth of information, especially when it comes to looking into diseases and diagnoses. This can be both helpful and dangerous, particularly for hypochondriacs! Regardless, the ability to check symptoms assists individuals in determining whether they should seek medical help for a condition. For the following three individuals, use the WebMD symptom checker to check each symptom, complete the table, and answer the questions. Leave the "Zip code" and "Email" blank. Use the "Search Symptoms" box at the bottom of the page.

- Your friend Thomas Toms is a 15-year-old male. He is the star of the football team, and has always been very healthy. He and his family recently returned from a cruise in Thailand.

Symptoms	What condition could he have? <i>(list the top 5 possible conditions after submitting each symptom)</i>
<b>Cough:</b> can be felt in the chest, with yellow sputum	
<b>Fever:</b> 102.7° F and increases with exercise	
<b>Fatigue:</b> severe, made worse with exercise; better with rest	
<b>Diarrhea:</b> severe, bloody, and nothing makes it better	

- What is the most likely cause of this individual's condition? Describe the condition. What brought you to this conclusion?
- Should he seek medical help? Why or why not?

Name(s):

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b. Your friend's aunt Hilda Higgins is a 28-year-old female. She is not currently taking any medications. She has not traveled or had surgery recently.

<b>Symptoms</b>	<b>What condition could she have?</b> <i>(list the top 5 possible conditions after submitting each symptom)</i>
<b>Anxiety</b>	
<b>Dry skin:</b> over her entire body	
<b>Constipation</b>	
<b>Dizziness</b>	
<b>Wheezing</b>	
<b>Headache:</b> severe, throbbing, at the back of the head; appeared suddenly and does not go away	

- i. What is the most likely cause of this individual's condition? Describe the condition. What brought you to this conclusion?
- ii. Should she seek medical help? Why or why not?

c. Your retired elementary school teacher Wanda Woo is a 66-year-old female. She had hip replacement surgery a year ago, and spent the last 6 months in Papua New Guinea living with a native tribe in the jungle.

<b>Symptoms</b>	<b>What condition could she have?</b> <i>(list the top 5 possible conditions after submitting each symptom)</i>
<b>Decreased appetite</b>	
<b>Difficulty swallowing</b>	
<b>Difficulty walking:</b> in general	
<b>Dizziness</b>	
<b>Easily distracted</b>	
<b>Frequent infections</b>	
<b>Trembling</b>	

- i. What is the most likely cause of this individual's condition? Describe the condition. What brought you to this conclusion?
- ii. Should she seek medical help? Why or why not?

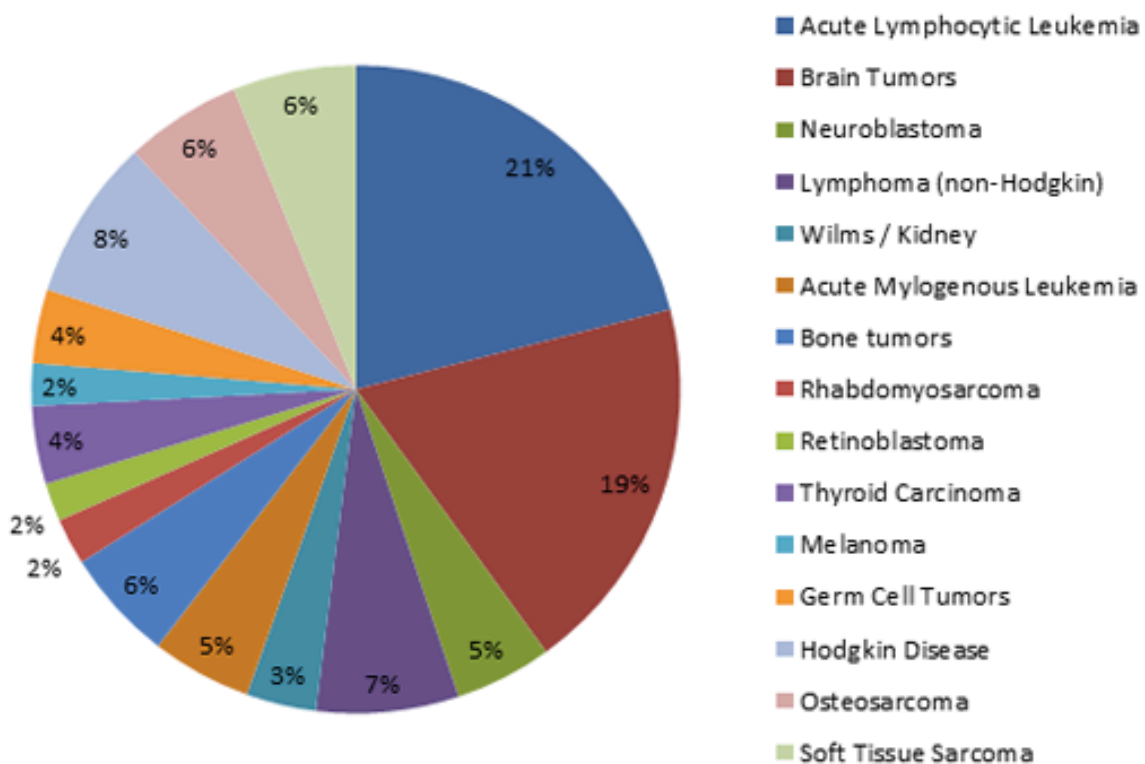
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3. **ANALYSIS OF DIAGNOSTIC DATA:** Chart A below contains the prevalence of childhood cancer types by diagnosis. Using Chart A and Internet research, answer the following questions.
- It is important to check the validity of a resource before using information found within that resource. How can we be sure the values provided in Chart A are accurate? Using the Internet, determine the validity of Chart A. Provide links to charts or papers with the same or very similar data.
  - What is the most prevalent type of childhood cancer? Provide a description of this cancer type.
  - What is the least prevalent type of childhood cancer(s)? Provide a description of these cancer type(s).
  - A total of 15,500 patients were taken into account for this data. Do you think the data would be as accurate with only 1,000 patients? Explain your answer.
  - How can data like this be used by healthcare professionals to better prepare and treat childhood cancer types? Explain your answer.

**CHART A. Childhood Cancer Types & Prevalence**  
**Number of Diagnoses**  
**Total= 15,500**



Source: American Cancer Society, Inc.

<http://www.curesearch.org/uploadedImages/MedicalInformation/NumberOfDiagnoses.png>

**Name(s):**

**Period:**

**Date:**