

# FOOD SAFETY HAZARDS

NORLIA MAHROR  
18/11/2020



ATTENDANCE





# Timetable

Week	Date	Lecturer	Topics	Assessments	CLO
	18/11/2020	Dr. Norlia	Hazards		CLO1
7.	24/11/2020	Dr. Norlia	Food allergen		CLO1
	25/11/2020	Dr. Norlia	Food toxicology		CLO1
8.			SEMESTER BREAK		
9.	08/12/2020	Dr. Musfirah /Dr. Norlia	Presentation	Presentation	CLO3
	9/12/2020	Dr. Musfirah /Dr. Norlia	Presentation	Presentation	CLO3
10.	15/12/2020	Dr. Musfirah /Dr. Norlia	Presentation (Submission of assignment 1)	Presentation	CLO3
	16/12/2020	Dr. Musfirah	TEST 1 (MZ)	Test	CLO1&2
11.	22/12/2020	Dr. Hayati	Safety in food packaging		CLO1
	23/12/2020	Dr. Norlia	HACCP plan	Discussion	CLO1, CLO4
12.	29/12/2020	Dr. Norlia	HACCP plan	(5%)	CLO1, CLO4
	30/12/2020	Dr. Norlia	Environmental monitoring		CLO2
13.	05/01/2021	Dr. Tan Thuan Chew	Guest lecture: Food defense		CLO1, CLO4
	06/01/2021	Dr. Norlia	Risk Analysis		CLO1, CLO4
14.	12/01/2021	MOH officer	Guest lecture: Food Safety Certifications TEST 2 (NM) Submission of slide presentation	Test (5%)	CLO1, CLO4
	13/01/2021	Dr. Musfirah /Dr. Norlia	Presentation - HACCP	Presentation	CLO3
15.	19/01/2021	Dr. Musfirah /Dr. Norlia	Presentation - HACCP	(10%)	CLO3
	20/01/2021	Dr. Musfirah /Dr. Norlia	Presentation - HACCP		CLO3
16.			REVISION WEEK		
17.	2/2/2020	Dr. Norlia	Submission of written assignment 2-HACCP	Assignment	
	3/2/2020	Dr. Musfirah	Test 1	(10%) Test	
18	9/2/2020				
	10/2/2020	Dr. Norlia	Test 2	Test (20%)	

# Assignment 2 - HACCP<sup>III</sup> Plan

Develop a **HACCP Plan** for the **food product** that you have chosen in **Assignment**. Below is the guideline for your HACCP plan preparation:

- Assemble the HACCP Team
- Describe the product
- Identify intended use
- Construct a process flow diagram
- Verify the flow diagram
- Conduct hazard analysis
- Determine Critical Control Point (CCP)
- Establish critical limit for each CCP
- Establish a monitoring system for each CCP
- Establish corrective action
- Establish verification procedures
- Establish documentation and record keeping

**20%**

You need to **present your HACCP plan** and submit the **written assignment**.



# FOOD SAFETY HAZARDS

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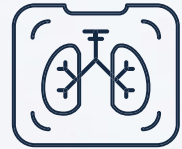
ATTENDANCE





# Content

## HAZARDS



BIOLOGICAL HAZARD



CHEMICAL HAZARD



PHYSICAL HAZARD

## PROCESS CONTROL



# What is a Food Safety Hazard?

- Any agent (**biological, chemical, physical**) in food with the potential to cause **adverse health effect** for consumers.
- Hazards may be introduced into the food supply any time during **harvesting, formulation and processing, packaging and labelling, transportation, storage, preparation, and serving.**





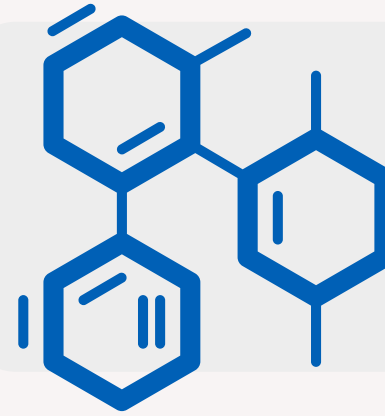
## Biological hazard

### Agents:

- Bacteria
- Viruses
- Protozoan
- Helminth
- Etc..

### Adverse effect

- Foodborne illnesses (diarrhea, vomiting, nausea, etc.)
- May result in death



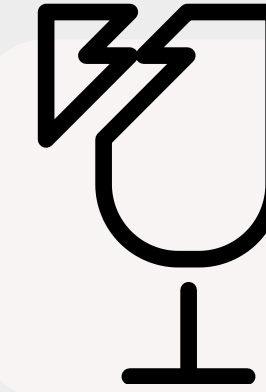
## Chemical hazard

### Agents:

- Mycotoxins
- Allergens
- Heavy metals
- Cleaning & sanitation agents
- Etc.

### Adverse effect

- Gastrointestinal distress
- Immunological reactions
- Chronic effect - cancer
- May result in death



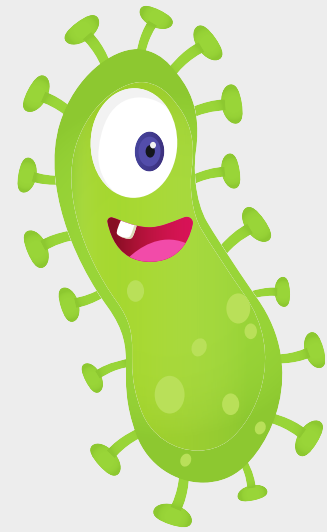
## Physical hazard

### Agents:

- Stone
- Bone
- Shells
- Broken glass
- Etc.

### Adverse effect

- Choking
- Oral or internal cut
- Rarely result in death



# BIOLOGICAL HAZARDS





# What is not a Food Safety Hazard??

## Quality defect

- Food spoilage may produce flavour, odour, and visual defect without making the food harmful for consumption
- e.g. souring in milk, putrefaction of meats (off odour), slimy meat product

## Regulatory defects

- Food does not conform to the requirement of particular regulations.
- Violate the regulations without causing health hazard
- e.g. undeclared ingredients (non-hazardous), mislabelled product, ingredient substitution (fraudulent activity)

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# Characteristics of Foodborne Illnesses



## Food infection

- Ingestion of live pathogens in food
  - Survive the acidic condition in stomach and invade intestinal wall, enter blood circulation (may cause septicemia)
- 

## Toxicoinfection

- Ingestion of live pathogens in food
  - Enterotoxin is produced in the intestine, causing diarrhea
- 

## Intoxication

- Pathogen produce toxins while growing in food
- Botulinum toxin, staphylococcal food poisoning



Older people (> 60 years old)



Pregnant woman



Baby & Children (< 5 years old)



People with weakened immune system

- diabetes
- HIV/AIDS
- cancer
- receiving chemotherapy
- receiving dialysis
- organ transplants

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# People at risk of foodborne illness

# Infectious dose

Depends on the concentration of pathogens / toxins in food, the virulence of pathogens, and the health status of consumer

< 100 - 1 millions of pathogen cell can cause illness

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# Incubation period

Typically short (hours or days) for bacterial infection

Foodborne intoxication have shorter incubation period (pre-formed toxin)



# Characteristics of common foodborne illness

Microorganism	Incubation period (range)	Symptoms		
		Fever	Diarrhoea	Vomiting
<i>Salmonella</i> spp.	12 h (6–48)	+	+	+
<i>Staphylococcus aureus</i>	2 h (0.5–8)	–	+	+
<i>Bacillus cereus</i> <sup>a</sup>	1 h (0.5–6)	–	–	+
<i>Clostridium perfringens</i>	12 h (9–15)	–	+	–
<i>Shigella</i> spp.	24 h (12–48)	+	+	–
Hepatitis A virus	28 d (15–50)	+	–	–

<sup>a</sup>emetic toxin-producing strains

## SYMPTOMS



Abdominal Pain



Diarrhea



Nausea and Vomiting



Chills and Sweating



Fever



Headache



# Characteristics of less common foodborne illness



Microorganism	Incubation period (range)	Key symptoms
<i>E. coli</i> O157:H7	4 d (3–9)	Bloody diarrhoea, possible haemolytic-uremic syndrome
<i>Listeria monocytogenes</i>	7 d (3–21)	Septicaemia, meningitis
<i>Clostridium botulinum</i>	24 h (12–40)	Double vision, difficulty swallowing, possible respiratory paralysis
<i>Yersinia enterocolitica</i>	24 h (18–36)	Diarrhoea, vomiting, severe abdominal pain
<i>Vibrio</i> spp.	12 h (4–30)	Fever, diarrhoea, vomiting

# Sources of bacterial pathogens involved in foodborne infections

Pathogen	Natural habitat	Associated food sources
<i>Salmonella</i> spp.	Animal intestine Process environments	Raw meat, poultry and eggs Multiple dry foods
<i>Campylobacter jejuni</i>	Animal intestine and soil	Raw poultry and milk
<i>Escherichia coli</i> O157:H7	Ruminant intestine	Raw beef, milk, water, and farm animal contact
<i>Listeria monocytogenes</i>	Soil, animal intestine, and moist processing areas	Raw milk and meat, soft cheeses, and RTE* deli products
<i>Shigella</i> spp.	Animal intestine Human carriers	Freshly prepared foods Foodservice operations
<i>Vibrio</i> spp.	Marine water	Raw shellfish and seafood
<i>Yersinia enterocolitica</i>	Animal intestine and water	Raw milk and water

## Sources of bacterial pathogens involved in foodborne intoxications

Pathogen	Natural habitat	Associated food sources
<i>Staphylococcus aureus</i>	Human and animal skin	Raw meat and poultry, and fermented sausage and cheese
<i>Clostridium botulinum</i>	Soil and water	Raw vegetables and fish
<i>Bacillus cereus</i>	Soil, root, and cereal crops	Cooked rice and potatoes
<i>Clostridium perfringens</i>	Soil and animal intestines	Steam table meat and poultry, and stuffed poultry



# Noodles from laksa kebok stall contaminated with salmonella bacteria, says Health Ministry

NATION

Sunday, 21 Oct 2018

12:55 PM MYT



The Health Ministry said there were no new cases reported since Oct 9, and the overall number of cases stood at 83, with two deaths.

There were 34 cases in Perak (where two patients died), 25 cases in Kedah and 24 cases in Selangor. The patients who were hospitalised were all discharged.

## 48 keracunan makanan dipercayai akibat puding buih



KUALA TERENGGANU: Telur tamat tempoh digunakan untuk mengadun puding buih, punca utama berlakunya kes keracunan makanan, Isnin lalu.

Pengerusi Jawatankuasa Kerajaan Tempatan, Perumahan, Kesihatan dan Alam Sekitar, Dr Alias Razak menjelaskan, keputusan sampel dilakukan Unit Keselamatan dan Kualiti Makanan Pejabat Kesihatan Daerah Kuala Terengganu mendapati, penggunaan telur tamat tempoh punca utama 99 orang menghadapi kes keracunan puding buih.



The majority of biological hazards are bacteria that can be **controlled through time, temperature, acidity, and water activity.**



However, some bacteria form **spores** that are **highly resistant** and may not be destroyed by cooking and drying



# Spore-forming bacterial pathogens

## *Clostridium botulinum*

Obligate anaerobes

Do not grow in acidic condition (pH < 4.6)

Produce botulinum toxins (neurotoxic)

< 1 ng/kg - paralysis of the respiratory muscle

Spores - heat stable

The toxin is heat-labile - can be inactivated by pasteurization

Main problem in canned food

<https://www.who.int/news-room/fact-sheets/detail/botulism>

## *Clostridium perfringens*

Anaerobic, slightly thermophilic, grows rapidly in food without sporulation

Associated with hot-held food (steam table/hot buffet) foods

Cell sporulate in the human intestine & release enterotoxin

high number of cells must be ingested to cause toxicoinfection

## *Bacillus cereus*

Facultative anaerobe pathogens

Produce heat-stable emetic toxins (in cooked rice), and

heat-labile enterotoxins

psychrotrophs

# Non spore-forming bacterial pathogens



## ***Staphylococcus aureus***

Produce heat-stable enterotoxin

Surviving 10 mins at 121C or more than 20 min at 100C> aureus contamination is usually caused by food handlers

## ***Campylobacter jejuni***

Associated with meat, raw poultry and milk

It does not survive in processed foods

## ***Escherichia coli* 0157:H7**

Very low infectious dose : 10-100 cells (may cause death)

Produce shiga toxins

Associated with meat, unpasteurised milk & juices, sprouts , water, etc.

## ***Listeria monocytogenes***

Psychrotrophic bacteria

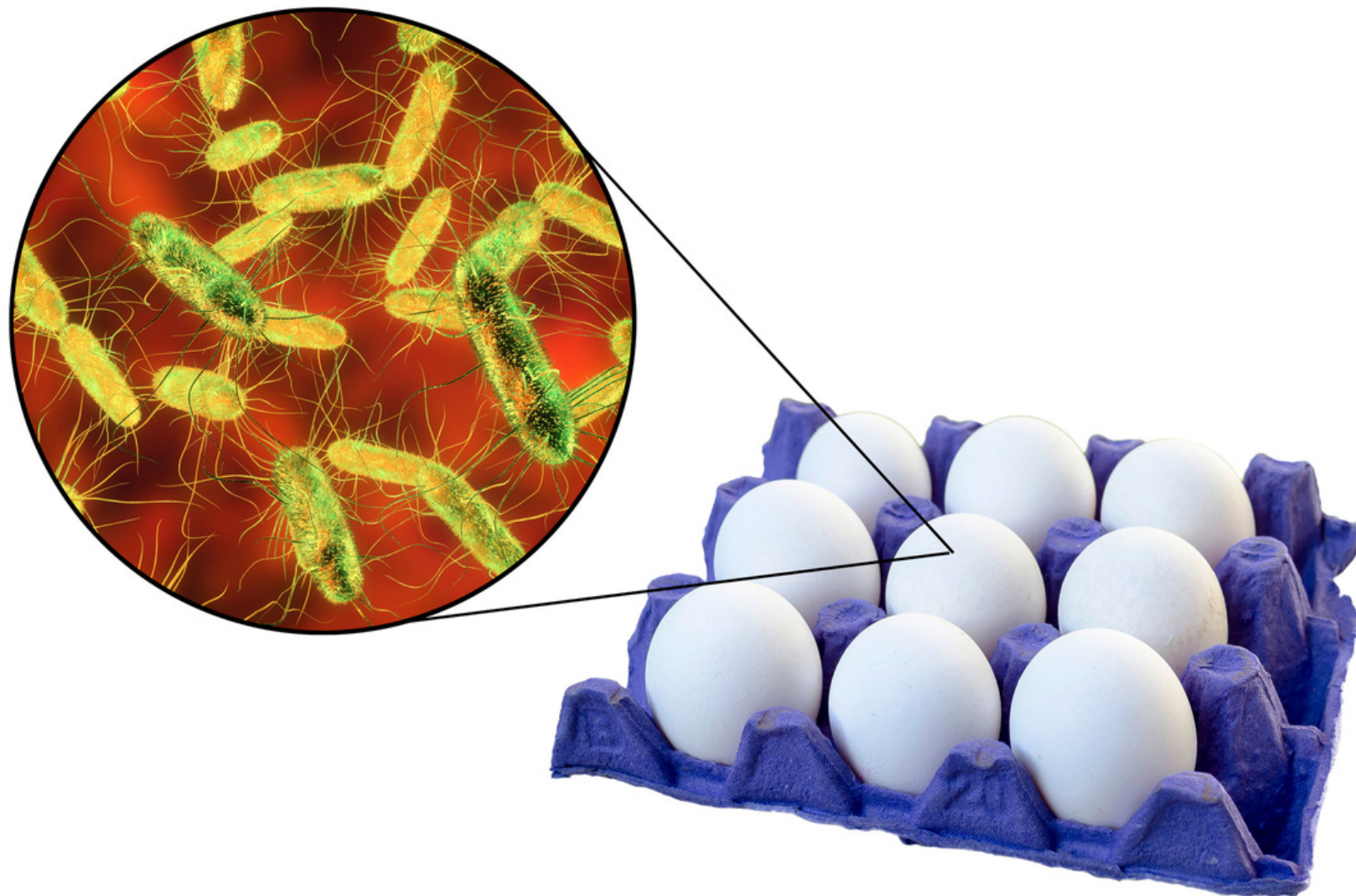
Associated with RTE, refrigerated foods

Require high number of cells (millions) to cause infections

However, the infection can lead to septicemia, meningitis, death.

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# Non spore-forming bacterial pathogens



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## **Vibrio spp.**

Halophilic bacteria

microflora of fish and seafoods

*V. parahaemolyticus* - psychrotrophs and often found in shellfish

*V. cholera* - cause cholera disease (waterborne infection)

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## **Yersinia enterocolitica**

Psychrotrophs

Cause illness that are associated with raw milk or water

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## **Salmonella spp.**

Can survive in dry condition

Contaminate processed / packages food products (dried dairy products, dried eggs, chocolate, soy flour, peanut butter)

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## **Cronobacter sakazakii**

Opportunistic pathogens

rarely cause illness

Rare cases: mishandling of rehydrated infant formula in the clinical setting



# Viral foodborne pathogens

Viruses are obligate parasites that grow only in human cells

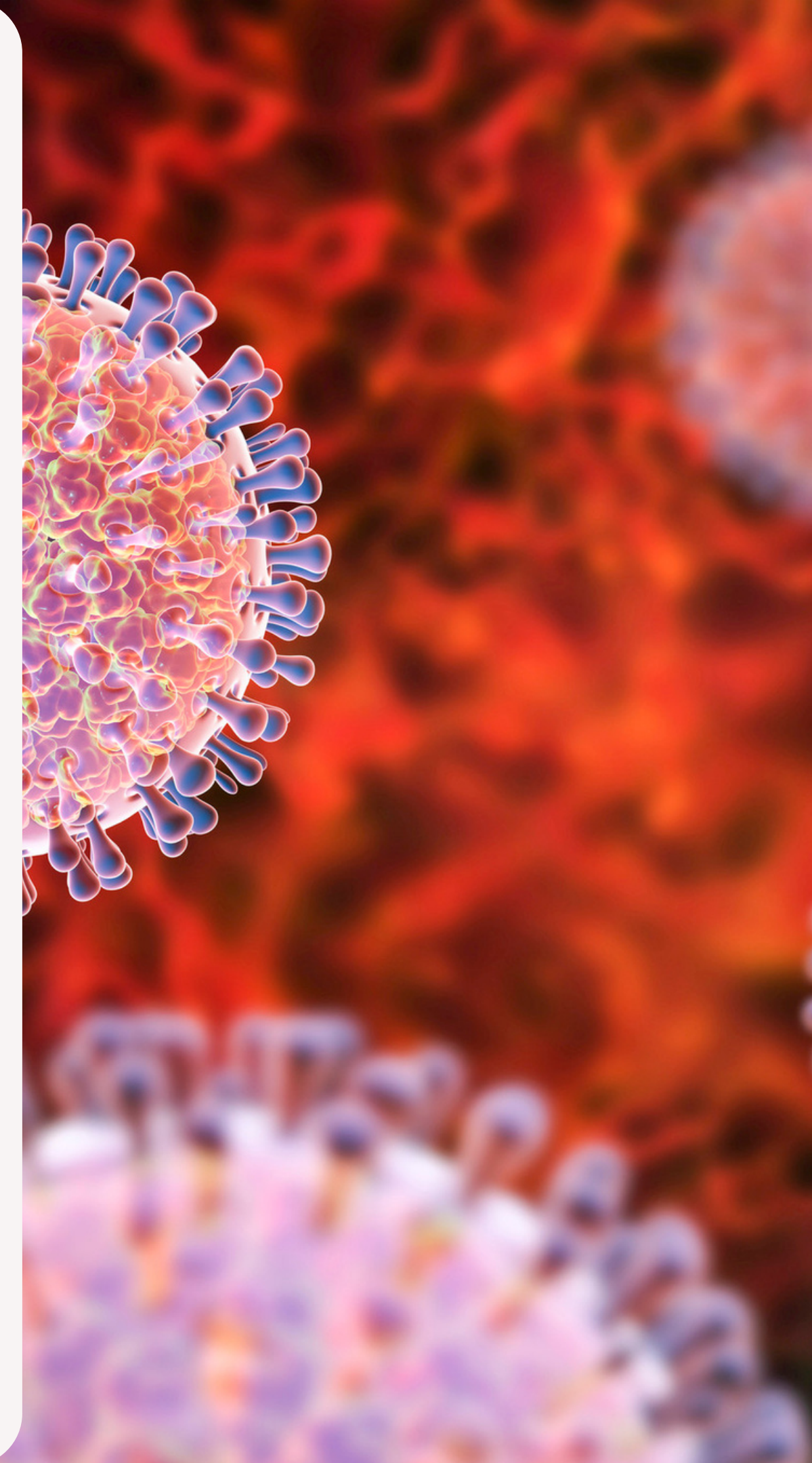
Primary source is human feces

Transmitted via fecal-oral-route, poor hygiene practice

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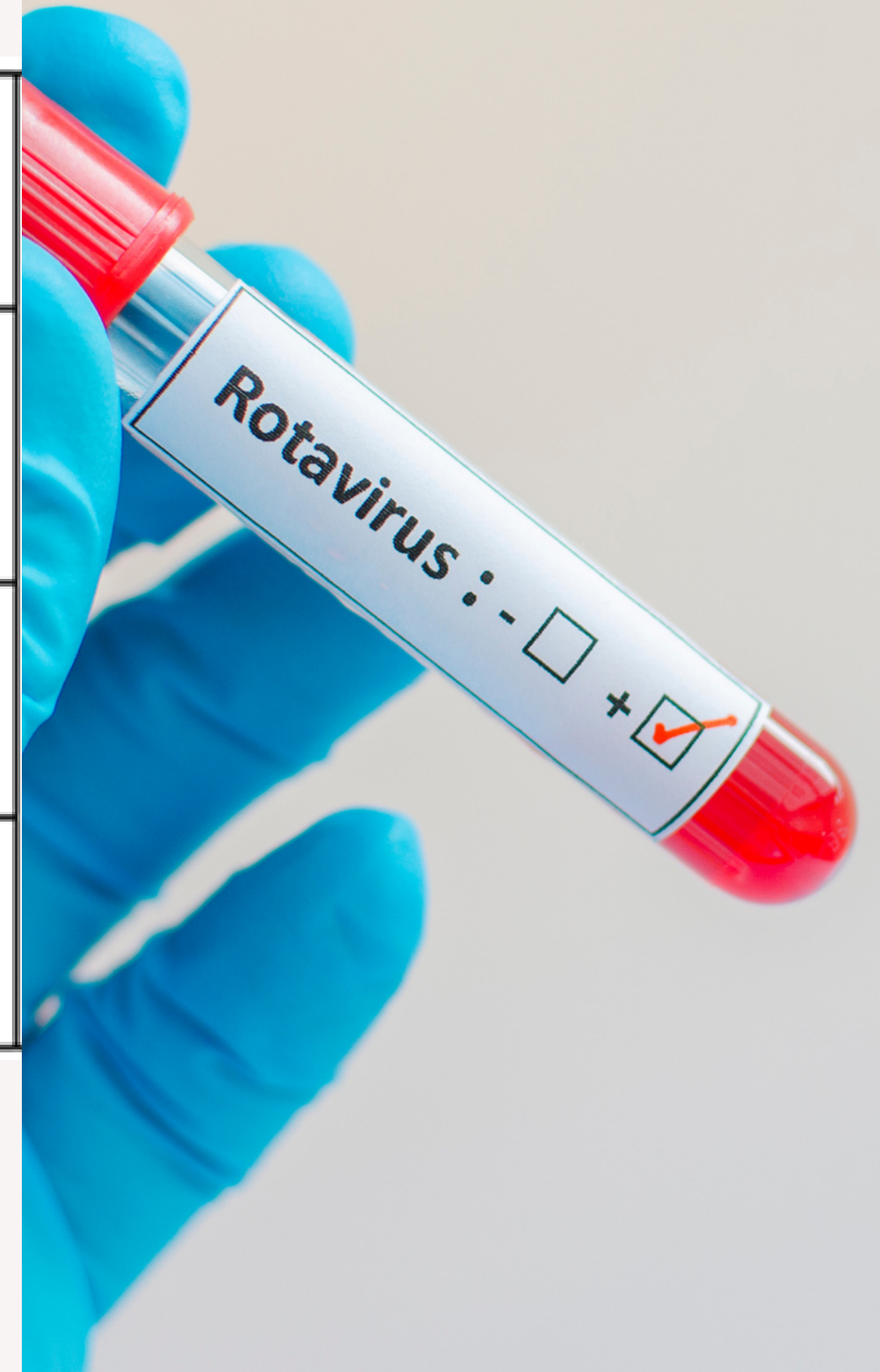
<b>Virus</b>	<b>Incubation period [d] (range)</b>
Hepatitis A	28 (15–50)
Norovirus	1 (1–2)
Rotavirus	2 (1–6)

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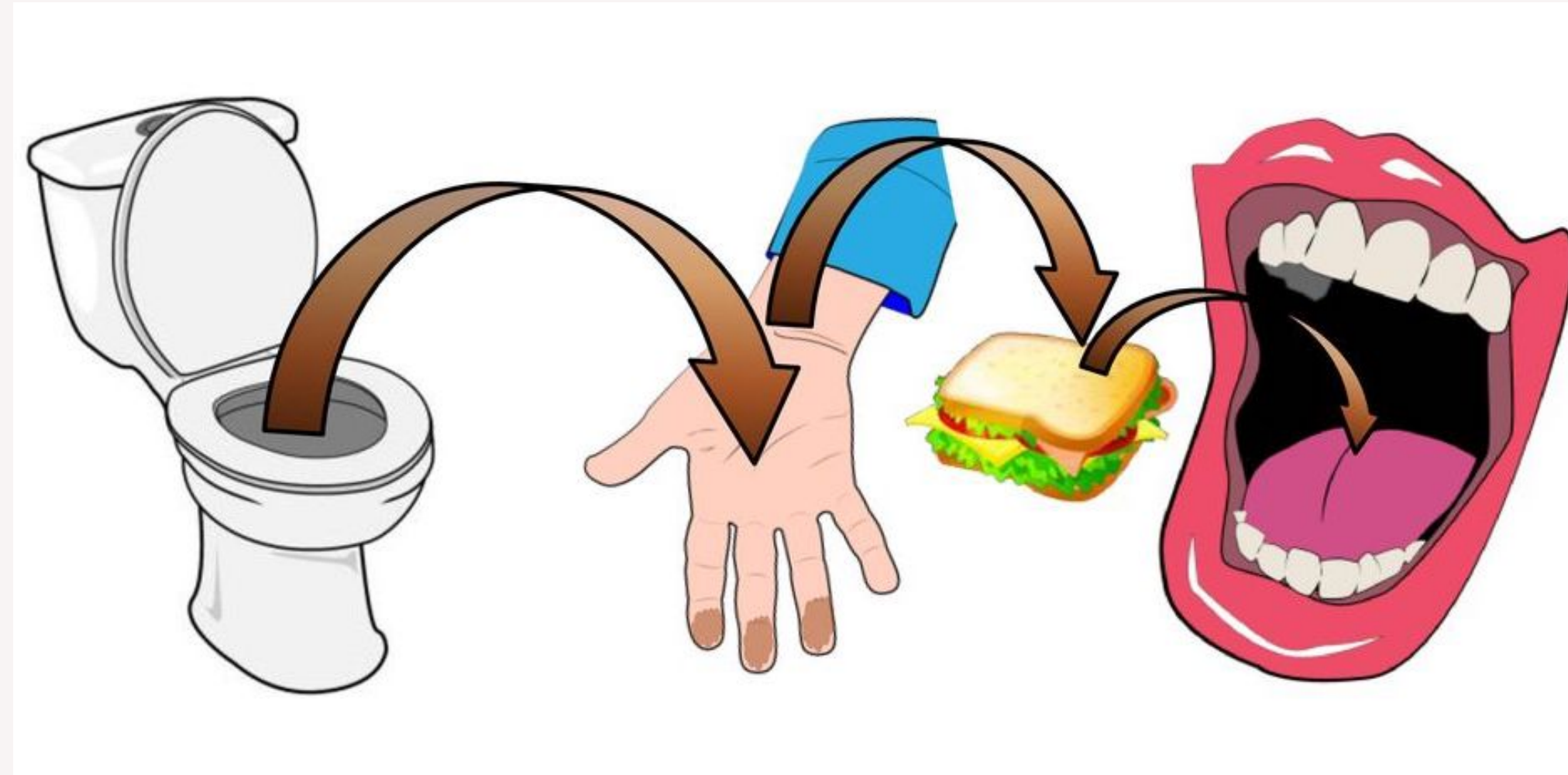
Microorganism	Why a hazard?
Hepatitis A virus	Causes fever and abdominal discomfort, followed by jaundice.
Norwalk virus	Headache and low-grade fever may also occur.
Rotavirus	Causes nausea, vomiting, diarrhea and abdominal pain (gastroenteritis).





# METHODS OF PREVENTING TRANSMISSION OF FOODBORNE PATHOGENS TO FOODS BY FECAL CONTAMINATION

- Good personal hygiene practices
- Elimination of insufficiently treated animal waste to fertilize crops
- Proper sewage and water treatment.
- Thorough cooking of foods eliminates all foodborne pathogens





# Protozoan parasites

- Parasite need host to survive
- The illness is caused by the consumption of contaminated raw food / water

Protozoan	Incubation Period (d)
<i>Toxoplasma gondii</i>	10–23
<i>Cryptosporidium parvum</i>	1–12
<i>Cyclospora cayetanensis</i>	7
<i>Giardia lamblia</i>	5–25
<i>Entamoeba histolytica</i>	14–28



# Parasitic worms

- Numerous tapeworm and roundworms involved in foodborne infections
- long incubation periods
- Associated with undercooked meat or seafood, raw fruits and vegetables, esp. soil crops.



## Parasitic worms of humans associated with food consumption

Parasite	Incubation period	Typical food source
<b>Tapeworms</b>		
<i>Taenia solium</i>	8 weeks to 10 years	Undercooked pork
<i>T. saginata</i>	10 to 14 weeks	Undercooked beef
<i>Diphyllobothrium latum</i>	3 to 6 weeks	Undercooked fish
<b>Roundworms</b>		
<i>Ascaris lumbricoides</i>	2 to 8 weeks	Raw fruits and vegetables and soil
<i>Trichinella spiralis</i>	8 to 15 days	Undercooked meat
<i>Anisakis simplex</i>	1 to 14 days	Undercooked marine foods

# Parasitic worms found in raw seafood dishes

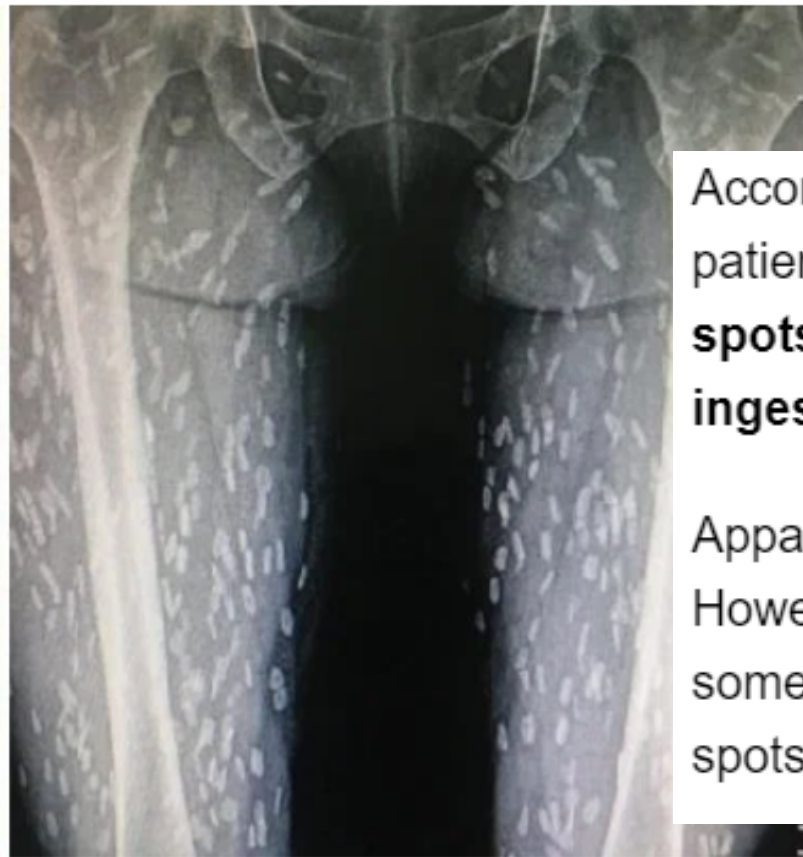


# Woman's Legs Infected With Parasitic Worms Due to Her Love for Eating Raw Meat



Published 2 years ago on November 2, 2018

By Pui Fun



According to [HK01](#), a netizen in Thailand shared some photos of some X-rays taken from a female patient which shocked other people. **The images showed two legs that were covered with white spots and it was believed that these spots are the larvae of the parasite that the woman had ingested.**

Apparently, the woman had a fondness for eating raw pork and had been eating it for quite some time. However, she felt unwell one day and went to the doctor for a check-up. The doctor proceeded to take some X-rays for her and was shocked when he saw the images of her legs, which were full of white spots.

Upon further inspection, **he deduced that she was infected with parasitic worms due to her habit of eating raw pork that could be contaminated with the parasites.** It looks like the larvae from the worms were able to pass through the intestinal tract and proceed to infect other parts of the body including the muscles, where they would stay.

## Disease-Causing Worms Found In Canned Sardines Imported From China To Penang



According to MAQIS director-general Datuk Mokhtaruddin Husain, **the worms were likely to be from the genus *Anisakis* spp. which causes the Anisakiasis disease in humans.**

Anisakiasis is a parasitic disease that is normally caused by the consumption of raw or undercooked seafood that is infected with the *Anisakis* spp. parasite.

In his statement, Mokhtaruddin said humans infected by this disease would typically experience gastrointestinal problems or symptoms such as abdominal pain, diarrhoea, nausea, and vomiting.



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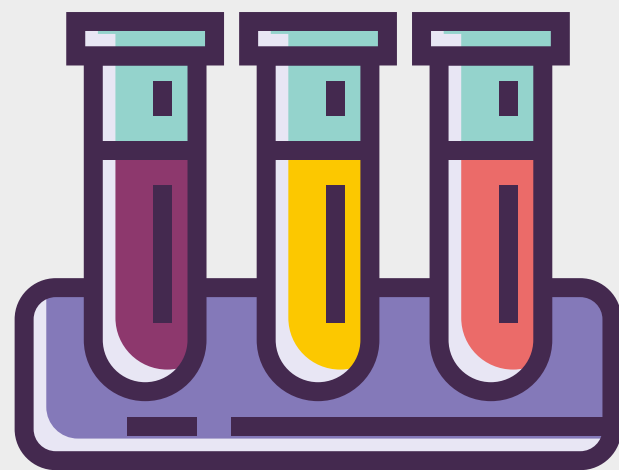
**Kahoot!**



QR Code



**AFLATOXIN**



**CHEMICAL  
HAZARDS**



## Naturally occurring chemicals

These are toxins produced by plants, animals or microorganisms (eg: aflatoxins in peanuts, poisonous neurotoxins in mushrooms, scrombotoxins in fish)

## Intentionally-added chemicals

These are chemicals added to food that are beyond the acceptable limits established by the Food and Drugs Act and its regulations (ex: food additives like sodium nitrate).

## Unintentionally or incidentally added chemical

These are chemicals that accidentally contaminate food being processed (ex: sanitation or maintenance chemicals, pesticides or environmental pollutants).

## Food Allergens

These substances in food can cause a dangerous reaction in people who are allergic (ex: peanuts, fish, dairy products).

# Types of chemical hazards



# Naturally occurring chemicals (includes **Allergens**)

## Source

*Certain fish species*  
(e.g., tuna, mahi-mahi)

*Nuts, Seafood*

*Corn*

*Molluscan shellfish*

## Why a hazard?

Spoilage of certain species of fish can result in production of toxic levels of histamine and related compounds.

Certain varieties or species produce an allergic reaction in sensitive people.

Certain molds that grow on corn can create toxins (e.g., aflatoxin).

Some of the microscopic organisms and plants upon which they feed can produce a toxin, such as domoic acid, that affect people but not shellfish.

Naturally  
occurring  
chemical



## Intentionally added chemicals

# Intentionally added chemicals

### Source

*FD&C Yellow No. 5*

*Sodium nitrite*  
(preservative)

*Vitamin A*  
(nutrient supplement)

*Sulfiting agents*  
(preservative)

### Why a hazard?

Can produce an allergic-type reaction in (food coloring) sensitive people.

Can be toxic in high concentrations.

Can be toxic in high concentrations.

Can cause allergic-type reaction in sensitive people.

# Unintentionally or incidentally added chemicals

## Unintentionally added chemicals

### Source

*Agricultural chemicals*  
(e.g., pesticides, herbicides)

*Cleaning chemicals*  
(e.g., acids, caustics)

*Maintenance chemicals*  
(e.g., lubricants, paint)

### Why a hazard?

Can be acutely toxic if present in the food at high levels and may cause health risks with long-term exposure.

Can cause chemical burns if present in the food at high levels.

Chemicals that are not approved for food use and may be toxic.

# Mycotoxins

## Aflatoxins

- Produced by *Aspergillus flavus*, *A. parasiticus*
- Contaminate peanuts, cereals, spices, dried fruits, maize, milk, coffee

## Ochratoxins

- Produced by *A. ochraceus*, *A. carbonarius*, *Penicillium verrucosum*,
- Contaminate fruits juices, wine, cereals, coffee

## Fumonisin

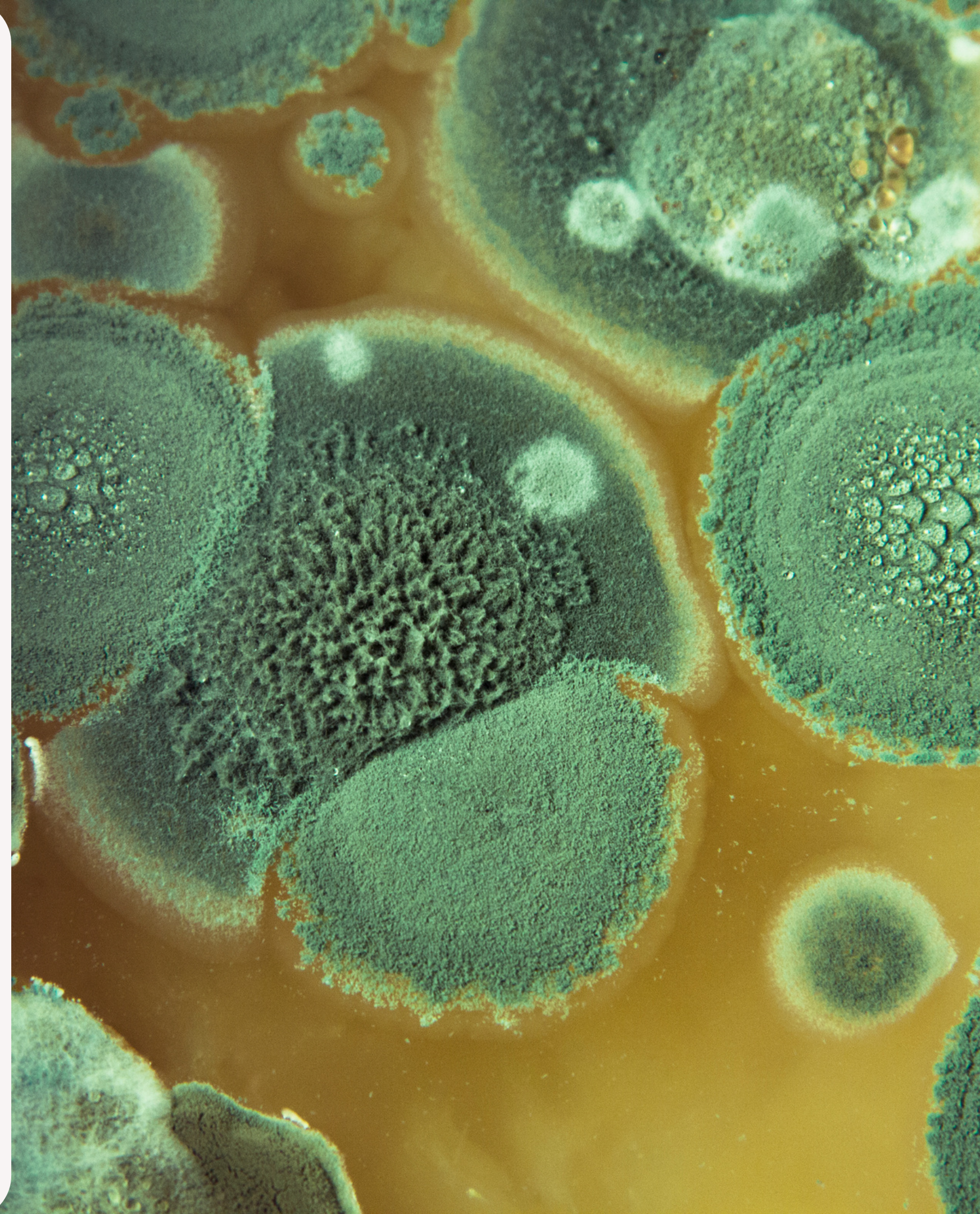
- Produced by *Fusarium verticillioides*, *F. proliferatum*
- Contaminate maize, cereals at the pre-harvest stage

## Zearalenone

- Produced by *F. graminearum*, *F. culmorum*
- Contaminate maize, cereals

## Amatoxins and muscarine

- Mushroom toxins





# Risk of mycotoxin contamination in foods

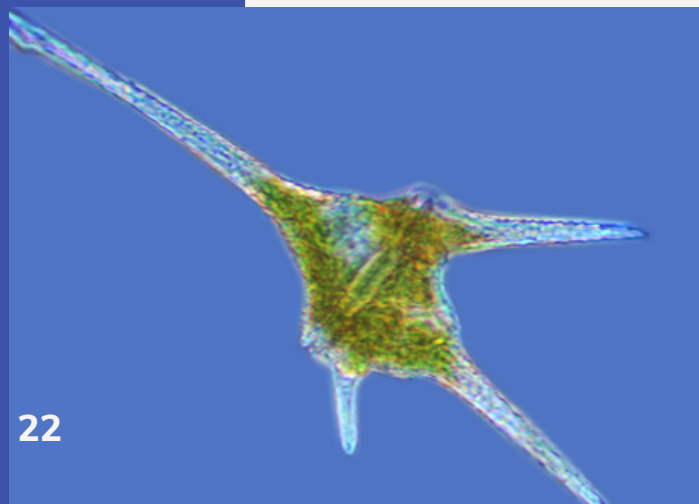




# Marine foodborne toxins

## Shellfish poisoning

- Associated with bivalve molluscs such as mussels, clams, oysters
- Molluscs filter seawater, they concentrate pathogenic dinoflagellate or diatoms that produce toxins
  - Paralytic shellfish poisoning
  - Diarrhoeic shellfish poisoning
  - Neurotoxic shellfish poisoning
  - Amnesic shellfish poisoning







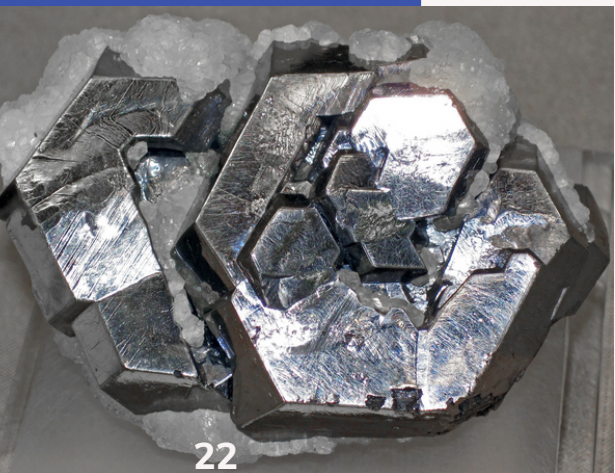
## Finfish poisoning

- Ciguatera poisoning - toxin produced by dinoflagellate
- Scombroid (or histamine) poisoning - involve tuna, mahi-mahi, mackerel which contain high level of histidine. *Proteus* spp. can grow in improperly chilled fish and convert histidine to histamine (mimic allergic reaction)
- Puffer fish poisoning - tetrodotoxin is produced in the internal organ of the fish by several pathogenic bacteria, e.g. *Vibrio*, *Aeromonas*,



## Heavy metal poisoning

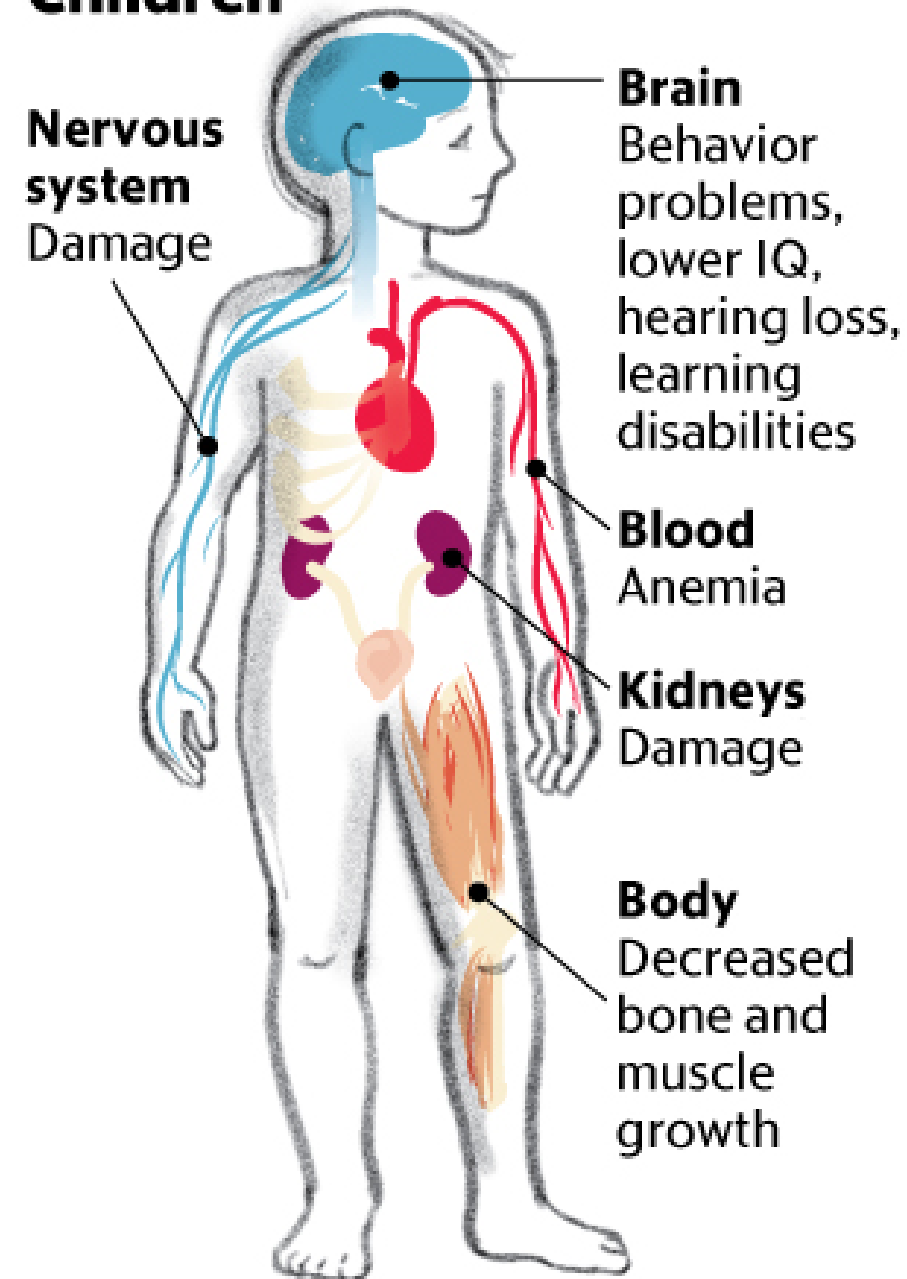
- Mercury - mercury is transformed to methyl mercury in marine & freshwater environment - accumulated in the food chain (only 1.0 ppm level is allowed in fish & shellfish)
- Lead - caused by ceramic used for serving food
- Cadmium - associated with ceramic ware
- Arsenic - used in rodenticide, fungicide



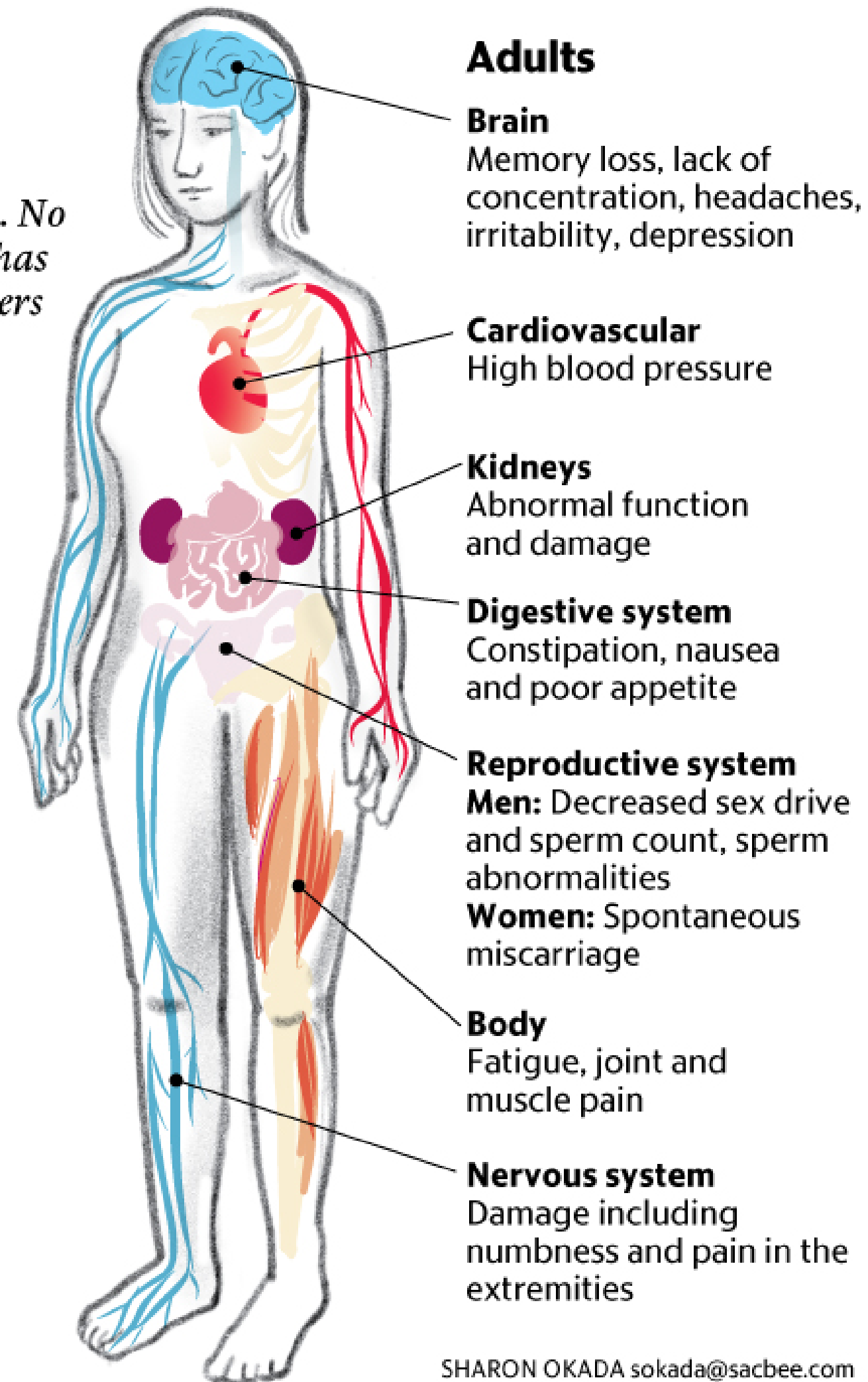
# Lead exposure

Although often without obvious symptoms, lead exposure can affect nearly every part of the human body. No safe level of lead in the bloodstream has been determined by the federal Centers for Disease Control and Prevention.

## Children



## Adults



Sources: Centers for Disease Control and Prevention; National Institutes of Health



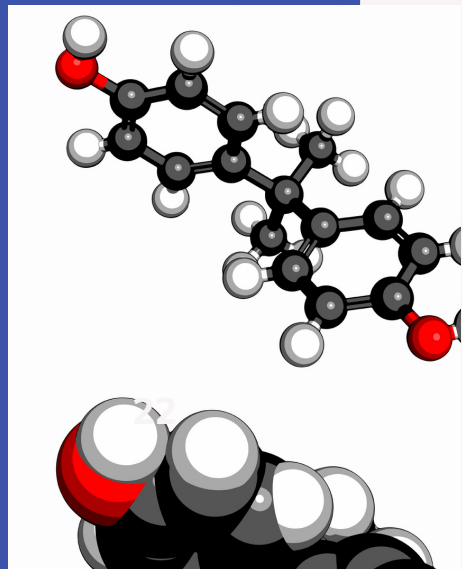
## UNINTENTIONALLY ADDED CHEMICALS

### Chemicals used in food processing environment

- Lubricant, detergent, sanitizer

### Chemicals used in food packaging materials

- bisphenol A can leach into water and food packaged in polycarbonate plastic bottle / metal cans





# Unanticipated Potential

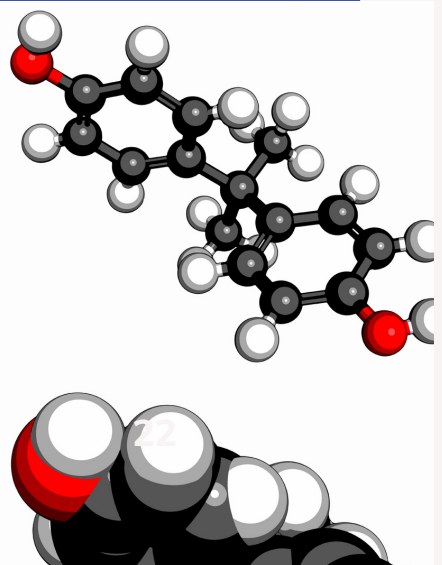
## Chemical hazards:

### Acrylamide

- It is formed when glucose and asparagine interact during the baking, or frying of food at temperature above 120C

### Melamine

- Melamine is a nitrogen-rich compound that can mimic the presence of protein in analytical test.
- It was found in adulterated wheat flour, milk and cause illnesses to the consumer.



Food Allergen Testing Market - Market Size, by Region, Global, 2018



Market Size

High

Mid

Low


Source: Mordor Intelligence

*Food Allergens*

# What Are Major Food Allergens?

The **8** foods identified by the law are:

- MILK
- EGGS
- FISH
- TREE NUTS
- PEANUTS
- WHEAT
- CRUSTACEAN SHELLFISH
- SOYBEANS



## *Food Allergens in US*

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# The most effective chemical hazard control is **PREVENTION!**



What to do??

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Employee training for safe handling, good storage practice

Allergen, mycotoxins, food additives, heavy metals

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Proper labeling, cleaning and removal of chemical residues

Maintenance, cleaning & sanitation chemicals

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Use designated tools for handling allergens & scheduling products using allergens last in the production cycle

Allergen

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Receive incoming materials and raw ingredients from reputable suppliers

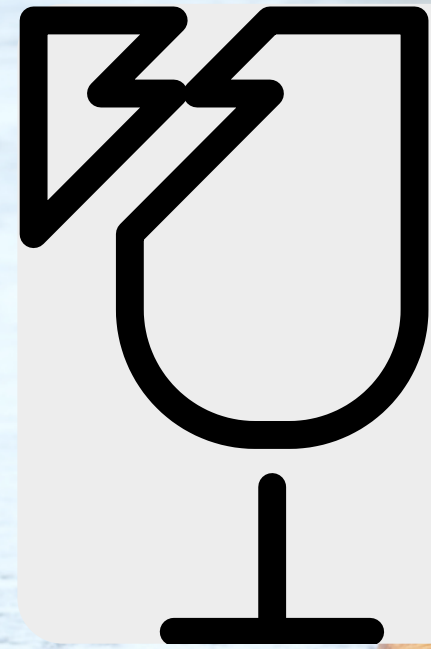
Mycotoxins, heavy metals

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Ensure restricted ingredients and additives are correctly measured & regularly re-evaluate

Food additives





# PHYSICAL HAZARDS

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# Physical hazards - 'foreign materials' in foods that can be potentially harmful



## Physical hazard from the environment

Soils, stone, insect, rodent - contaminant during harvesting and storage

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## Physical hazard from the food itself

Fruit pits, stones, stems, bone from fish and meat, corn cobs, nut shells

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## Physical hazard from the food processing facilities

Metal shavings, nut and bolts, broken utility blades, broken glasses, hard plastic

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## Personal objects

Rings, pencils, paper, earrings, buttons, hair

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# SEEDS vs PITS

FRUITS  
with seeds



Apple



Kiwi



Fig



Papaya



Passion Fruit

FRUITS  
with pits



Avocado



Mango



Nectarine



Cherry



Apricot



# Physical hazards



## Metal detector

To detect and eliminate threats of tramp metal contaminants in food goods.



## X-Ray machine

Usually this applies to metals such as steel and stainless steel, ceramic, stone, but also to glass, sandstone, quartz, shale, and many others.



## Food radar system

The technology uses microwaves to detect foreign bodies.

e.g. Wood splinters, Fruit stones, Hard and soft plastic, Shells, Rubber, Seeds, Paper





# DESIGNING A SAFE FOOD PROCESS

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# Process control of microbiological hazards



## Destruction of microorganism

Thermal process (pasteurization, sterilization, canning, UHT)

Non-thermal (filtration, UV, pulse-light, non-thermal plasma, oscillating magnetic field, ionizing irradiation, high hydrostatic pressure, pulse electric field)

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## Prevention of microbial growth

Refrigeration, freezing, hot-holding, MAP, cavum packaging,

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## Prevention of contamination

High risk ingredient control, allergenic ingredient control, aqueous control, sanitary design and sanitation, moisture control

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# Process control of chemical hazards



## Allergen control

Allergen containing ingredient must be labeled and stored separately from non-allergen-containing ingredients

Production sequencing / scheduling - non-allergen-containing food can be produced before those that contain allergen

Thorough cleaning and verification of allergen absence

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## Cleaning and maintenance chemicals

Establish a chemical control plan to to organize control and monitoring procedure to prevent food product contamination with chemicals not intended for use in food.

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# Process control of physical hazards



## Exclusion techniques

Control of glass and brittle plastic instrument, utensils  
Exclusion of wooden pallet and wooden handles on tools and equipment, personal practice, pest control

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## Removal techniques

Control of metal contamination using in-line magnet on incoming ingredients, processing equipment, packaging operations  
Control of foreign material in product stream using filters, screens and sifters

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## Detection techniques

Metal detectors - can be used on-line for packaged product  
X-ray device - to inspect container before packaging, foreign materials inside food  
Optical technologies using visible or UV light - used for fruits, vegetables, nuts to detect surface defect



## HAZARDS

- BIOLOGICAL
  - Bacteria, viruses, parasites
- CHEMICAL
  - naturally occurring chemicals
  - intentionally added chemical
  - unintentionally added chemicals
- PHYSICAL
  - from environment
  - from food itself
  - from food processing facilities
  - personal items

## PROCESS CONTROL

- BIOLOGICAL
  - Destruction
  - Prevention of microbial growth
  - Prevention of contamination
- CHEMICAL
  - allergen control
  - cleaning and maintenance chemical control
- PHYSICAL
  - exclusion technique
  - removal technique
  - detection technique

Thank you!

