

MEDMYST MAGAZINE

A Companion to Web Adventures at <http://medmyst.rice.edu>

1.6

DISEASE CONTROL



Once a new disease has been identified, health professionals and policy makers must come up with ways to control its spread.

Disease control involves several actions, such as monitoring new outbreaks, avoiding contact with animal vectors that carry the disease, developing a new vaccine, or administering an existing vaccine.

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LAB IN A Backpack

Disease Diagnosis in Remote Areas

One of the first steps in controlling infectious diseases is to diagnose them correctly. What if you found yourself in a part of the world without a medical clinic or reliable electricity? How would you diagnose the illnesses of local villagers? Thanks to some clever bioengineering students at Rice University in Houston, Texas, a low-cost, practical solution is available.

The college students developed **lab-in-a-backpack**. The idea is simple; include batteries that last for days instead of hours and design power packs that use solar energy. There is a mini-microscope, a centrifuge (a device for spinning lab samples), an otoscope for examining ears, and a pulse oximeter to measure oxygen levels in the blood. And the pack weighs only 40 pounds when fully loaded!



Beyond Traditional Borders: Use Your Imagination to Improve Disease Detection!

Beyond Traditional Borders (BTB) offers college students the chance to create health solutions that impact the poorest places in the world. Creativity, science and technology are combined to solve health problems. Examples of projects are:

- **labs-in-a-backpack** and additional backpacks for women's health care, dental care, and eye care.
- an **IV drip monitor** to control the rate that fluids are put intravenously into patients' blood.
- a **neonatal pulse oximeter** to measure oxygen levels in the blood of newborn babies.
- a **bilingual dosing guide** that uses diagrams and simple text to instruct parents on how to give medication to their children.
- an inexpensive **warming crib** for premature and ill newborns who are not good at regulating their own body temperatures.
- a low-cost **phototherapy device** used to treat jaundice in newborns.

As part of the program, students go to underdeveloped countries to assess needs, test their ideas in local clinics, and return with a deeper understanding of the problems facing these communities.

Get more info on the BTB program at:
beyondtraditionalborders.rice.edu.



Photos courtesy of Beyond Traditional Borders

Using items in the backpack, healthcare workers can more easily diagnose diseases like malaria and tuberculosis, and identify the causes of diarrhea. This ingenious backpack has already been used in 14 different countries from Ecuador to Tanzania.





EMERGING ZOOONOSES

A DISCOVERY-TO-CONTROL CONTINUUM CONUNDRUM!

PART TWO

SCIENTISTS
WORKING

Emerging zoonoses are new diseases transmitted to humans by animals or insects. Can you think of some diseases transmitted by animals? In our previous issue, we discussed **DISCOVERY**, the process that health professionals use to figure out if a disease outbreak is occurring and what is causing it. DISCOVERY involves answering the question,

What is going on here?

If we DISCOVER that an outbreak has occurred and we identify the pathogen that is making people sick, we need to figure out how to keep the disease from spreading and from re-occurring. This brings us to the second part of the continuum, **CONTROL**. The CONTROL part helps us answer the question,

What are we going to do about it?



DIAGNOSTICS

These are the tests that help identify who is sick or likely to get sick.

The tests should be cheap and quick so that they can be used in a lab or in the field without a lot of specialized equipment.

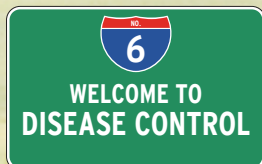


DRUGS

New drugs, or therapeutics, should be developed so that we can treat people that already have the disease.

VACCINES

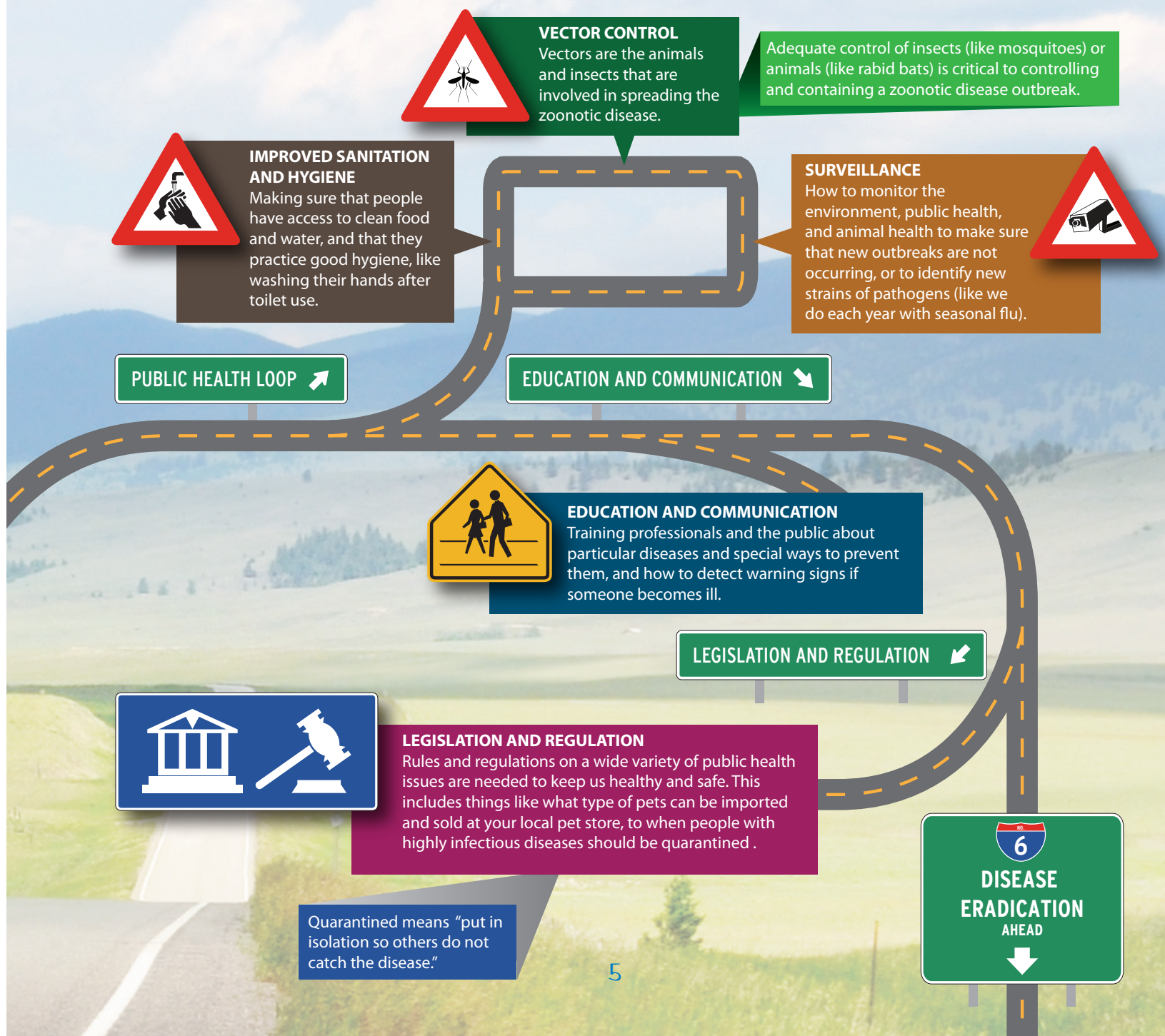
Research helps us develop new vaccines to prevent the disease from spreading in both humans and animals.



Disease control is not easy! It takes a concerted effort by many different people to control an emerging zoonotic disease, and then it takes a coordinated effort to keep a disease under control. **Disease eradication**, or getting rid of a disease agent for good, is the ideal, but this is very difficult to do with zoonotic disease agents because they usually are in the environment or are transmitted by insects that are too numerous to control.

The **smallpox virus** was eradicated in 1979, and public health workers think we will be able to eradicate the **polio virus** very soon. But neither smallpox nor polio are zoonotic agents. Both are spread by person-to-person transmission. This made it easier to control these diseases through a vaccination campaign.

When it comes to CONTROL, things can get pretty complicated! Let's look at just a few areas to see how we attempt to CONTROL zoonotic diseases:



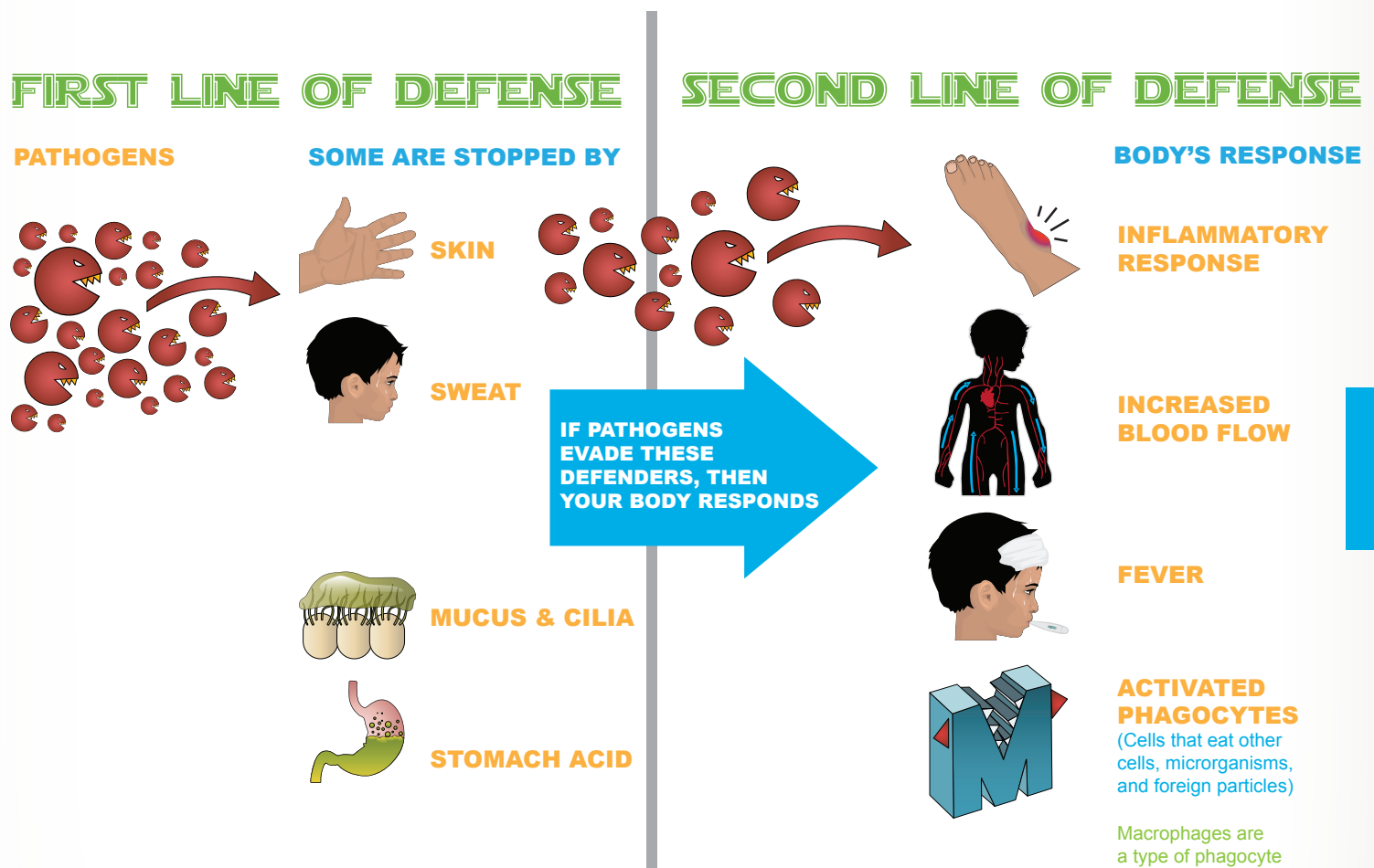
IMMUNE RESPONSE

PREPARE FOR BATTLE!

The immune system is your body's way of defending against pathogens (germs). Your body is fighting off invading pathogens all the time – sometimes the *innate immune response* can stop the invasion. Other times your body requires the *adaptive immune response* to join the battle. Check out how your body is armed for the fight.

INNATE IMMUNITY: NON-SPECIFIC DEFENDERS

You are born with *non-specific immune defenders* that can work against most invading pathogens. Look below to see how *innate immunity* serves to fight pathogens.

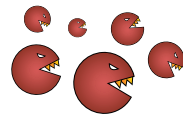


ADAPTIVE IMMUNITY: **SPECIFIC DEFENDERS**

Sometimes the *innate immune system* cannot fight invading pathogens. When this occurs, the specific defenders of the *adaptive immune response* are activated to fight off specific types of pathogens.

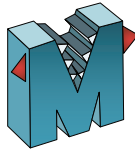
IF PATHOGENS
EVADE INNATE
IMMUNITY, THEN
YOUR BODY RESPONDS

Antigens, which are proteins from the pathogen, signal your body that a “foreign” intruder is present. A battle then begins to eliminate the intruding pathogen.



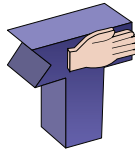
When **PATHOGENS**

evade the innate response,



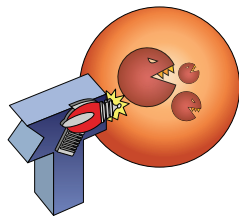
MACROPHAGES

capture antigens from the pathogen and alert

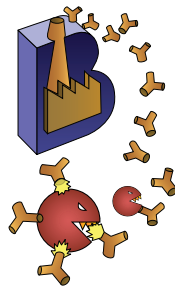


* **HELPER T CELLS** to continue the battle

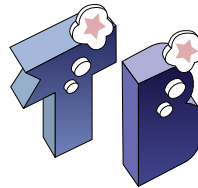
through complex interactions among immune cells and pathogens



KILLER T CELLS
destroy infected cells.



B CELLS
make antibodies that bind specific antigens and inactivate them.



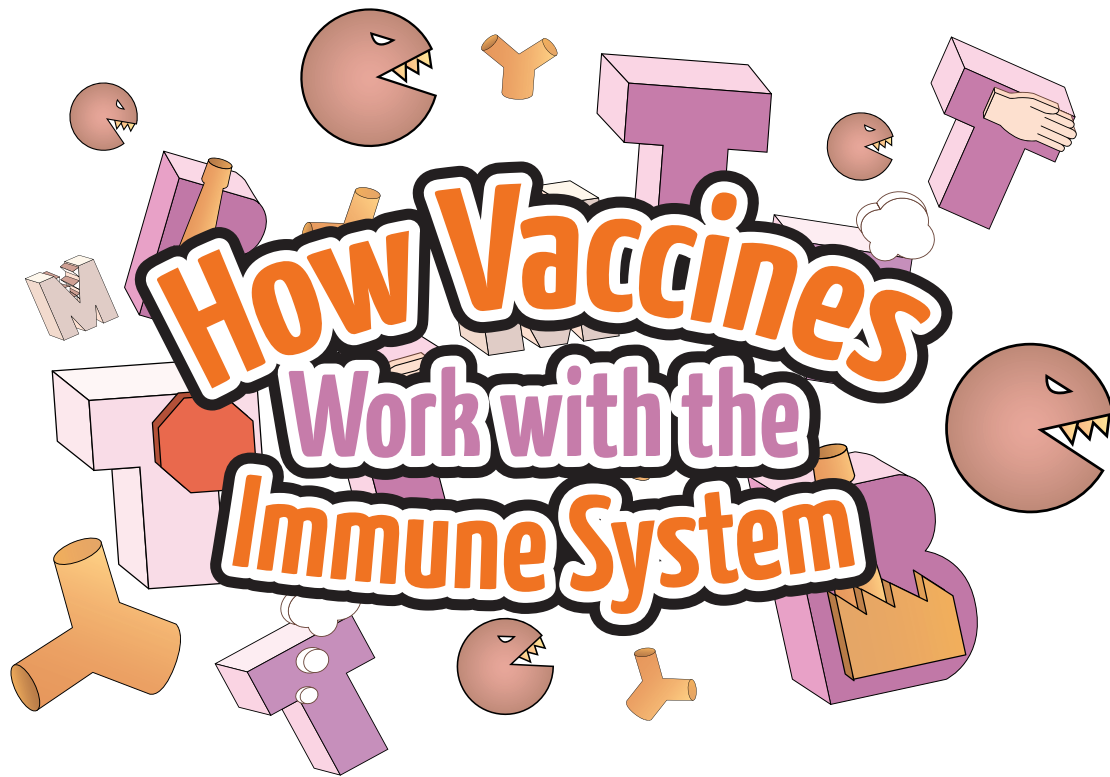
MEMORY B CELLS and MEMORY T CELLS

remain active and help the body remember the specific pathogen that attacked it by remembering the antigen. This provides future protection against the pathogen.

* Did you know?

Helper T cells are targeted and destroyed by HIV (Human Immunodeficiency Virus). Without helper T cells the body cannot make antibodies or properly eliminate infected cells. After years of battling HIV and trying to make enough helper T cells, the body eventually wears down and the immune system can no longer fight off pathogens. This leads to Acquired Immunodeficiency Syndrome, also called AIDS.

ARTWORK BASED ON DALE GLASGOW/NATIONAL GEOGRAPHIC STOCK



What's the connection between vaccines and cows?

The word **vaccine** comes from vacca, Latin for cow. How did this happen? Let's go back to 1796, when Edward Jenner was developing a way to prevent smallpox. He collected virus from the pus-filled lesions on the hands of milkmaids who had **cowpox**. Sounds disgusting! But cowpox is a much milder disease than smallpox, a disease that kills most people who get it and can leave people disfigured if they are lucky enough to survive.

The body's immune response to cowpox will protect a person from getting smallpox, so getting injected with cowpox pus was a lot better than getting smallpox! We have Louis Pasteur to thank for using the word "vaccine" to describe any mixture used to prevent a disease. "Vaccination" is the administration of the vaccine, usually by injection. But more on that later!



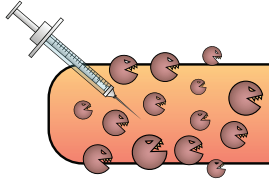
Photo courtesy of MedImmune, LLC.

How do vaccines work?



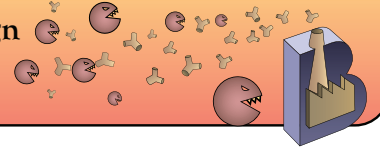
Vaccines provide active immunity to disease. Active immunity can be acquired by getting sick, say from a case of measles. Once you have measles, you won't get it again because you are immune. But there is a much easier way to become immune without getting sick, and that is where vaccines come in. Vaccines work with your body to trigger an immune response, just like if you had a disease. Memory B and T cells will be made and they will remember the specific antigens from the pathogen that attacked.

Here's how it works:



When a vaccine is given, a weakened form of the pathogen is injected into the body.

The immune system sees antigens from the weakened pathogen as foreign invaders. B cells make antibodies that match these specific antigens.



A person is left with a supply of memory B cells for future protection against the pathogen.

Vaccination continues to be the best way to control many diseases. One example is pertussis (whooping cough). Infants are most at risk to get very sick or die from the whooping cough. Because they are too young to get the vaccine, it is important that people around babies receive the vaccine. When most people are vaccinated, it protects those in the population who are vulnerable and cannot get the vaccine. This is known as **“herd immunity”**, which has nothing to do with cows, but just means a group of people are immune to a certain disease. Getting childhood vaccinations is very important. Unfortunately, misinformation about the side effects caused by vaccines has resulted in the re-emergence of diseases that were once under control.

Some people think it is better to let a person catch a disease “naturally.” Take chickenpox as an example. Some parents think it is better to let their child catch the disease when they are young because the disease is a lot worse in adults. However, chickenpox can lead to severe complications that could lead to a child’s hospitalization or even death. It is far better to get a chickenpox vaccine than to get “natural” chickenpox!

But I hate shots!

It’s true that most vaccinations given today are by shots, which inject antigens from a pathogen into your body, but scientists are looking for new ways to give vaccines. One new way is to inhale them. This is the case with the FluMist vaccine for seasonal influenza, which is inhaled through the nose. Inhalable powders known as aerosols have been shown to be an effective way to give a vaccine.



Photo courtesy of the United States Department of Agriculture. Photo by Keith Weller.

Scientists are also working on nanopatches, which are worn on the skin for a short time. The patches are made up of microscopic projections that deliver antigen to immune cells just below the surface of the skin.

Edible vaccines that can be given by mouth are also in the works, especially for pathogens that cause diarrhea. Some are quick dissolving films that melt into a liquid and can be swallowed easily. Edible vaccines are being engineered into vegetables, like potatoes and tomatoes, which will produce antigens from a pathogen and stimulate immunity after being eaten. The Sabin polio vaccine is one of the most widely used oral vaccines, and has greatly benefitted the fight to eradicate polio.

CLINICAL TRIALS



*Vaccines are developed to control disease.
But how do we know if new vaccines are safe and effective?
Clinical trials provide the answer.*

Often, scientists come up with promising new vaccines that work well in laboratory studies.
But how do we know if the vaccine is effective in people?

Clinical trials are well-designed studies involving humans. The purpose is to **compare** a new **vaccine, medication or treatment** to a **placebo (a harmless, look-alike medication)** or the current **standard medical treatment**. Without these carefully controlled studies it would be impossible to safely develop new vaccines.



*Which is the placebo and which is the vaccine?
They are made to look alike.*

How would you feel about volunteering for a clinical trial?

People are asked to **volunteer** for clinical trials. The benefits and the risks of the research are detailed for them. Then they can make their decision as to whether they want to participate. Researchers must obtain **informed consent** from participants. In other words, volunteers may sign up **ONLY AFTER** they are “informed” about the potential benefits and risks.



Usually the medical care associated with the trial is at no cost to the volunteers. Volunteers in clinical trials receive excellent care from the physicians conducting the study. The results of clinical trials advance our knowledge of medicine and ultimately help many people.

A person may be reluctant to participate in clinical trials because he or she has heard of past abuses in experiments involving humans. Today, scientists follow a **strict code of ethics**.

Safeguards have been developed to make sure that people are not exposed to risks for the benefit of others, and that they are not made to feel like “guinea pigs.” Regulations known as the *Federal Policy for the Protection of Human Subjects*, along with Food and Drug Administration rules regarding testing of certain products, applies to research involving people. These regulations make sure that institutions conducting research comply with all the rules when humans are involved.

How is a clinical trial planned?








Typically, volunteers are **randomly assigned** (using a computer program) to either the **investigational group** or the **control group**. Some of volunteers will get the new vaccine and some will get the **placebo**. A placebo is a treatment designed to look like the medicine being tested, but is really just a harmless alternative. For example, the placebo could be salt water in the same type of bottle as the vaccine.

So that the results will not be biased, **double-blind studies** are often set up. This means that neither the participants nor the researchers know who belongs to the control group and who belongs to the investigational group. Only after the study is complete is this information revealed.

What are the steps in a clinical trial?

Safety is the utmost consideration. We can’t just give a new vaccine and ask a large number of people to get it without first seeing if the vaccine is safe. We also need to know the dose at which the vaccine is effective. For these reasons, clinical trials are done in **phases**. Each of the four phases is designed to ask a specific question, and usually involves an increasing number of participants.

	Pre-clinical Studies	Phase 1	Phase 2	Phase 3	Phase 4
					
Number of Participants	No human volunteers; studies usually done in cells or animals	15-30 volunteers	Less than 100 volunteers	100 to 1000s of volunteers	100 to 1000s of volunteers
Purpose	TO TEST A DRUG OR TREATMENT BEFORE IT IS GIVEN TO PEOPLE A wide range of doses are examined to determine how well a vaccine works, if it is toxic, and what doses are effective	SAFETY Determine what dose is safe, how to give the vaccine (by mouth? by injection?), and its effect on the body	HOW WELL THE NEW TREATMENT OR VACCINE WORKS, CONTINUED SAFETY TESTING To see how the vaccine affects the body (does the person develop an immune response?), what dose is best, and to make sure it is safe in a larger number of people	TEST A NEW DRUG OR VACCINE IN LARGE NUMBERS OF PEOPLE Monitor safety and side effects, and evaluate effectiveness of the vaccine; randomized trials are common in Phase 3 studies	CONTINUING EVALUATION Usually the drug or treatment has been approved and is on the market. The goal is to study the long-term safety and effectiveness, including any side effects, risks, and benefits. These trials can last for years

BAT FACTS

- Bats are the natural reservoir for some zoonotic diseases (diseases that are transmitted from animals to humans), like Nipah (KNEE-pah) virus and rabies virus.
- Bats are the only mammals that fly.
- Like other mammals, bats produce milk to nurse their young (called pups).
- Some bats fly very long distances when migrating.
- Bats feed at night, and spend the day sleeping in caves, tree tops, under bridges, or in buildings.
- Most smaller bats rely on ECHOLLOCATION, in which they make high-pitched squeaks that bounce back (or echo) when the sound waves vibrate off an object, and their sensitive hearing tells them where objects are located, including prey.

FLYING with BATS

There are over 900 bat species, and the smallest is the size of a jellybean!

To learn about saving bats and our ecosystem, check out:
<http://www.batconservancy.org/>

Most people don't know that our wings are stretched across our fingers. Bat fingers have the same number of bones humans fingers do.

Fossilized remains of bat skeletons indicate that we have been around for at least 50 million years!

Why do bats fly at night?
Because we can't drive!

WORD SEARCH

Can you find the hidden words? Search carefully because they can be backwards and diagonal.

S F Y L W S T C E S N I H
N I G H T T I M E S R W T
O N O I T A C O L O H C E
I G P O L L I N A T O R E
T E F U R A B I E S I S T
A R R I P M V A F P O R T
R S U F U M E W M U A F K
B W I N G A C A V E R V I
I O T E E M V F L Y E R S
V N I P A H A B I T A T Y

ECHOLLOCATION
NIGHTTIME
FINGERS
FURRY
WING
POLLINATOR

FRUIT
INSECTS
RABIES
NIPAH
VAMPIRE
VIBRATIONS

TEETH
FLYERS
HABITAT
CAVE
MAMMAL
PUP

BATS HAVE GOTTEN A BAD RAP

- Only a few species of bats drink blood. Most eat insects and fruit.
- Bats are very important to the ecosystem. When they feed on flowers and fruit, they pollinate and disperse seeds. Because bats tend to fly long distances, they help maintain a wide plant diversity in the forests.