

# Principles of Environmental Hygiene and Sanitation

by

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**Lecture 1**

# Sanitation

- “All precautions and measures which are necessary in production, processing, storage and distribution, in order to assure an unobjectionable, sound and palatable product which is suited for human consumption”-(WHO)
- Sanitation from Greek (Sanitas – Health)

N. G. Marriott- “The creation and maintenance of hygienic and healthful conditions”

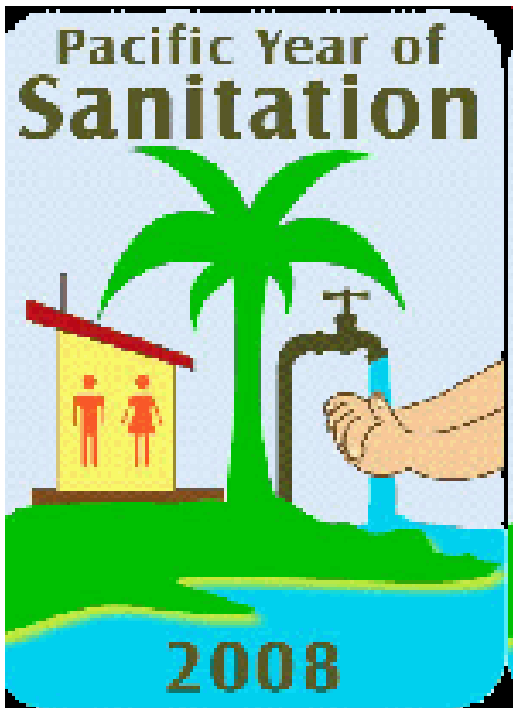


**"Sanitation"** in this Guide refers to the infrastructure and service provision required for the safe management of human excreta, e.g. latrines, sewers, and wastewater treatment.

**"Hygiene"** in this Guide refers to the set of human behaviors related to safe management of excreta, e.g. washing hands with soap at appropriate times, the safe disposal of child feces etc.



October 15, 2010



# Observed rate of hand washing in some countries

Setting	Handwashing with Soap	Prevalence
Kerala State, India	After defecation	34 percent
	After cleaning up a child	35 percent
Ghana	After defecation	3 percent
	After cleaning up a child	3 percent
Peru	After defecation	6 percent
	After cleaning up a child	30 percent
Senegal	After defecation	31 percent
	After cleaning up a child	26 percent
Kolkata, India (slums)	After defecation	16 percent
Kyrgyzstan (rural)	After cleaning up a child	0 percent
	After using a toilet	18 percent

Nigeria (rural)	After cleaning up a child	10 percent
<hr/>		
Burkina Faso (urban)	After cleaning up a child	13 percent
	After using a toilet	1 percent
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Brazil (childcare centers)	After cleaning up a child	16 percent
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Lima, Peru (shanty town)	After defecation (soap use 'rare')	12 percent
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Northern England (peri-urban)	After cleaning up a child	47 percent
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Pakistan	??	??

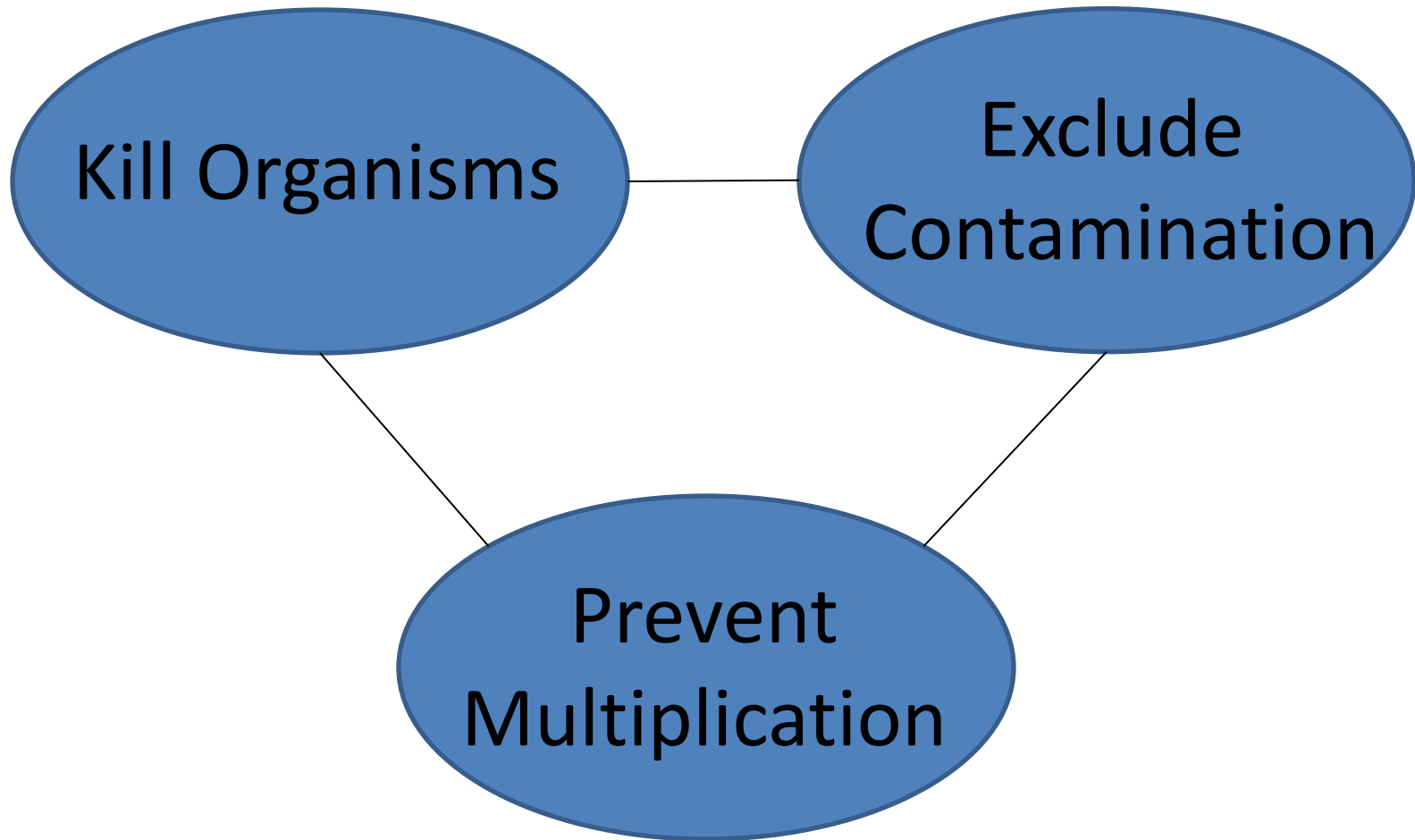
Water, Sanitation and Hygiene are the building blocks for achieving prosperity



Results of public poll of the top 15 medical advances since 1840, from over 11,000 votes.

<b>Most important advance</b>	<b>Number</b>	<b>Proportion (%)</b>
Anaesthesia	1574	13.9
Antibiotics	1642	14.5
Chlorpromazine	73	0.6
Computers	405	3.6
Discovery of DNA structure	1000	8.8
Evidence-based medicine	636	5.6
Germ theory	843	7.4
Immunology	182	1.6
Medical imaging (x-rays, etc.)	471	4.2
Oral contraceptive pill	842	7.4
Oral rehydration therapy	308	2.7
Risks of smoking	183	1.6
<b>Sanitation</b>	<b>1795</b>	<b>15.8</b>
Tissue culture	50	0.4
Vaccines	1337	11.8
<b>Total Respondents</b>	<b>11341</b>	<b>100</b>

# Sanitation Basics



Microorganisms

```
graph TD; A[Microorganisms] --> B[Bacteria]; A --> C["Fungi (mold/yeasts)"]; A --> D[Viruses]
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Bacteria

Fungi  
(mold/yeasts)

Viruses

# Beneficial Microorganisms

- Fermentation
  - Cheese, Bread, Yogurt
- Enzymes
- Aids to human metabolism
- Decay
  - Waste treatment, composting, decomposition

# “ The Enemies”

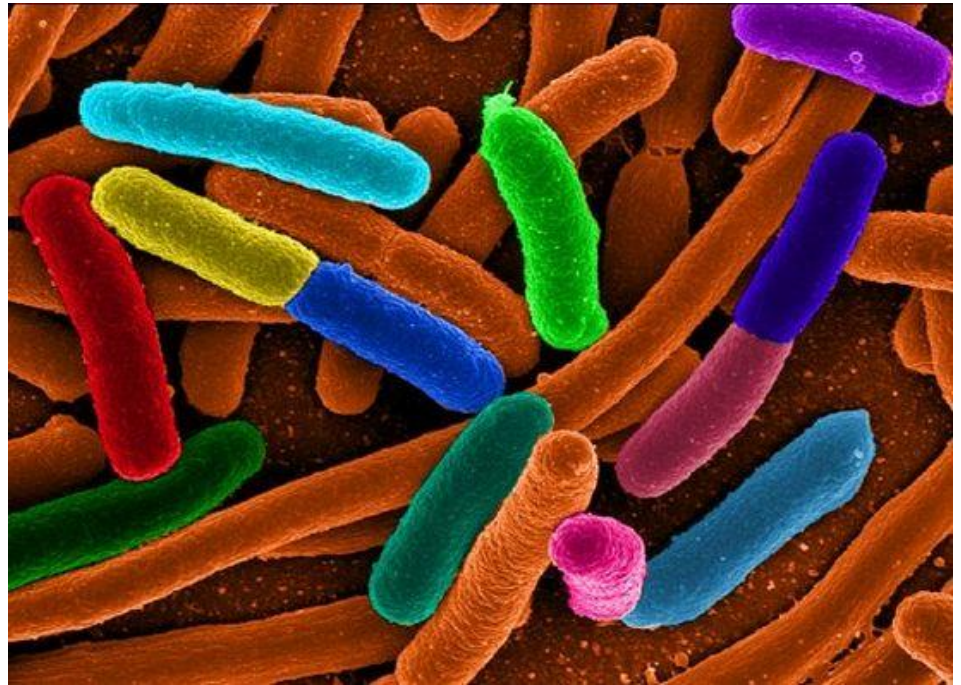
- Pathogens – Food Safety
  - Illness, disease and death
- Spoilage – Food Quality
  - Poor quality, short shelf life, off flavors, customer dissatisfaction



"I HEAR THAT THEIR HOSPITALS  
ARE KILLING MORE PEOPLE THAN WE ARE..."

# Bacteria

- Microscopic single cells
- Lots of moisture required
- Cause most food illness
- Three basic shapes
  - Rod
  - Cocci
  - Spiral
- Some spore formers
- Grow, grow, grow
  - Binary fission



*E. coli*

# Growth of bacteria

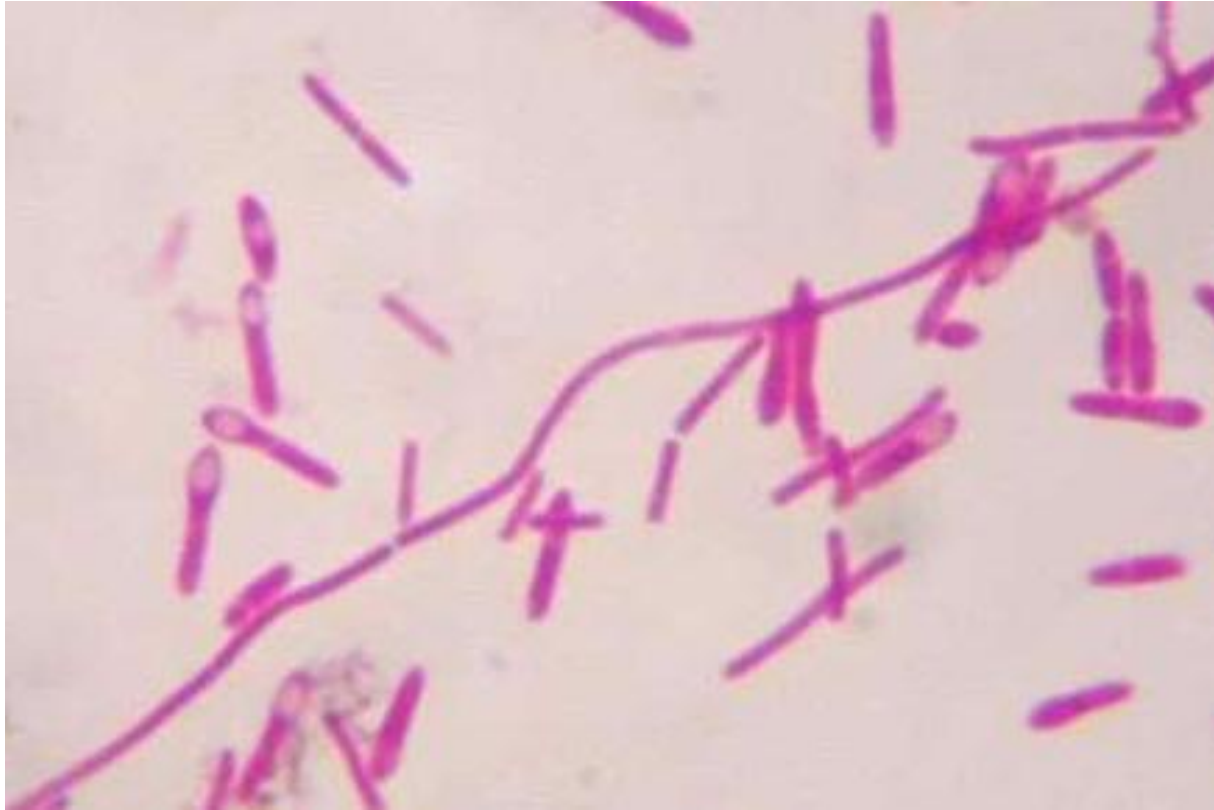
## Requirements

- Food
- Acid (pH)
- Time
- Temperature
- Oxygen
- Moisture

# The Spores

- Spores VERY resistant
- Two species from spores
  - Bacillus
  - Clostridium
- Difficult to destroy-reduce strategy
- Problem in cooked foods

Example: Clostridium

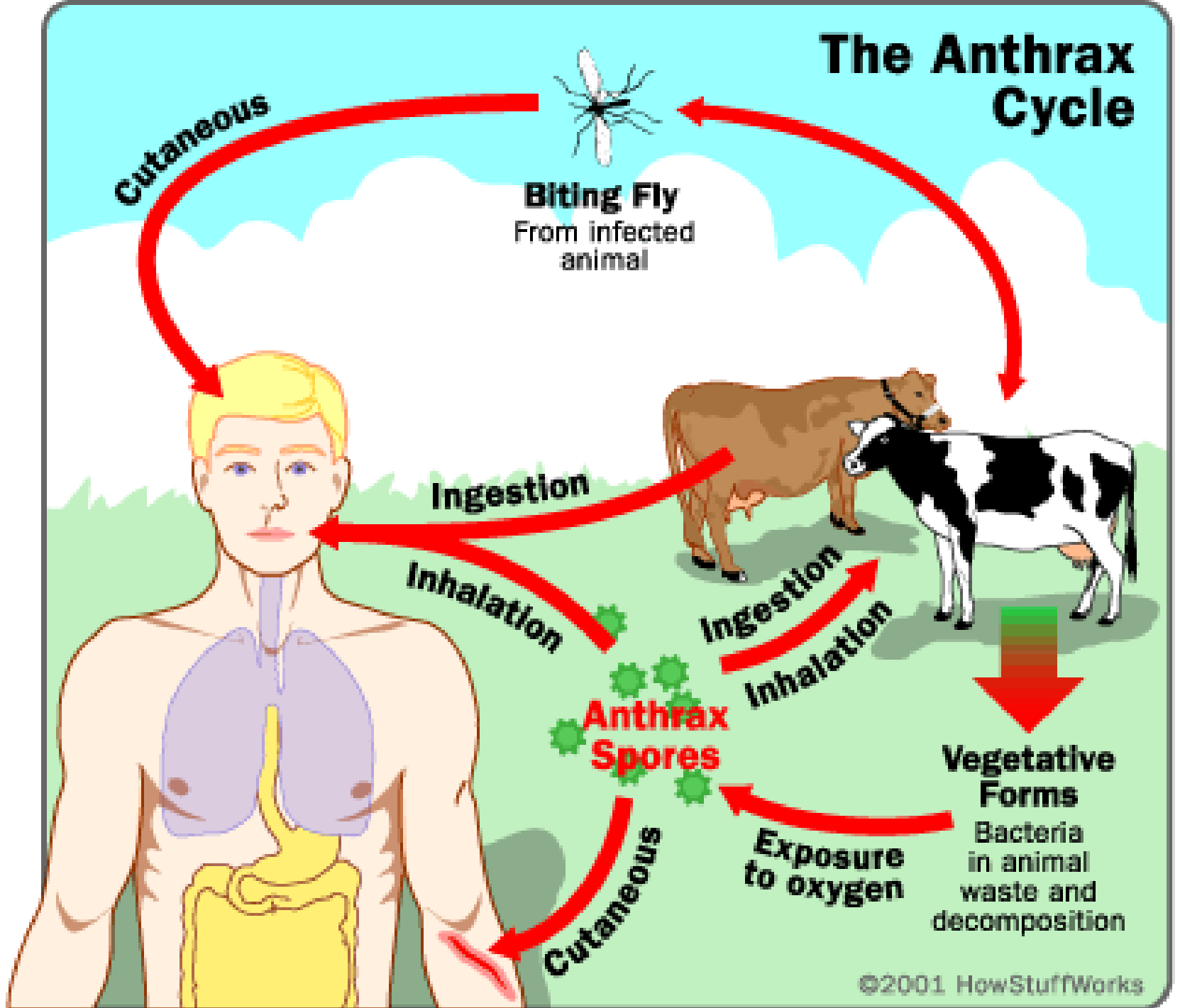


Example: Bacillus

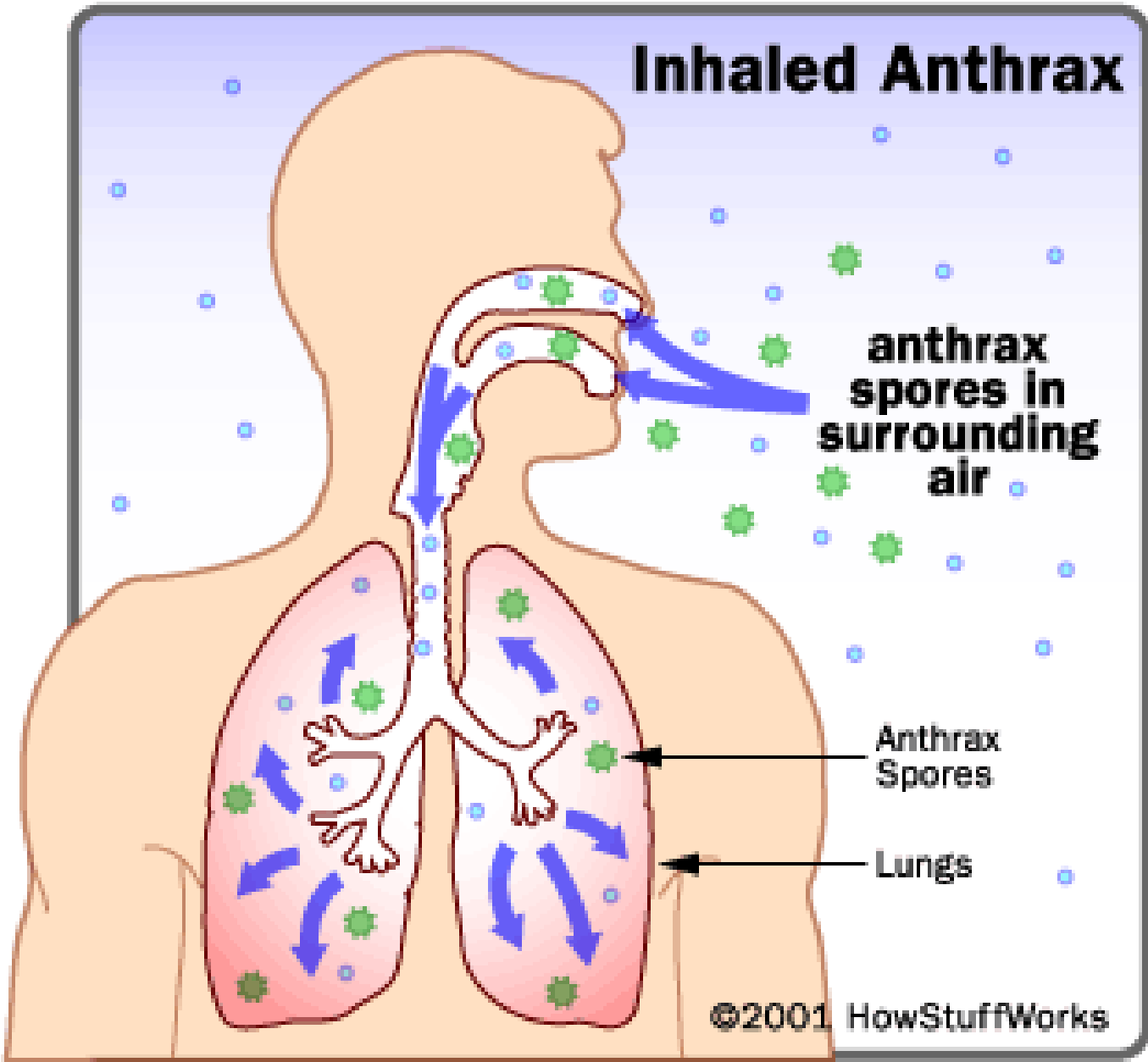


**Anthrax bacteria (*Bacillus anthracis*), stained**

# The Anthrax Cycle



# Inhaled Anthrax



anthrax spores in surrounding air

Arthrax Spores

Lungs

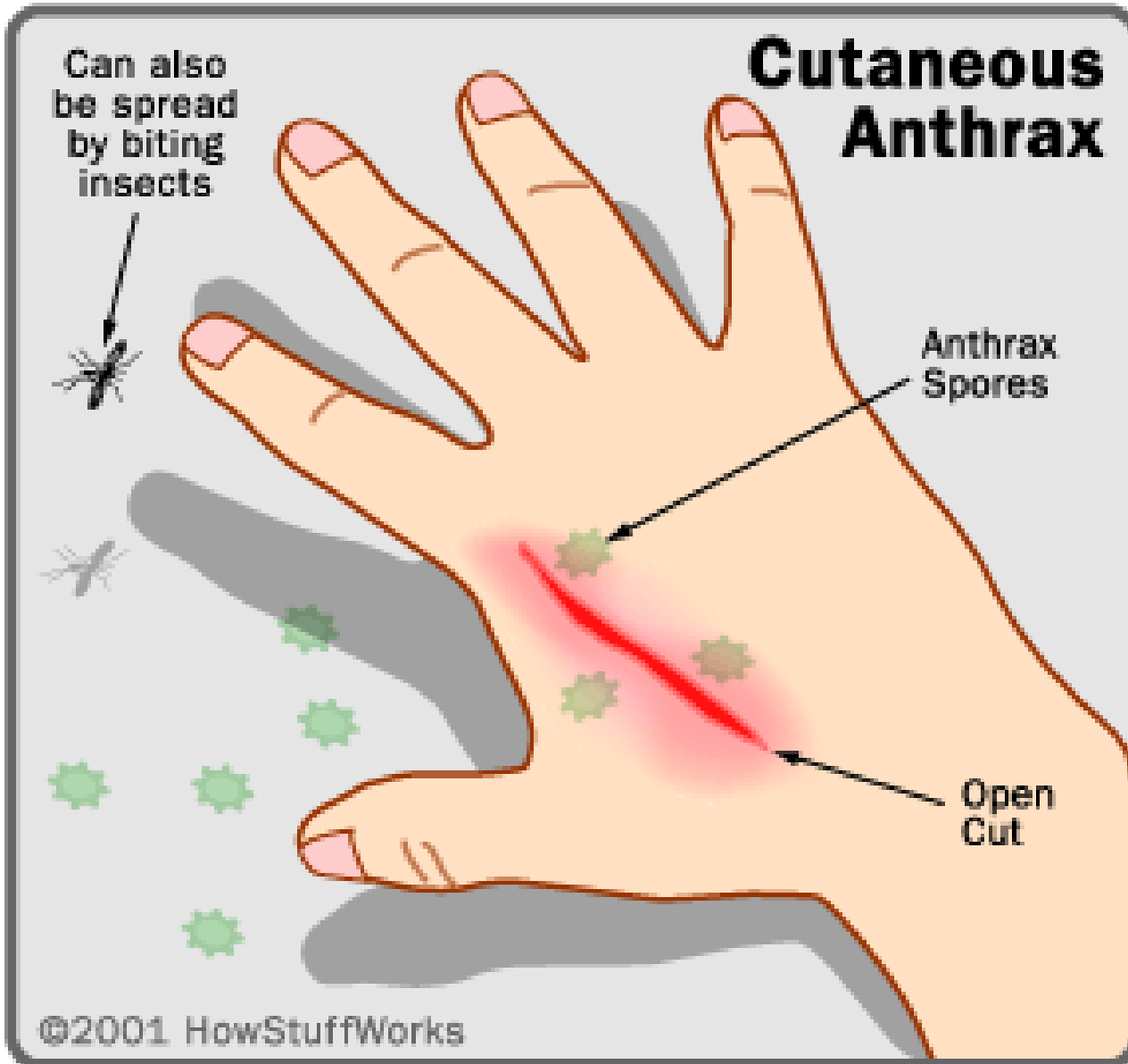
# Cutaneous Anthrax

Can also be spread by biting insects

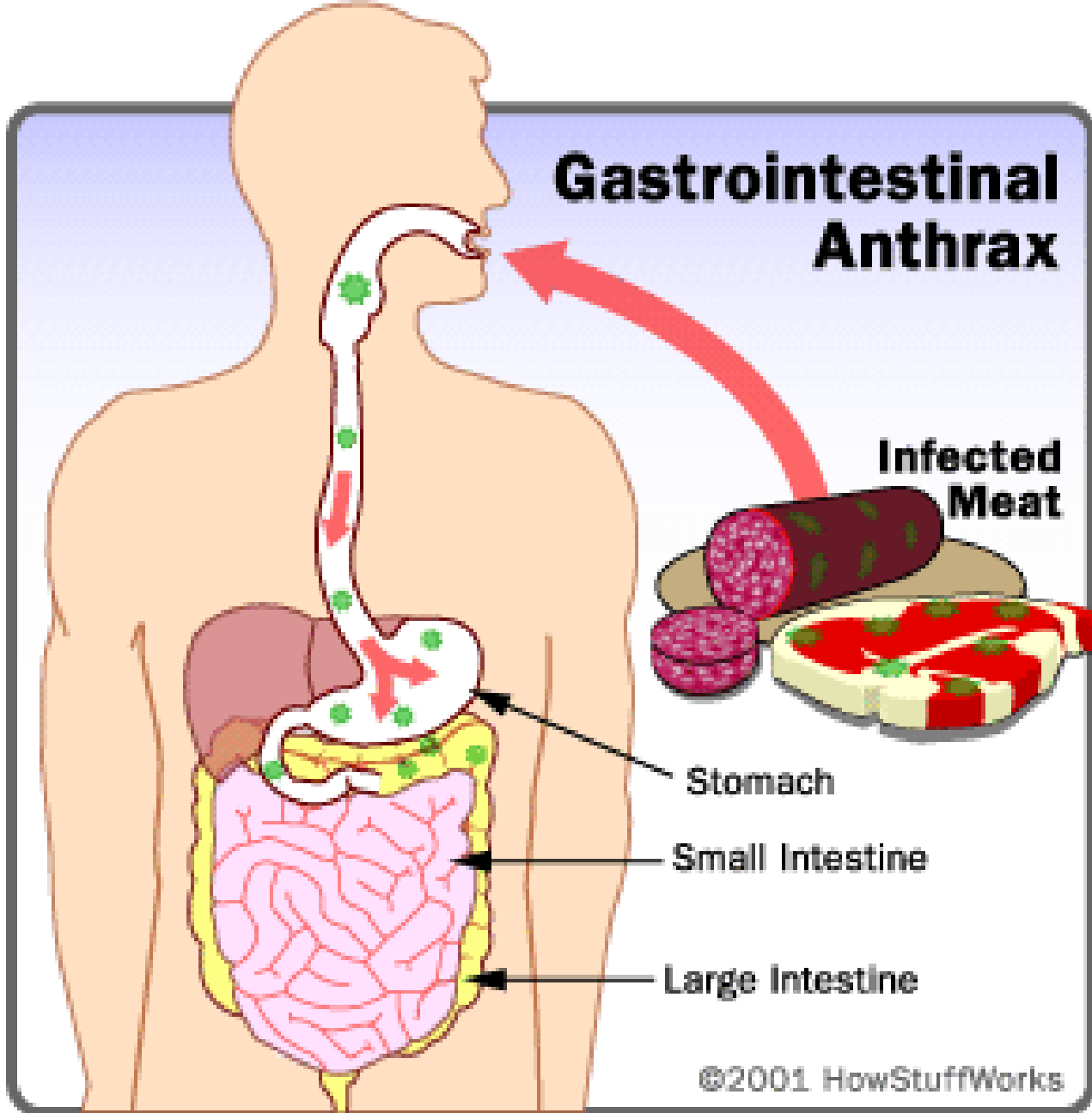


Anthrax Spores

Open Cut



# Gastrointestinal Anthrax



Stomach

Small Intestine

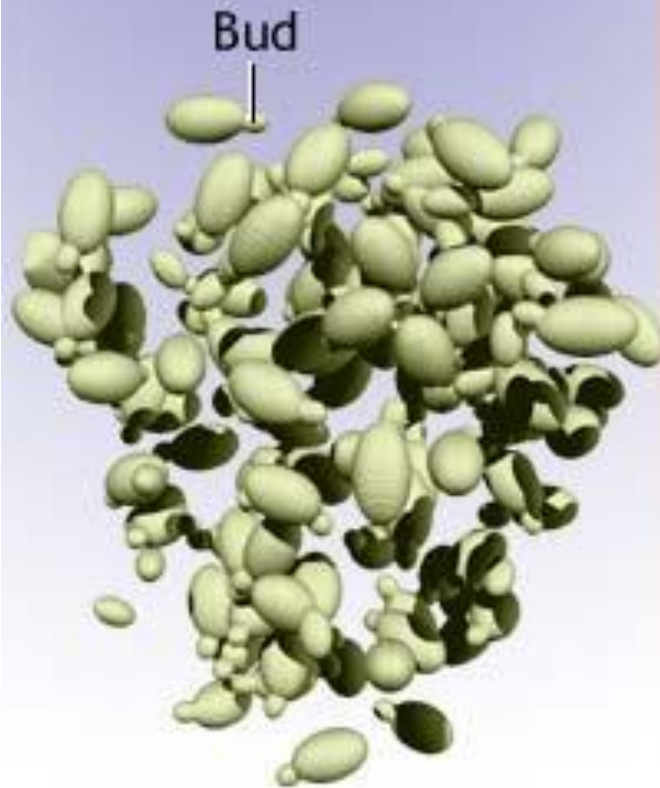
Large Intestine

# Fungi (Molds and Yeasts)

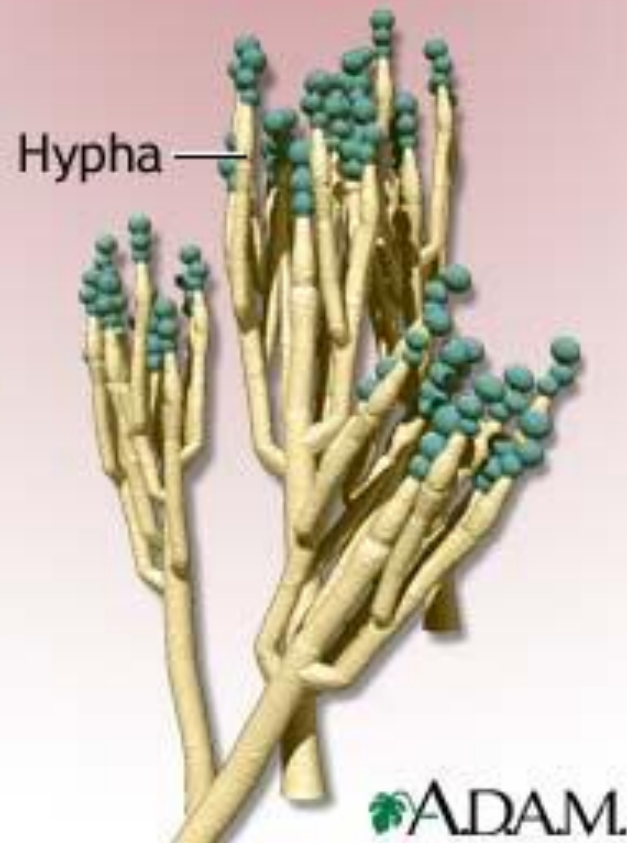
- Require less moisture
- Can grow in acid pH
- Very adaptable
- Grow slower than bacteria
- molds-multicellular
- Form spores that are less resistant than bacterial spores
- Yeasts bud

# FUNGUS FAMILY

Yeast



Mold



# **SPOROTRICHOSIS (*Sporothrix schenckii*)**

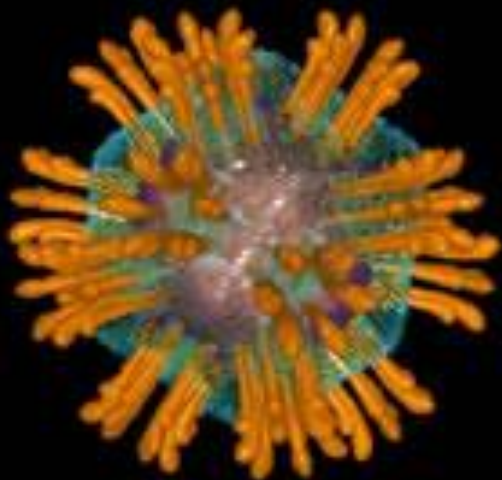
# Virus

## Basic virus structure

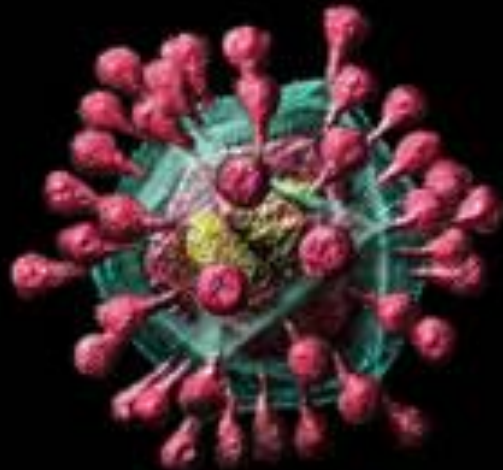
- Genetic material (DNA or RNA)
- Protein coat
- Tail fibers
- Hollow protein tail

## Virus

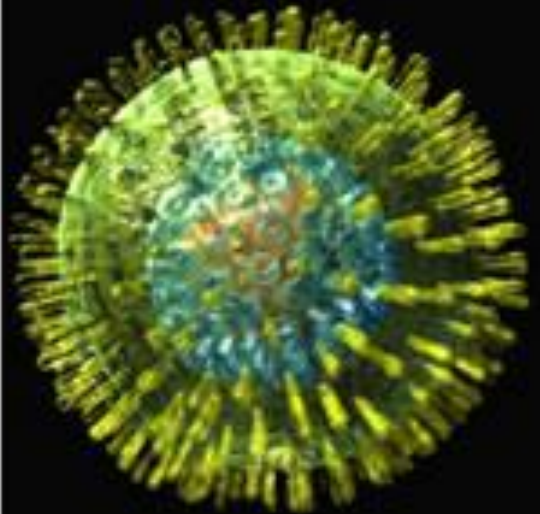
- Tiny
- Simple structure
- Must grow in cells
- In foods-fecal contamination
- Personal sanitation to prevent
- Living?



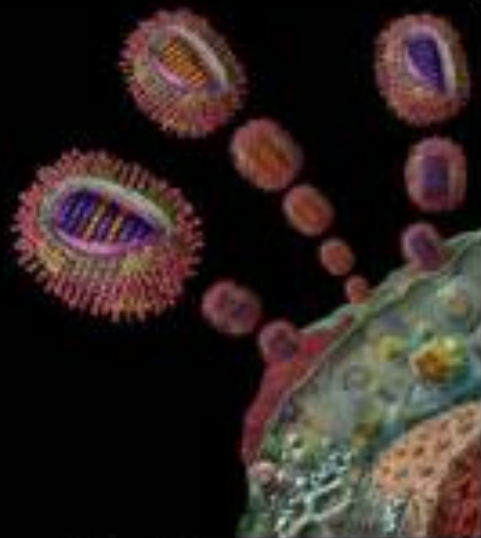
**Hepatitis C virus**



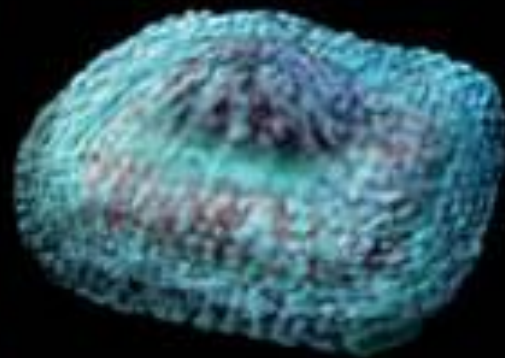
**Coronavirus**



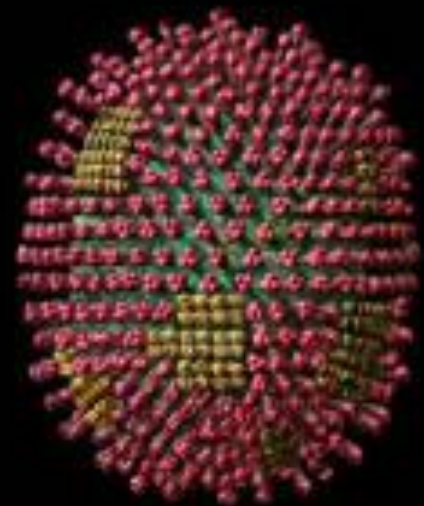
**Herpes virus**



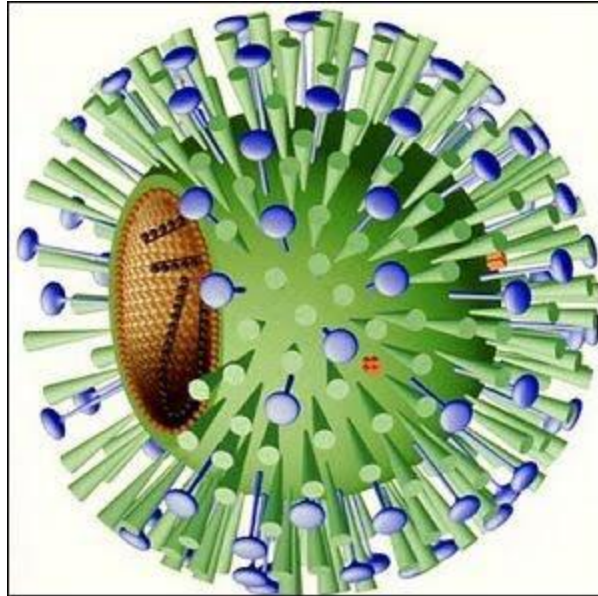
**Bird flu virus**



**Smallpox virus**



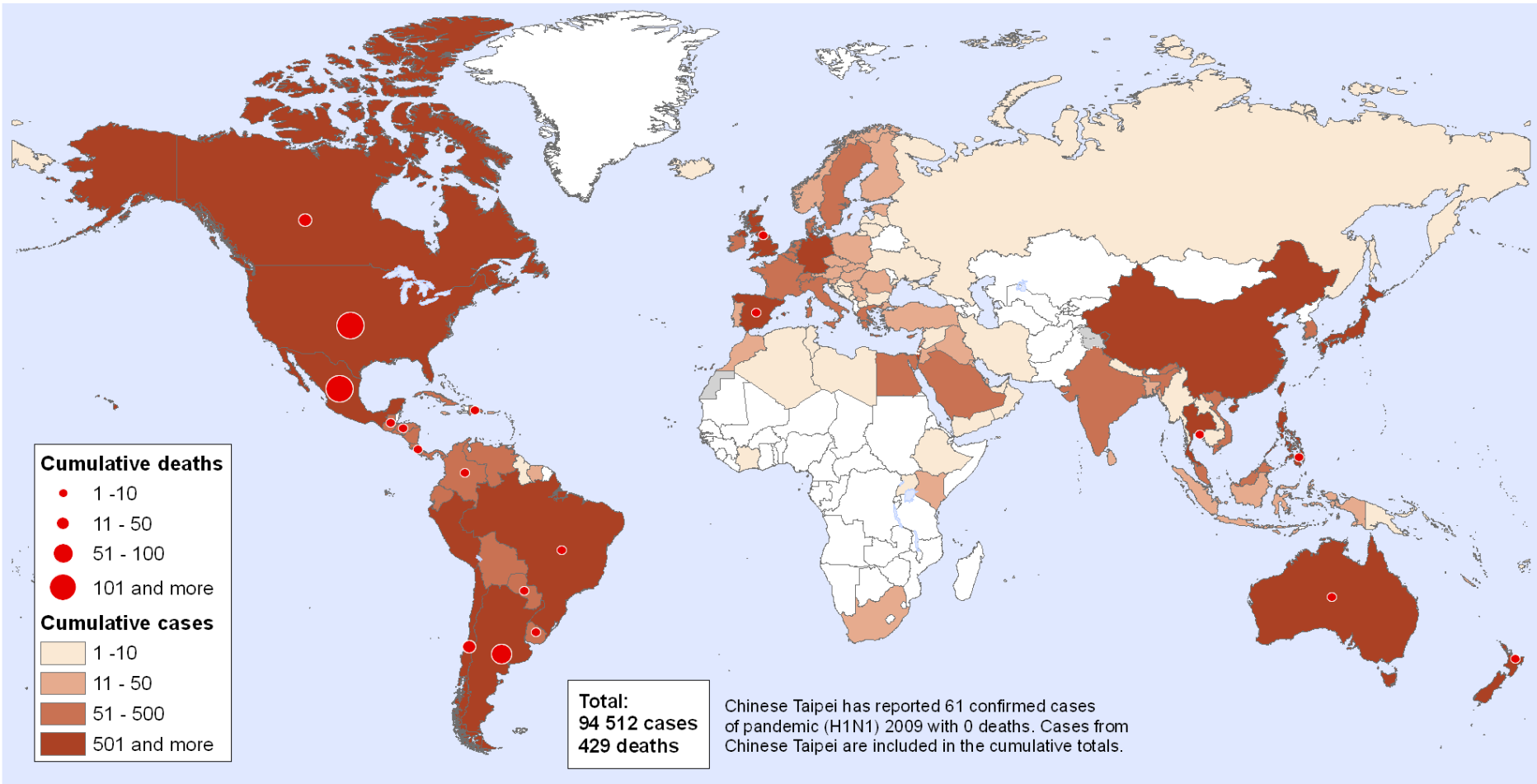
**Influenza virus**



Influenza A (H1N1) virus is a subtype of influenza A virus and was the most common cause of human influenza (flu) in 2009

# Pandemic (H1N1) 2009, Number of laboratory confirmed cases as reported to WHO

Status as of 06 July 2009  
09:00 GMT



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization  
Map Production: Public Health Information and Geographic Information Systems (GIS)  
World Health Organization



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Map produced: 06 July 2009 09:00 GMT

# Our losses

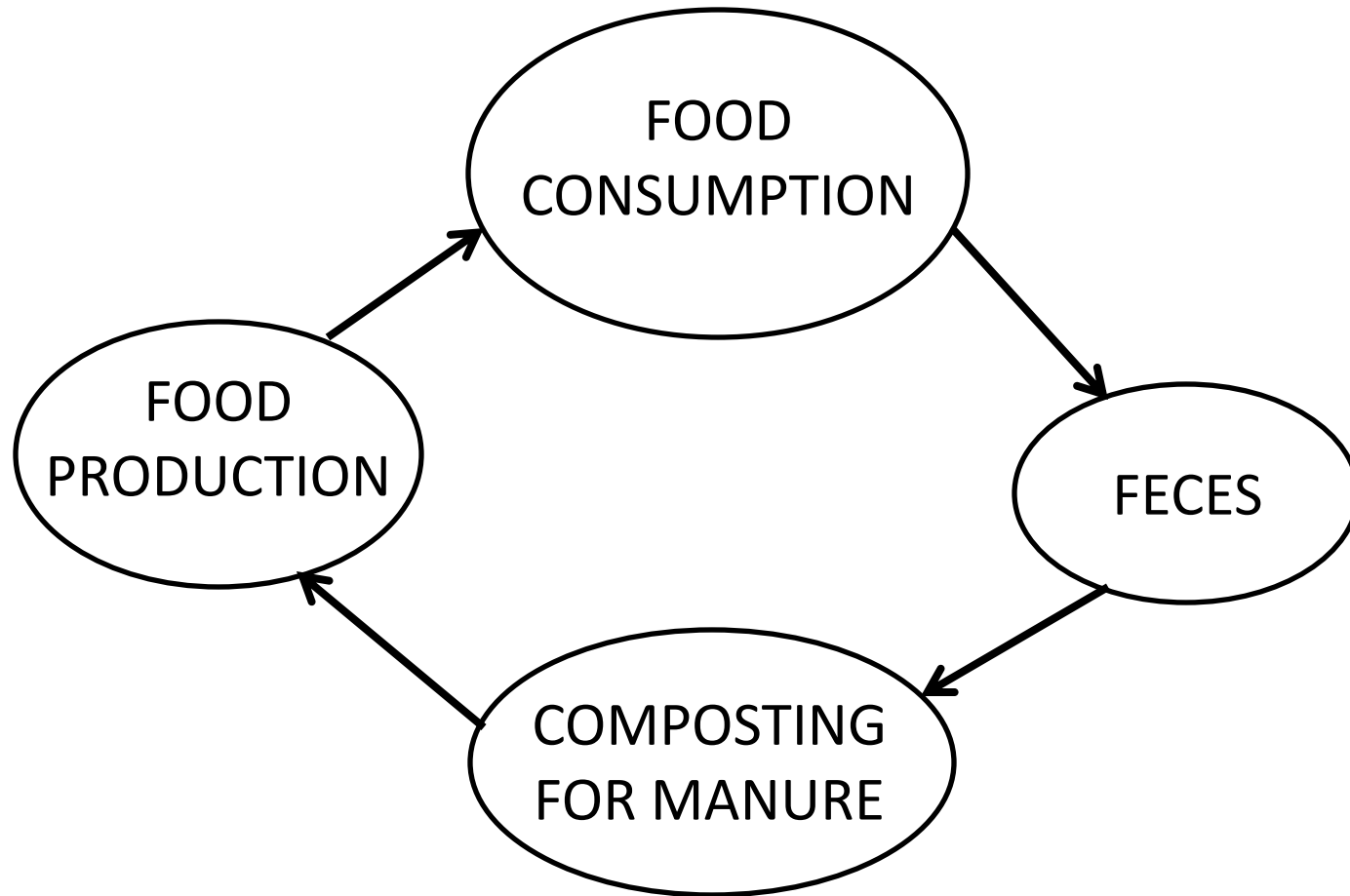
- Every year (based on CDC data):  
Over 250 billion meals are prepared
- An estimated 76 million food-borne illnesses occur
- >5000 food-borne associated deaths  
Costs = \$7.7 to 23 billion

# Facts

- Approx. 2.6 - 3 billion people living without proper sanitation. Due to inadequate water supply, sewerage systems and lack of sanitation millions of people face death annually.
- Over 2 million people die annually only to diarrhoea, wherefrom most are under the age of five.
- Every day approximately 6000 children die to diarrhea related diseases. According to some estimates two thirds of the costs of medical treatment are used to nurse diarrhea related diseases.
- At the same time 300 million people in developed countries are using the same amount of water what many people in developing countries are entitled for a whole day by simply flushing once.
- According to WHO and UNICEF safeguarding access to clean water and sanitation to all people would cost approximately 9 billion USD annually from the year 2005 to 2015 (including only building costs).
- If you compare this cost to the cost of global armament (780 billion USD annually), to the cost of alcohol and cigarette consumption in Europe (155 billion USD annually) or even to the cost of ice-cream consumption in Europe (11 billion USD) it can be considered as a rather small cost.



# The principle of nutrient cycle



# Food-borne Hazards

<u>Hazard</u>	<u>Est. Cases</u>	<u>Deaths</u>
Norwalk virus	23,000,000	na
<i>Campylobacter</i>	2,453,926	0.1%
<i>Salmonella</i>	1,412,498	0.8%
<i>C. perfringens</i>	248,520	0.05%
<i>S. aureus</i>	185,060	0.02%
<i>E. coli O157:H7</i>	73,480	0.83%
<i>L. monocytogens</i>	2,518	20%
<i>C. botulinum</i>	58	8.6%

# Food-borne pathogens

## “Target Pathogens”

- Four major pathogens of food borne illness
  - *Salmonella*
  - *E. coli O157:H7*
  - *Campylobacter*
  - *Listeria Monocytogens*

# Salmonella

- Most frequently reported
- Introduced anywhere within the food chain
- Grown on any food under the right conditions: moisture and temp
- Ideal growth temp. 10-40C
- Cook temperature essential to kill
- Safe handling of food by consumer essential

## *E. Coli* O157:H7 & Campylobacter

- Natural inhabitant of the GI tract of all animals
- Sanitary practices throughout the farm to table essential for control
- Consumer education of safe handling practices for food, raw and cooked, essential for control

## *L. monocytogenes*

- Commonly found in GI tract of all animals
- Can survive for long periods in soil, sewage, dust, vegetation and water
- Resistant to cool temp. – cold storage
- Can form biofilms on surfaces to resist cleaning and sanitizing
- Biggest threat: pregnant women-miscarriages and birth defects

# Example: Sanitation in live production

- Will never be sterile but don't give up!

## 7 basic steps in live production sanitation

- Obtain clean stock
- Proper bird care
- Vermin control
- Moisture control
- Feed storage
- Biosecurity
- Water sanitation

# Obtaining clean stock

- Know the seller
- Don't look for bargains
- Isolate birds for 2 weeks
- Monitor birds daily and separate sick ones

# Proper birds care

- Healthy birds are more resistant
- Pay attention to bird behavior
- Collect dead at least daily
- Provide ventilation

# Moisture control

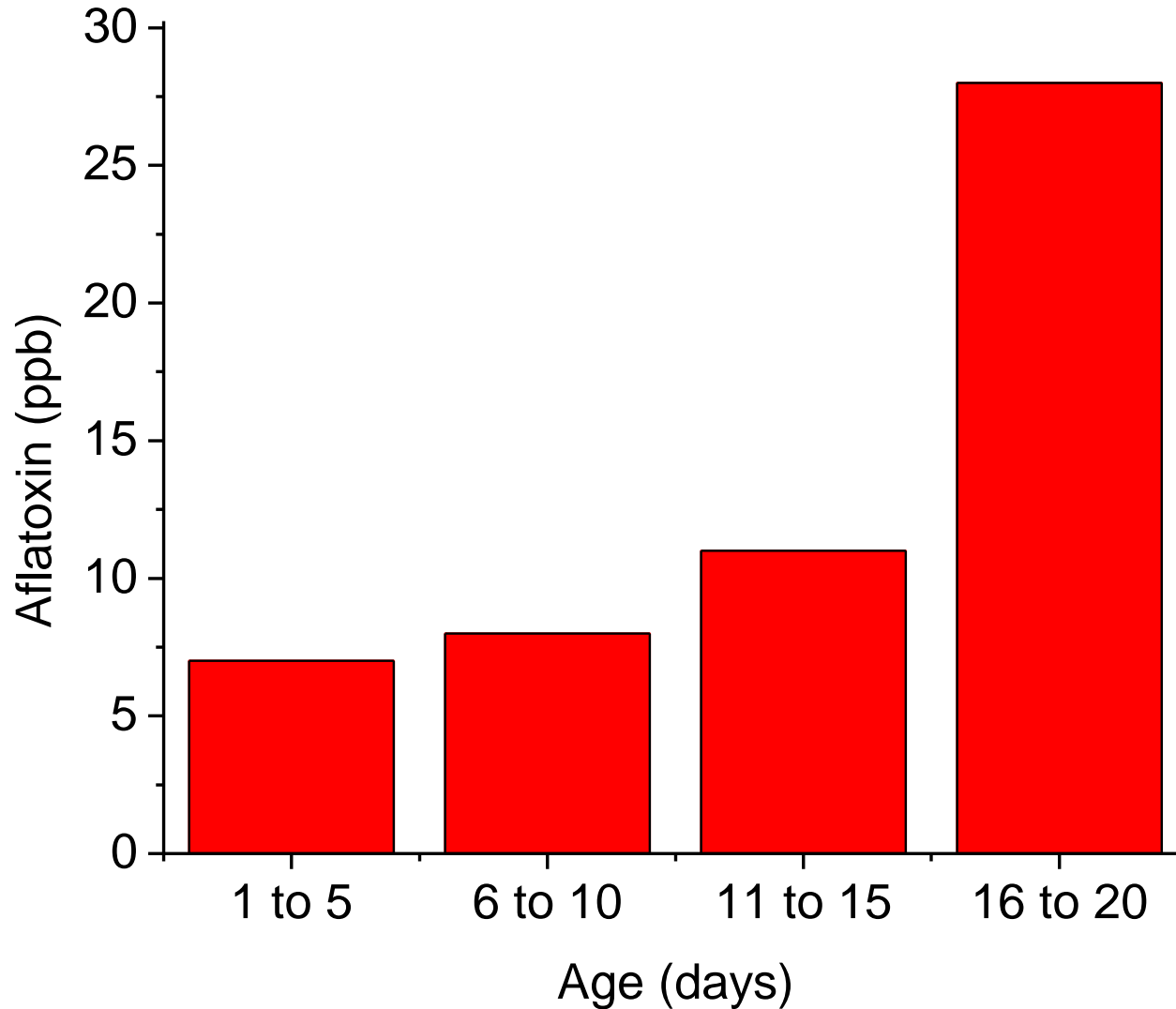
- Litter moisture related to pathogens
- Moisture control related to:
  - Addressing obvious sources
  - Ventilation

**Moisture is often **the single** most important factor in determining microbial growth**

# Feed storage

- Protection from rodents and wild birds
- Protection from moisture
- Protection from heat and sunlight
  - Moisture migration
  - UV destruction
- Feed freshness

# Effect of feed age on aflatoxin conc.



# Biosecurity

“a set of preventive measures designed to reduce the risk of transmission of infectious diseases”

Procedures that work for bird pathogens also keep out human pathogens

Basic steps

- No visitor policy
- Protect personnel
- Clean equipment
- Proper dead disposal
- No visits to problems
- Lock & security
- Avoid mixing animal species

- Have farm clothes
- Clean vehicles
- No contact with other birds
- No borrowed equip.
- No wild game

# Basic steps in sanitizer use

- Avoid mixing sanitizers particularly chlorine @ pH < 4 = chlorine gas
- In general, clean, scrub, rinse then sanitize
- Store sanitizers away from feed and birds
- Protect sanitizers from heat and light
- Avoid long storage times
- Use for approved purposes
  - General sanitation
  - Food contact surfaces

# Disinfectant types and qualities

Type	Activity	Organic matter effect	Cost	Human toxicity	Comments
Alcohols	Wide no spores	Reduces effects	Exp	Low	Non corrosive, fire hazard, conc 70-95%
Hypochloride	Wide no spores	Kills effects	Low	Low	Can be corrosive
Iodophors	Wide no spores	Reduces effects	Mod	Low	May stain clothing, porous surfaces
QAC (quaternary ammonia comp)	Limited no spores	Reduces effects	Low	Low	Soaps, detergents and hard water limit effectiveness
Phenolic	Wide no spores	Little to none	Mod	Low	Good residual activity
Aldehyde	Wide	Limits effects	Mod	Mod	Gets everything, but can be highly toxic
Oxidizer	Mod. no spores	Kills effects	Mod	Low	Limited residual, mod. corrosive

# Water sanitation

- Water - a great organism transmitter
- Consider closed line system

## Water line cleaners for use once a week

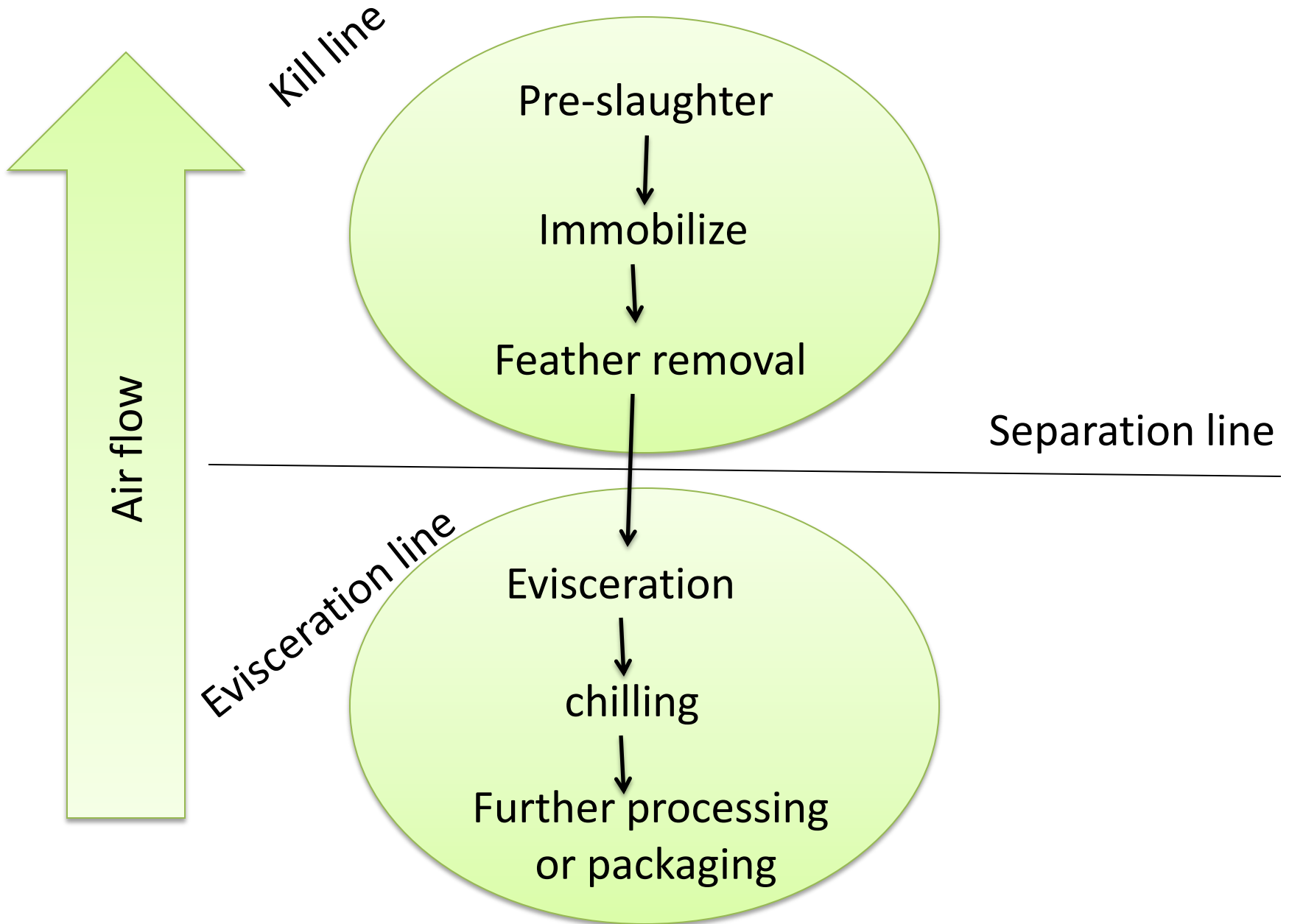
Clear household ammonia	Household bleach	White household vinegar	Iodine (18.05%)
½ teaspoon per gallon of water	½ teaspoon per gallon of water	1 oz per gallon of water	¼ teaspoon per gallon of water

# Cleaning closed watering systems with birds in the house

## prepare a stock solution

Clear household ammonia	Household bleach	Clear vinegar	Iodine (18.05%
6 oz per gallon	6 oz per gallon	128 oz per gallon	2 oz per gallon

# Basic steps in poultry processing



# Sanitation in small processing

- Work indoors if possible
- Use sanitizers labeled for food contact surfaces
- Clean and sanitize equipment before use
- Separate slaughter and picking from evisceration and cut up – job specialize
- Avoid long delays
- Keep things as clean as possible (insects)
- Don't spare the water
- Cool processed carcasses quickly and keep them cool

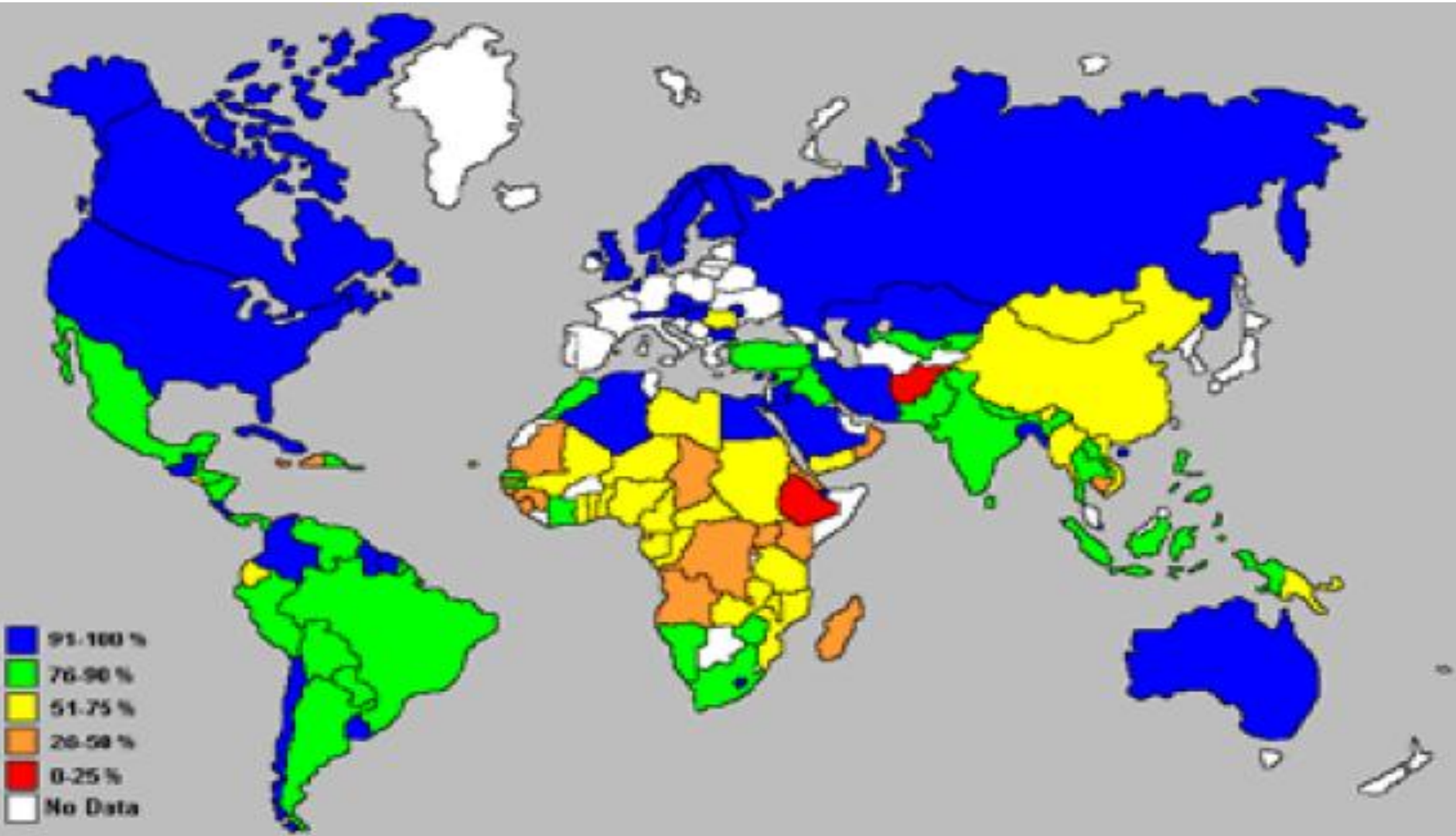
# Natural disinfecting agents

- Sunlight (UV rays)
- Heat (>35C)
- Cold (Freezing or below)
- Drying (aided by wind, light and heat)
- Effective, but are they reliable?

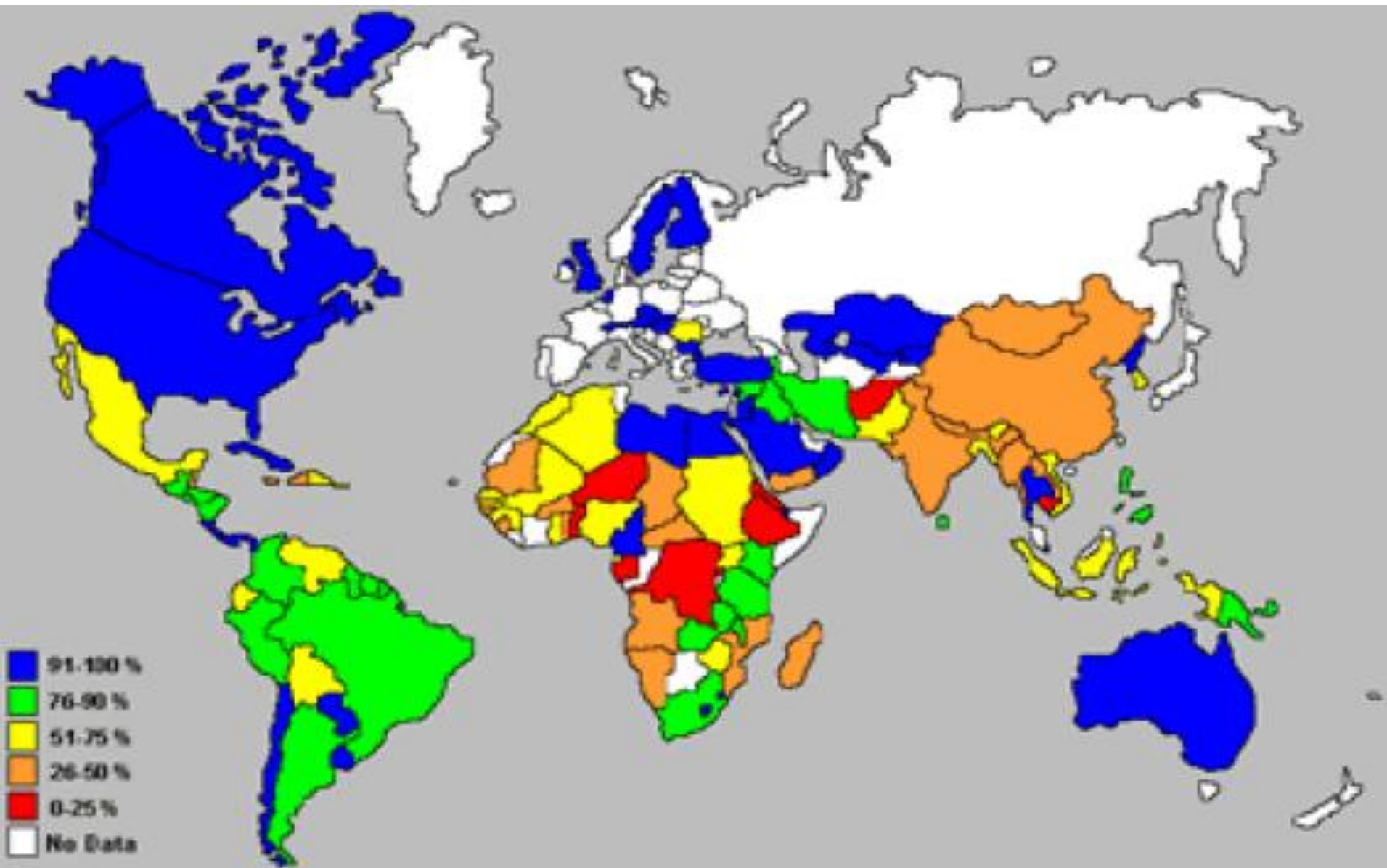
# Water quality: fraction of population using improved water sources by country



Global water supply coverage in the year 2000. Picture shows the percentage of population that have access to adequate drinking water supply



Global coverage of sanitation in the year 2000. Picture shows the percent-age of people with access to proper sanitation services



# HACCP

- Its often misused term
- A systematic method of documenting that food safety hazards have been addressed
- HACCP involves only food safety issues
- Out of control = unsafe food produced
- Plans unique for each unit and product

# HACCP – What is it?

Step	Meaning
1. Hazard analysis	What are the controllable food safety hazards?
2. Establish critical control points	Where do things go wrong and how can we reliably control it?
3. Establish critical limits	What value indicates the process is in control?
4. Establish monitoring procedures	Who, what, when, where and how will CCP's be monitored?
5. Establish corrective actions	What happens if we exceed a critical limit?
6. Establish a record keeping system	If you don't write it down it doesn't exist.
7. Establish verification procedures	How do you know the system works?

# How does HACCP work?

- Processors must take the following steps:
  - Assemble a HACCP team to design their plan
  - Describe the product and its method of production, distribution and intended consumer.
  - Develop and verify process flow diagrams

# How does HACCP work?

- Identify at each step the production flow chart and hazard to food safety as to:
  - Chemical
  - Physical
  - Bacterial
- Support the hazard with a decision making document and scientific data

# How does HACCP work?

- If a CCP deviation is found the following must take place:
  - Identify the cause of deviation
  - Describe how the critical limit was restored
  - Describe how the deviation can be prevented from happening again
  - Describe how the adulterated product was reconditioned or what happened to the product

**The End** lecture 1