

Biological

Hazards

Our Food:

Food Safety and Control System

Biological Hazards

Important milestones of food science

- **Struggle for life:** The search for food has always been a struggle to survive.
- **The discovery of fire by the cave man:** It was an important step in food handling.
- **Spices triggered the great voyages :** It was the time of discovery looking for a new way to the spices from India.
- **Global trade:** Nowadays the rarest of dishes are available everywhere and there are no restrictions as to the seasons. Global trade of food has made it possible.

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Implication of hazards

- **Sociological hazards:** Modern achievements bear the danger to destroy the economic, ecological and cultural isolated units. This destabilizes the economy of a region and endangers the ecology.
- **Food producing business:** The Food producing business is concerned about hazards which may cause tremendous costs from loss of products and recourses.
- **Retailers:** Loss of confidence of their customers is a nightmare for every manager.
- **Public health departments:** Food health departments and food regulations are top headlines.

Bioterrorism Act

**Public Health Security and Bioterrorism Preparedness and Response
Act of 2000 Public Law 107-188 , June 12, 2002**

The Bioterrorism Security Act

Response to the attack of September 11, 2001

Five Titles:

I - National Preparedness,

II - Biological Agents and Toxins,

III - Safety and Security of the Food and Drug Supply,

IV- Drinking Water Security and Safety,

V - Additional Provisions.

Export to the U.S. must register with the Food and Drug Administration before entering the US (FDA).

Bioterrorism Act

Prior notice of food imported or offered for import into the U.S. improves the traceability and the response. The recordkeeping proposal is designed to help FDA track foods implicated in future emergencies, such as terrorism-related contamination.

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Food safety depends on:

- Basic knowledge in farming, industrial know-how, transport and storage. Unawareness of basic rules of agriculture food processing and hygiene endangers food safety.
- Ethical behavior must be the basis of food business. Using loopholes of food regulations undermines food safety.
- Controls: HACCP, ISO 9001:2000, GMP, HALAL These safety systems were introduced recently as a response to series of food scandals.

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Bacterial infections

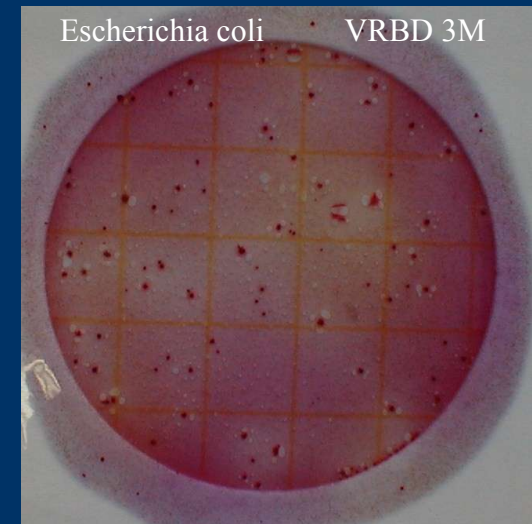
Food animals, like cattle, chickens or turkeys can carry bacteria without being sick. These bacteria can, however, cause serious diseases in humans.

Enteric bacteria

Enteric bacteria live in the intestinal tracts of animals and man.

Escherichia coli

Escherichia coli is indicator of fecal pollution of drinking water supplies, swimming beaches, foods, etc. A few strains are pathogenic such as the strain 0157:H7 .



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Enterococci

Enterococcus faecalis and *Enterococcus faecium* are enteric bacteria used to indicate faecal contamination and the possible presence of pathogens in water.

Enteric bacteria also include:

Shigella dysenteriae, *Salmonella typhimurium*, *Salmonella enterica* serovar Typhi.

Highly contaminated food



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Old nomenclature

Bergy`s Manual: “The first salmonellae were given names which indicated the disease or the animal from which the organism was isolated such as *S. typhy*, *S. choleraesuis*, *S. abortusovis*) continue to be used in clinical bacteriology.

Scientifically, none of the present methods of nomenclature of salmonellae is satisfactory. Nomenclature changes will be needed in order to account to new DNA findings.”

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New nomenclature according to DNA findings

Only two species of Salmonella are subdivided in serovars:

- **Salmonella enterica:** Meaning all human pathogens subdivided into serovars using the old genus names.

Salmonella typhi = *Salmonella enterica* serovar Typhi,
Abbreviation S. Typhi.

Salmonella enteritides = *Salmonella enterica* serovar Enteritides,
Abbreviation = S. Enteritides

- **Salmoella bongori:** Associated with cold-blood animals. Most of human infections are due to contact with reptiles.

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Salmonellosis ranges clinically from the common *Salmonella* diarrhea, abdominal cramps and fevers.

Non-typhoid salmonellosis

is caused by any serotype of *Salmonella* other than *Salmonella* Typhi. It is a worldwide disease of humans and animals. Animals are the main reservoir, and the disease is usually food borne, although it can also be spread from person to person.

Typhoid fever (Synonym: Enteric fever)

It is caused by *Salmonella* Typhi. Incubation can last up to two months. It is therefore difficult to remember the food which might have been the source of infection. Hosts are humans, which became carriers after an infection. Several negative microbiological tests should be made, to let a food worker go back to his working place after a salmonellosis. Should this not be a demand of the local medical regulations, auditing should try to get it listed as additional HACCP item.

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Paratyphoid fever

It is caused by *Salmonella paratyphi* and is milder than typhoid fever.

Typhoid Mary: Her name was Mary Mallone. She was a healthy carrier of typhoid fever. From 1900 to 1907 she worked as a cook, infecting many people. In 1915 she was found working as cook in a hospital infecting people there too. She was sent back to confinement where she died in 1938.

Other carriers such as Tony Labella and Alphonse Cotils both handling foods remained free, being an inconsequential attitude of the health authorities managing the epidemic in NY.

The major reservoir of Salmonella is poultry and livestock, ground meat and eggs.

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Measures to reduce salmonellosis in poultry:

- **Feed and hygiene:** All animal feed should be salmonellae free. Norway has a production of chicken, turkey and hens which is almost salmonella-free due to controls of feed and introduction of good veterinary hygiene measures.
 - **Slaughter:** Slaughtering practices with reduced cross-contamination of carcasses.
 - **Kitchen and handling:** Cooking and refrigerating food adequately.
- Irradiation:** Irradiation of poultry to reduce contamination by pathogenic bacteria. Not much in use.

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Shigella

Different kinds of Shigella bacteria

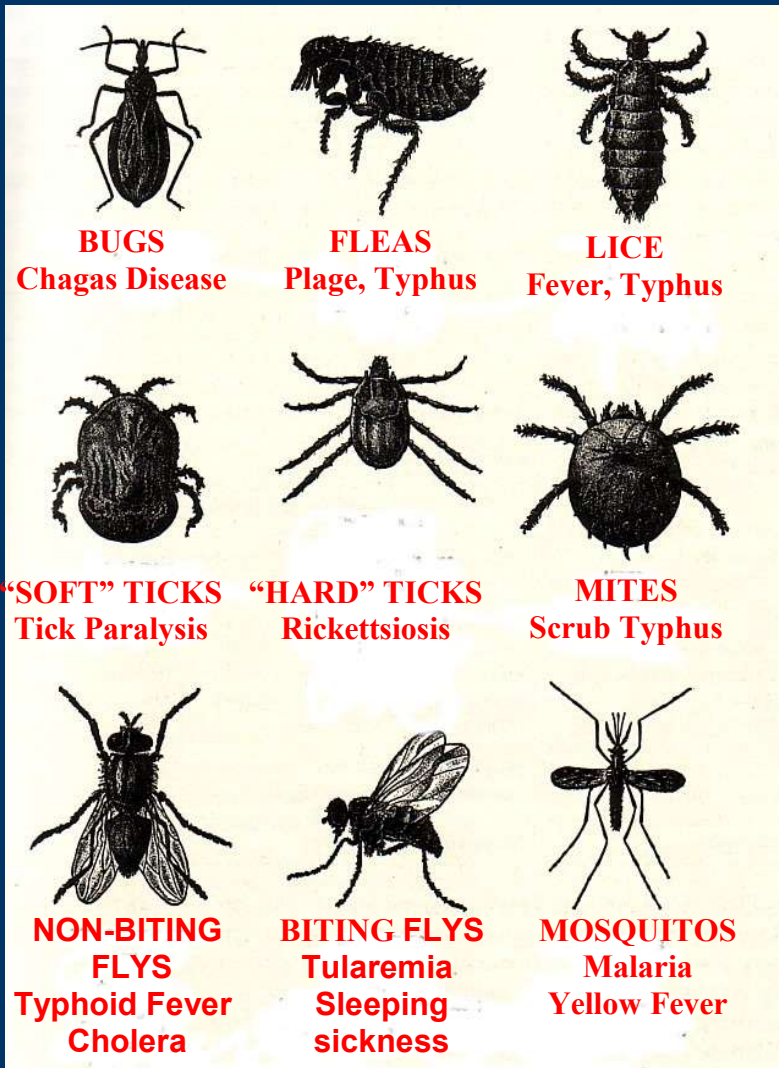
Shigella sonnei, also known as "Group D" Shigella

Shigella flexneri, or "group B" Shigella, accounts for almost all of the rest.

Shigella dysenteriae type 1 causes deadly epidemics in the developing world.

Shigella boydii.

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Common causes of food contamination with Shigella

- Infected food workers who forget to wash their hands .
- Vegetables which were contaminated with sewage.
- Flies living on infected feces can contaminate food.
- Drinking or swimming in contaminated water .

Arthropods Transmitting diseases

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Other bacteria related to food borne diseases

Listeria monocytogenes

Yersinia enterocolitica

Cryptosporidium parvum: Infects many herd animals and humans.

Cyclospora cayentanensis: Causes watery diarrhoea.

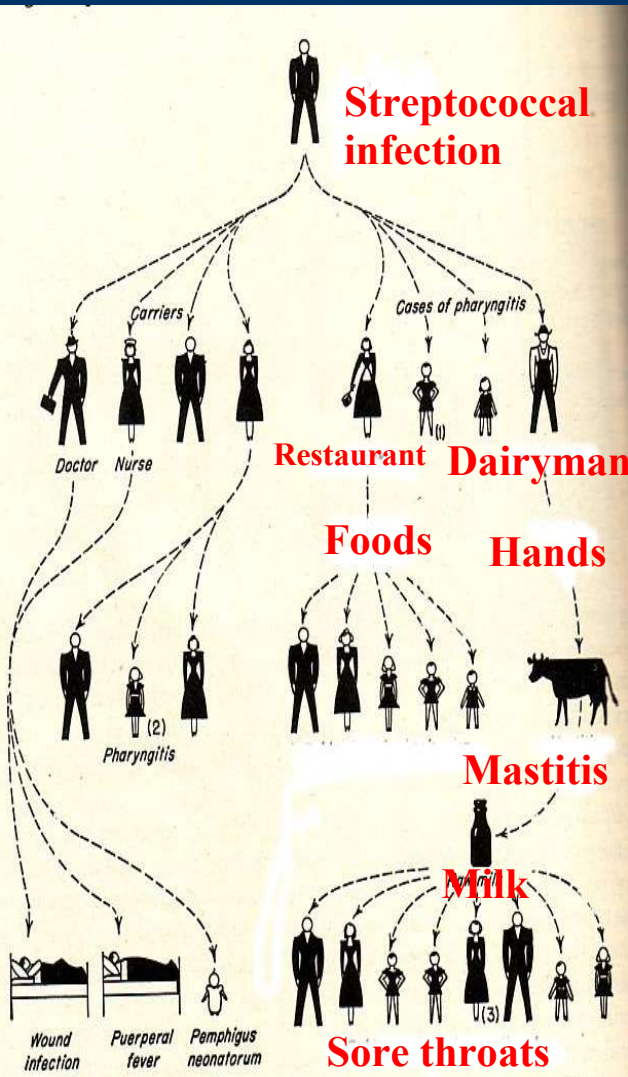
Campylobacter jejuni: It produces diarrhea with bloody stool, fever.
Many chicken flocks are silently infected with *Campylobacter jejuni*.

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Unpasteurized milk contaminated with manure. Surface water and mountain streams can become contaminated from infected feces from cows or wild birds.

Cooking chicken, pasteurizing milk, and chlorinating drinking water will avoid the bacteria to spread .

Not pasteurized milk is a possible source of Campylobacter and tuberculosis. Pasteurization time/temperature standards should be 145°F for 30 minutes (63°C for 30 minutes).



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Cholera

Vibrios are very common bacteria in aquatic environments. Pseudomonads favour fresh water and vibrios prefer salt water. The genus *Vibrio* contains an important human pathogen.

Vibrio cholerae

The cholera bacteria produces a toxin that inhibits the absorption of liquids by the body. It kills because it dehydrates the body.

Cholera is a disease associated with poverty, inadequate sanitation and low medical care. The key to effective control is environmental sanitation.

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Staphylococcus aureus

Causes suppurative infections in animals and man. Contact with infected wounds of animals or hands of food workers. Gloves are indispensable.



Contaminated fish cause intoxication with staphylotoxin which is resistant to heat. Cooked,boiled or fried fish remains poisoning.

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Other bacteria producing toxins

Bacillus anthracis: Powerful toxins are also known from *Bacillus anthracis* causing Anthrax, disease of cattle, sheep and humans.

Clostridium perfringens also produces an enterotoxin and is an important cause of food poisoning and infections such as gas gangrene.

Clostridium botulinum causes food poisoning, mainly in low acidic foods.

Botulism: *Clostridium botulinum* is widely dispersed in soils. Ingestion of the organism is not harmful. It becomes dangerous only when conditions are favorable for its growth and subsequent toxin formation.

The organism can survive in an environment containing decaying plant or animal organic material.

Biological Hazards

Moulds



Penicillium spp. spoiling oranges



Moulds cause spoilage of food and feed. Ochratoxin in coffee and in cocoa .

They cause off flavour in food and destroy paper, wood, drugs, cosmetics etc. Moulds can cause allergies and infections.

Mycotoxins in eggs and meat is mainly influenced by the concentration of mycotoxins in fodder. Auditing should always look after fodder quality of breeding stations.

Biological Hazards

Moulds

Aspergillus flavus and Aspergillus parasiticus, Aspergillus niger:

Aspergillus flavus causes broncopulmonary allergy. It produces aflatoxins B1, B2, G1, G2, sterigmatocystin and other mycotoxins in peanuts, pistachio nuts and Brazil nuts, in cereals from warm regions (corn, wheat, rice)



Several brands of dried figs with origin from Turkey and Greece have high amount of aflatoxin.

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Moulds

Aspergillus fumigatus

It is present in flower pots, compost, garbage and cereals. Conids may survive 10 minutes at 85°C.

Aspergillus fumigatus is the most pathogen Aspergillus. It causes allergies and produces fumigatin.

Aspergillus glaucus

It is xerotolerant spoiling food with low water content such as oat flakes and dried fruits, food with high amount of sugar, meat products with low water content and cereals.

Biological Hazards

Moulds

Aspergillus nidulans It is pathogenic and builds Sterigmatocystin It is present in cereals, bread and pastries and wet leather.

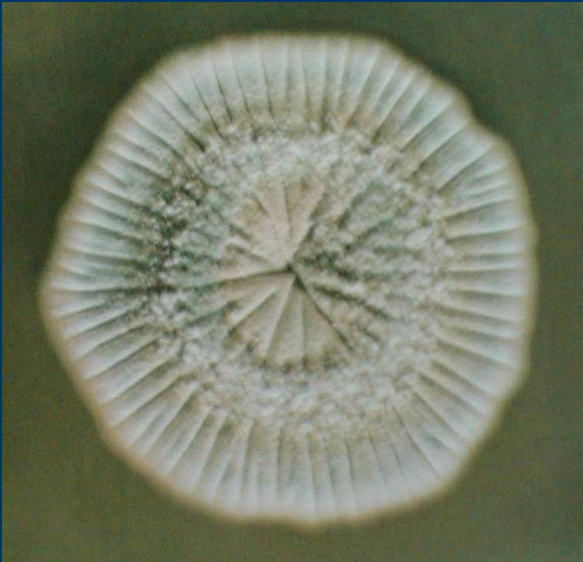
Aspergillus niger

A. niger is present in soil, dust, on cereals and fruits. It spoils food such as cereals, breads and pastries.

In biotechnology *Aspergillus niger* is used for the production of organic acids and enzymes.

Biological Hazards

Moulds



Penicillium expansum

Penicillium expansum: It is probably the most commonly encountered species.

The major sources of Patulin are apples and apple products.

Aspergillus ochraceus

Slow growing, produces ochratoxin A. It is present in cereal storehouse, bread, pistachio, salami and ham.

Patulin in Apple Juice

Patulin is a secondary metabolite produced by a number of fungal species in the genera Penicillium, Aspergillus and Byssochlamys. Penicillium expansum is probably the most commonly encountered species.

The major sources of Patulin are apples and apple products.

Biological Hazards

Viral Infections

- **Food** may be contaminated by food preparers or handlers who have viral gastroenteritis, especially if they do not wash their hands regularly after using the bathroom.
- **Shellfish** may be contaminated by sewage. Persons who eat raw or undercooked shellfish harvested from contaminated waters may get diarrhea.
- **Drinking water** can also be contaminated by sewage and be a source of viruses.

Important measures to avoid food born viral diseases

Personal hygiene, communal hygiene such as sewage treatment, isolation of diseased persons from food processing.

Biological Hazards

Viral infections

Norovirus

Noroviruses are leading causes of foodborn diseases

Norovirus should replace

"flu-like", "Norwalk-like", "Norwalk- and Norwalklike viruses (Caliciviruses)", "bug".

Norovirus was first identified in 1972 in the city of Norwalk (Ohio). They spread by person-to-person contact from the stool and aerosols of infected persons. Its symptoms are heavy vomiting and diarrhea.

The virus spreads in ships, hospitals, senior care facilities and other establishments. Incubation is 1 to 2 days. Recovery in 2 to 3 days.

People with the virus are contagious by direct contact for 3 days after symptoms have disappeared. The stool remains contagious for 2 weeks.

Biological Hazards

Viral infections

Reoviruses

Respiratory **E**nteric **O**rphan viruses, i.e. infect the human respiratory and intestinal tracts, usually without disease symptoms. There are 150 species in the family Reoviridae.

Rotaviruses

Rotaviruses belong to the group of the reoviruses. They resemble wheels with a central axis and radiating spokes (Rota=Wheel)

Rotaviruses are the most common cause of severe diarrhea worldwide.

Biological Hazards

Viral infections

Astroviruses

Astroviruses are the cause of most frequent viral gastrointestinal infections and are a significant cause of diarrhea in developing countries.

They are clinically similar to **caliciviruses**.

There are at least 7 human astrovirus serotypes.

Biological Hazards

Viral infections

Adenoviruses

Adenoviruses most commonly cause respiratory illness; however, depending on the serotype, they may also cause gastroenteritis.

Adenoviruses are unusually stable to chemical or physical agents and adverse pH conditions, allowing for prolonged survival outside of the body.

Transmission occurs by direct contact, faecal-oral transmission, and occasionally by water. Shedding can occur for months or years.

Biological Hazards

Viral infections

Monitoring trends of indicator organisms, e.g. **Enterobacteriaceae** and Standard Plate Count should indicate deviations from quality standard.

Any increase of indicators should trigger an active investigation of the reasons for the increased levels.

Biological Hazards

Viral infections

SARS Severe Acute Respiratory Syndrom

SARS coronavirus (SARS-CoV) type causes an epidemic of a respiratory disease which spreads in Guangdong and other provinces of China Canada, the United States.

The virus may remain on hands and surfaces for several hours. Strict hand-hygiene be enforced among food handlers and within the food processing industry.

Use gloves or utensils for an extra level of protection.

Biological Hazards

Viral infections

Proper hand washing continues to serve as a vital and necessary public health practice to eliminate the spread of food borne illnesses in retail food stores and food service.

Contamination factors common in retail and food service environments inhibit the effectiveness of alcohol-based hand sanitizers when used in place of hand washing.

Avian Diseases

Diseases of respiratory organs

Avian influenza

It is an Influenzavirus A of the family Orthomyxoviridae.

- 15 H subtypes (H1-H15)
- 9 neuraminidase subtypes (N1-N9).

Influenza infections in birds: Two groups

1 - **Highly pathogenic avian influenza viruses subtypes H5 and H7.** High mortality up to 100%.

2 - **Low pathogenic avian influenza (LPAI)** causing in general a mild disease. 8 deaths according to WHO at January 2004.

Parasites and Pathogenic Protozoa

Endamoeba histolytica

The vegetative form of *Endamoeba histolytica* multiplies by fission and is able to invade the mucosa of the large intestine where it causes ulcerations.

Ninety per cent of infected people are not obviously ill, distributing the cysts everywhere. Only about 10 per cent have active dysentery.

Parasites and Pathogenic Protozoa

As trophozoites die outside of the body and are killed by gastric juice and bile if they are ingested, the dysentery cases are not important as source of infection. The cysts, however, survive for sometime outside the body and can pass uninjured through the alimentary canal to the ileum.

Important source of infection are cyst passers which do not have signs of any disease but produce great amount of cysts which are spread by contaminated food and polluted water.



Imported vegetables and salads should therefore carefully rinsed or better, cooked when the origin of it is unknown. Flies should be kept away from food production.

Parasites and Pathogenic Protozoa

Prophylaxis of amebiasis

Improve the sanitary facilities.

Boil the infected water before drinking.

Avoid ingestion of infected vegetables.

Cook all meals and make combat to flies.

Giardia lamblia

Giardia lamblia is a pathogenic protozoa living in the duodenum often without symptoms. Giardia lamblia adheres to the surface of the epithelial cells of the mucous of the duodenum.

Fat absorption and digestion is disturbed. Dietary deficiency, diarrhea and bad smelling flatulence takes place. The disease is spread over cysts in water and foods.

Parasites and Pathogenic Protozoa

Cryptosporidium

Oocysts of *Cryptosporidium* are widespread in the environment and can be found in lakes and streams.

Balantidium coli

It is a very large protozoan which may cause severe ulcerations of the large intestine. Cysts and motile forms are found in feces. Hogs harbor commonly *Balantidium coli*. Infection of man is caused by contaminated food and water.

Parasites and Pathogenic Protozoa

Parasitic worms: three groups

Nematodes called roundworms

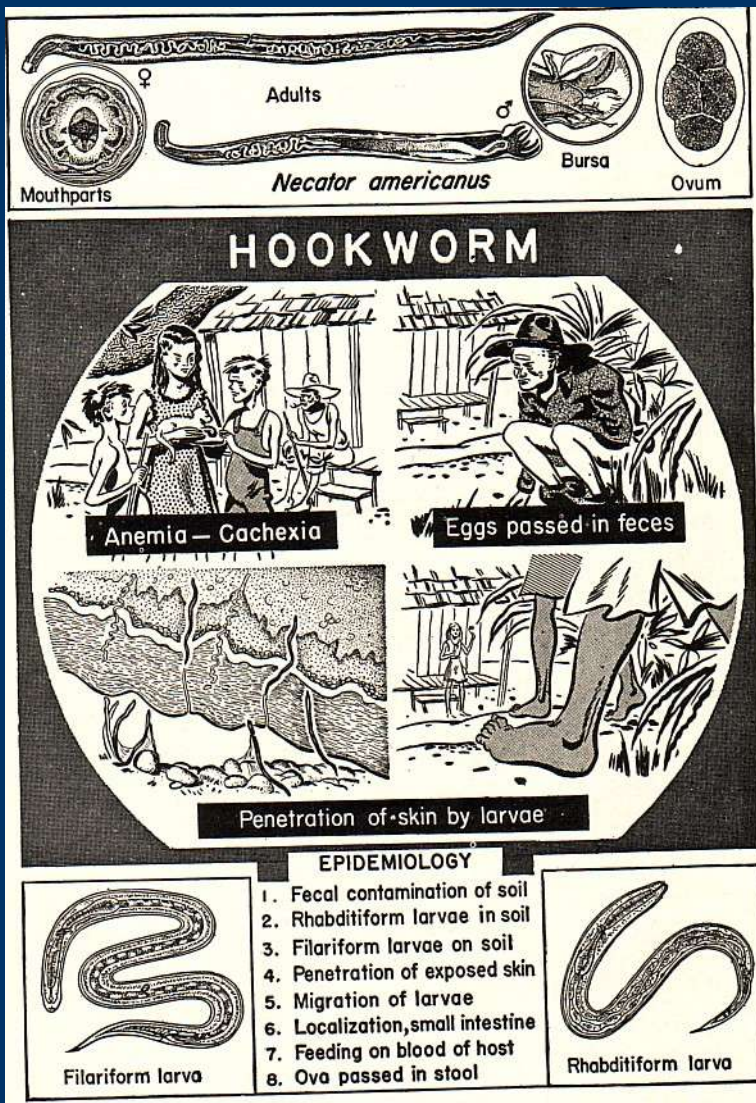
Trematodes like the flukes

Cestodes are the tapeworms.

Worm parasites do not multiply in the human host.

They need to pass through stages in the human host and other stages in one or more animals, in soil or water.

Parasites and Pathogenic Protozoa



Nematodes (Roundworms)

Ancylostoma duodenale and Necator americanus are hookworms, which infect persons, dogs and cats.

The loss of blood is the cause of the debilitation.

Life cycle of ancylostomideans

Hook worms attach themselves to the wall of the small intestines. The females produce eggs which are carried by feces.

Parasites and Pathogenic Protozoa

Infestation from contaminated food and water:

The larvae can be ingested from food and water lead to an infestation without the skin-blood-lung-cycle. This way of infestation is less common but should not be neglected handling with food, specially imported vegetables and fruits being eaten without proper washing and cooking.

The use of shoes reduces the possibility of an infection by the larva through the skin of the foot. The use of shoes is therefore a measure of food safety as it diminishes the possibility of spread of eggs and larvae on vegetables and fruits.

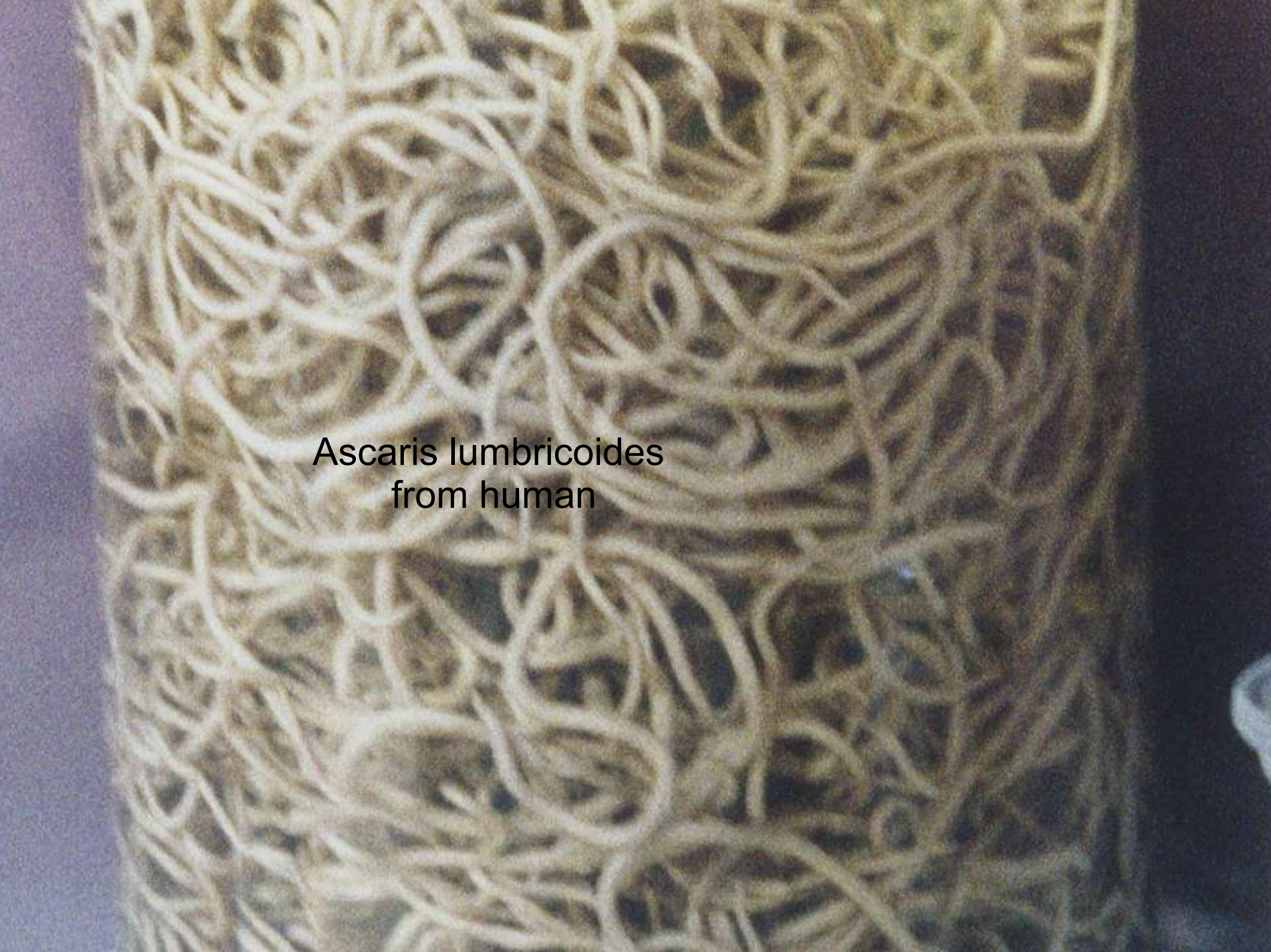
Parasites and Pathogenic Protozoa

Strongyloides stercoralis : The disease caused by *Strongyloides stercoralis* is similar to the hookworm disease.

Trichuris trichiura: It is also called whipworm because of its shape. The ova need several days in the soil to develop to infective larvae. They enter through the mouth in contaminated food and water.

Ascaris lumbricoides: This is the largest roundworm being up to 12 inches long. The eggs deposited in feces develop in soil during several weeks to infective stage. When swallowed the larvae penetrate the intestinal wall and a similar cycle as known as Ancylostomideans.



A large, dense mass of pale, thread-like worms, identified as Ascaris lumbricoides, filling most of the frame. The worms are intertwined and appear as a thick, tangled mat of fine, yellowish-white strands. The background is dark, making the worms stand out. The text is centered over the middle of the image.

Ascaris lumbricoides
from human

Parasites and Pathogenic Protozoa

Enterobius vermicularis: It is also called pinworm or seat worm. The female migrate through the anus and deposit thousands of ova on the skin of the perianal region. When these eggs are ingested they develop into larvae and adult worms in the intestine.

Trichinella spiralis: Is a common parasite of flesh eating animals and causes trichinosis. Adult trichina worms are just barely visible to the naked eye. They live in the duodenum. The female worm penetrates the intestinal wall and deposits its larvae in the mucous.

Parasites and Pathogenic Protozoa

As imported meat from unknown and sometimes dubious origin (pork) is coming on the market, the number of human trichinosis is increasing again.

Treatment is very difficult, all care should be made to avoid ingestion of meat with living larvae of *Trichinella spiralis* by refusing any food with raw or not sufficiently heated meat, including also all kinds of unheated sausages.

Parasites and Pathogenic Protozoa

Trematodes (Flukes): Flukes are uncommon in developed countries. However, due to increased travels and adventure trips their importance is growing. One divides the flukes according to the place where they live: **Blood flukes, Liver flukes and Lung flukes**

Blood flukes: There are three important blood flukes: *Schistosoma haematobium*, *Schistosoma mansoni* and *Schistosoma japonicum*.

Schistosoma haematobium is found as chronic disease in Africa and in Asia.

Avoid to take bath in swallow water with low stream velocity. Hygienic condition of drinking and water used in the preparation of food in these areas.

Parasites and Pathogenic Protozoa

Schistosoma mansoni: Causes endemic infections in the Caribbeans and the northern part of South America.

Intestinal flukes

Fasciolopsis buski: The fluke Fasciolopsis lives in the upper part of the small intestine. It contains both male and female reproductive systems causing diarrhea and anemia. The ova in faeces develop to larvae and penetrate certain types of snails as intermediate host.

Here again the hygienic condition of water is important in the areas where trematodes may be found. Cooking of all foods, sanitary disposal of sewage and the elimination of snail hosts.

Parasites and Pathogenic Protozoa

Cestodes (Tapeworms)

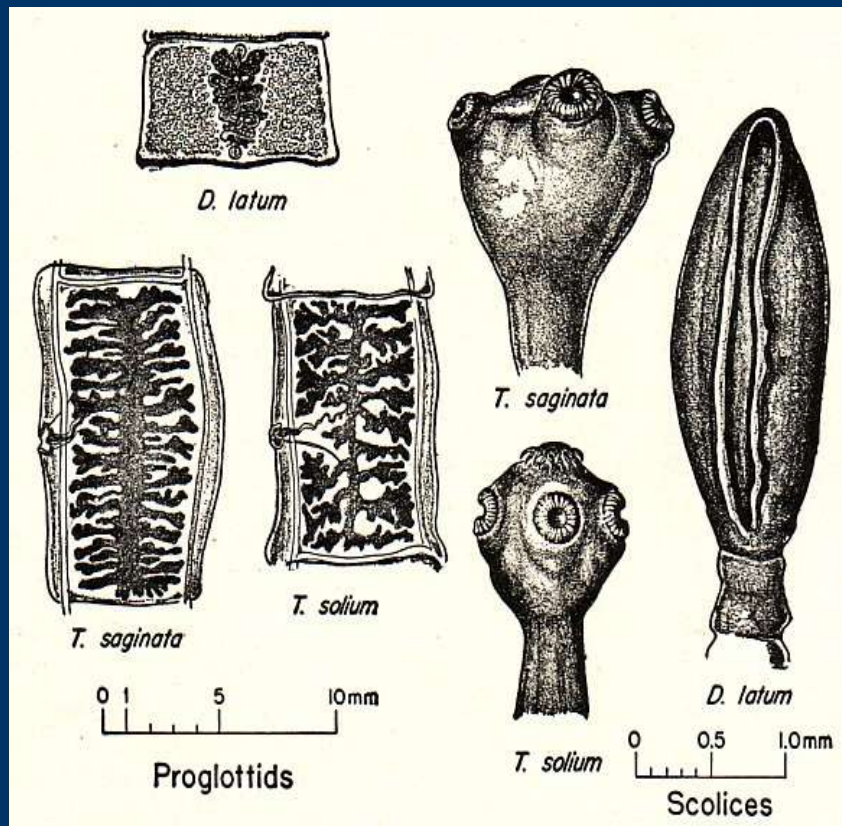
Tapeworms are cestodes with five important species: *Taenia solium*, *Taenia saginata*, *Diphyllobotrium latum*, *Hymenolepsis nana* and *Echinococcus granulosus*.

Taenia solium

It is the pork tapeworm.

Parasites and Pathogenic Protozoa

Taenia saginata: It is the beef tapeworm which can grow up to 6 meters long. The ova leave the body with the feces and are ingested from contaminated soil by the intermediate host like cattle.



The larvae develop in the intestine, penetrate the wall and are carried by the blood stream to the skeletal muscles becoming bladder worms or cysticerci being spherical and inverted scolex.

When beef containing these cysts are undercooked eaten the cyst wall is digested and the scolex may attach to the intestinal wall and the proglottids develop to form the adult parasites.

Parasites and Pathogenic Protozoa

If ova of *Taenia saginata* are ingested by men the same cycle observed in cattle takes place. The larvae migrate through the body and cyst formation in various organs may take place.

Cyst formation of *T. saginata* in man is very seldom. To control spreading of *Taenia saginata* it is important to avoid cattle to get in contact with human feces contaminated soil.

Don't eat raw or undercooked meat as they may contain cysts of *Taenia*. Don't drink water from suspected areas without boiling as they may contain ova of *Taenia*.