HYGIENE AND RISK MANAGEMENT

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General Hygiene

Definition

Health: a state of complete physical, social and mental well-being, and not merely the absence of disease or infirmity.

Hygiene: the science of preventing and protecting the health of people through control of the environment.

Environment: our physical surroundings (air, water and land), biological surroundings (animals and plants), and social surroundings.

General Hygiene

Areas of Hygiene

Environmental hygiene: it deals with the methods of defence from harmfulness (heat, cold, weather, rays, poison or pathogens) that originate from land, air and water.

Social hygiene: it avoids damages of the social environment of the human being.

Individual hygiene: it comprises of body cleaning and its clothing. Always keep your hands clean: after using the toilet, before cooking, before meals and after contact with raw or uncooked food wash your hands with **soap** or **detergent**.

General Hygiene

Areas of Hygiene

Food hygiene: it protects us not only from insufficient, unsuitable, rotten or poisoned food, but also changes our deficient dietary habit. Kitchen hygiene also belongs to food hygiene.

Occupational and domestic hygiene: working and residing place should be hygienic.

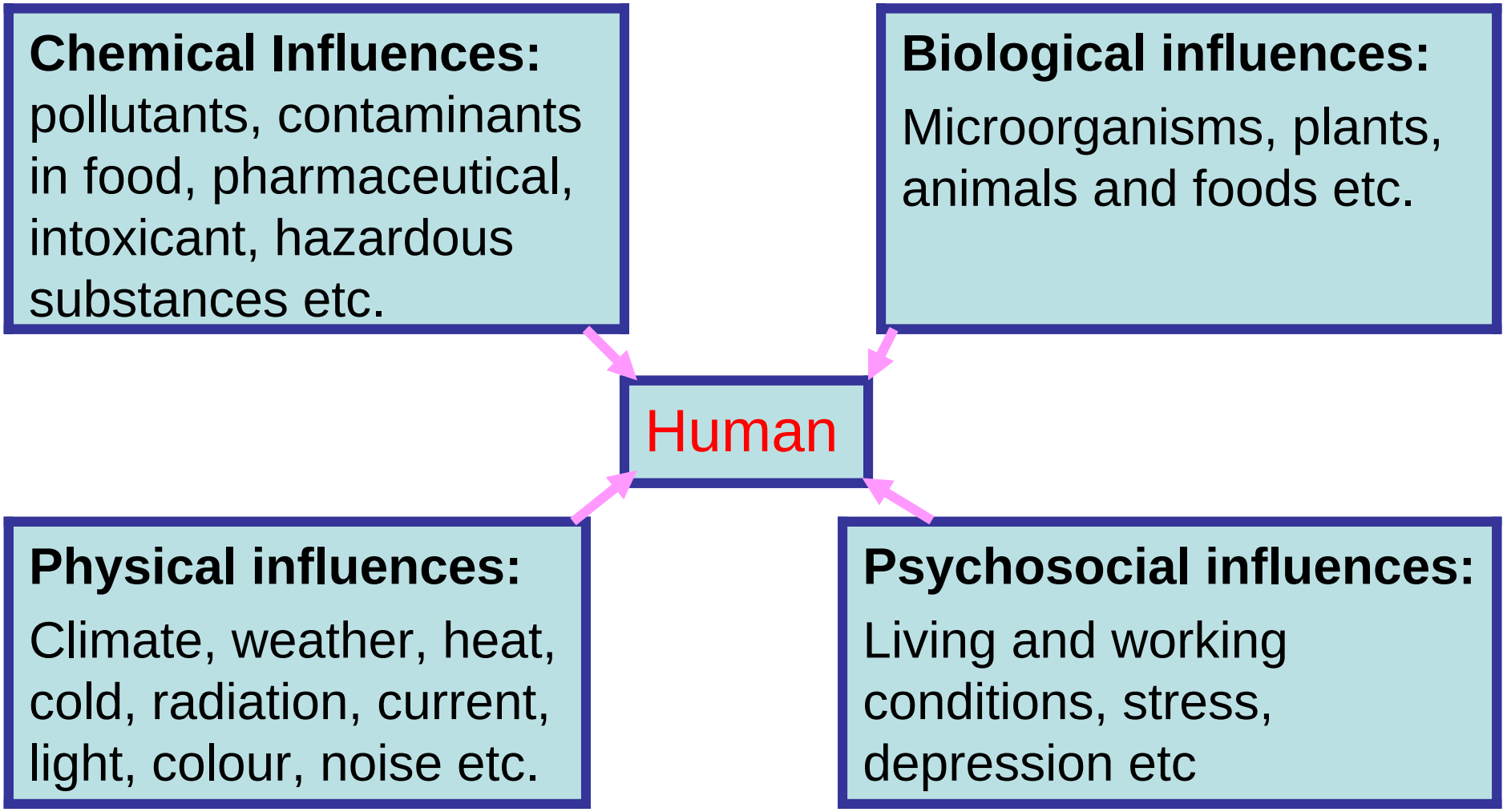
General Hygiene

Environmental Influences on human

Normally, **humans** can react physically, socially and mentally on changed **environmental influences**, in order to adapt themselves and thus avoiding damages. But, there are also many environmental influences, which can overcome human's adaptation and defence capacity and cause diseases.

General Hygiene

Environmental Influences on human



Diseases

Infectious

- Transmitted from one person to another or, sometimes, to or from animals.
- All infectious diseases are usually caused by Pathogens (Bacteria, Viruses, Protozoa and Helminths)

non-infectious

- Health problems related to environmental pollution are considered to be the result of contamination of water, food, and air with toxic chemicals. The resulting diseases are non-infectious.

Diseases

Infectious

Water-related infections

- **Transmission routes:**

Water-borne

Cholera, Typhoid, Dysenteries, Diarrhoeas, Infectious hepatitis

Water-washed

Skin and eye infections
Louse borne typhus

Water-based

Schistosomiasis
Guinea worm

Water related insect vector

Yellow fever, River blindness, Malaria
Sleeping sickness

Excreta-related infections

- Diseases which are faecal-orally transmitted usually enter the environment by the excretion of faeces from infected persons.

Diseases

Classification of water-related infection

Category	Infections
Faecal-oral: (water-born or water-washed)	Diarrheas and dysentaries, *Amoebic dysentary,Campylobacter enteritis,Cholera, E. coli diarrhea, Giardiasis, Rotavirus diarrhea, Salmonellosis, Shigellosis, Yersinosis,*Enteric Fevers *Typhoid, Paratyphoid*, Poliomyelitis, Hepatitis A, Leptospirosis
Water-washed: (skin and eye infections, and other Infectious skin diseases)	Infectious skin diseases, Infectious eye diseases, Louse-borne typhus, Louse-borne relapsing fever
Water-based: (penetrating skin,ingested)	Schistosomiasis, Guinea worm, Clonorchiasis others
Water-related insect vector: (biting near water, breeding in water)	Sleeping sickness,Filariasis Malaria, River blindness, Mosquito-borne, *Yellow fever, Dengue others*

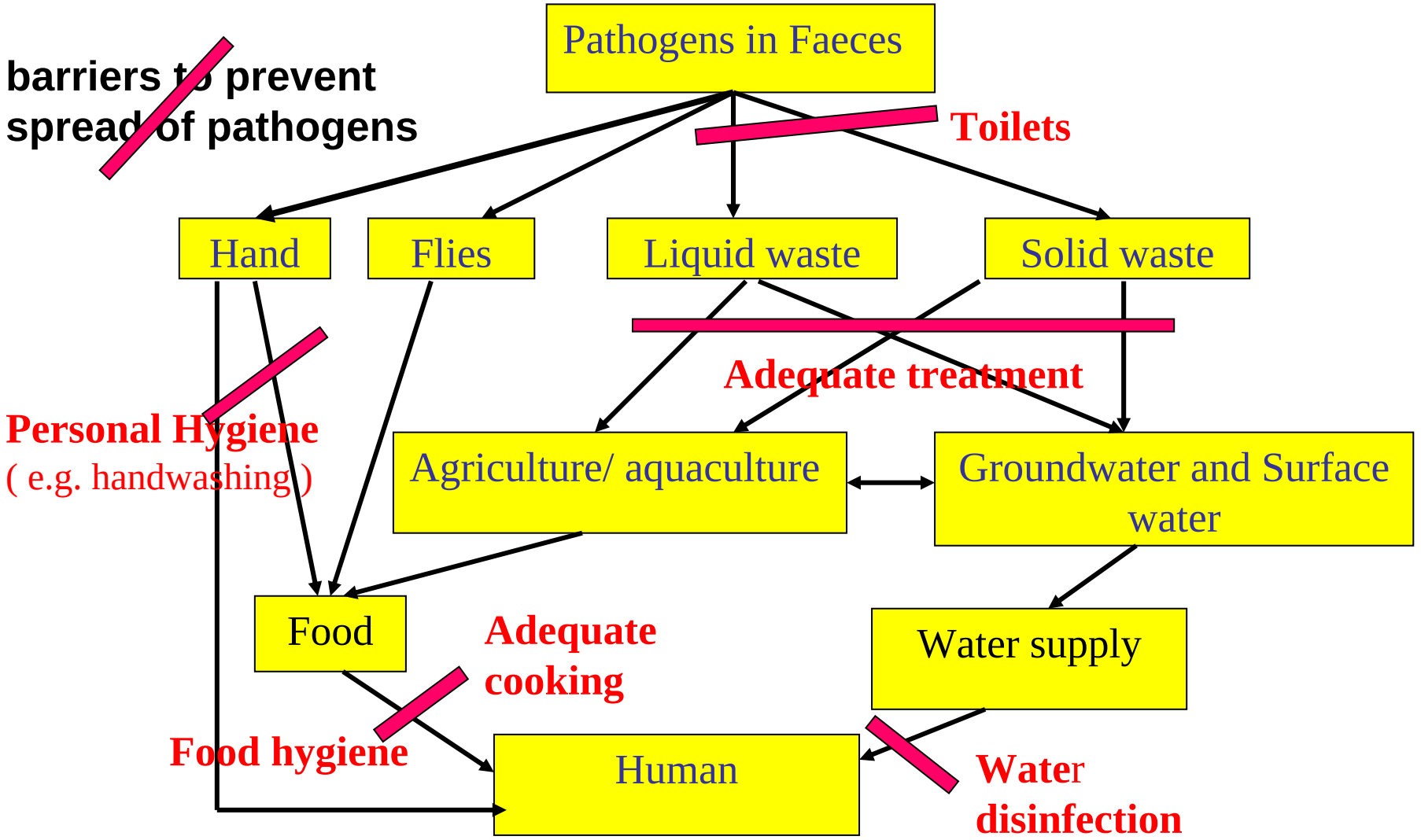
Diseases

Classification of excreta-related infections

Category	Infections
Faecal-oral: (non-bacterial)	Poliomyelitis, Hepatitis A, Rotavirus diarrhoea, Amoebic, dysentery, Giardiasis, Balantidiasis, Enterobiasis, Hymenolepiasis
Faecal-oral: (bacterial)	Diarrhoeas, Dysenteries, *Campylobacter enteritis, Cholera, E. coli diarrhoea, Salmonellosis, Shigellosis, Yersiniosis,* Enteric fevers, *Typhoid, Paratyphoid*
Soil-transmitted helminths:	Ascariasis, Trichuriasis, Hookworm, Strongyloidiasis
Beef and porktapeworms:	Taeniasis
Water-based helminths:	Schistosomiasis, Clonorchiasis, Diphyllobothriasis Fasciolopsiasis, Paragonimiasis
Excreta-related insect vectors:	Filariasis

Routes of Pathogens Transmission from Faeces to Human

(Adopted from Franceys et al. 1992 and modified)



Survivability rate of pathogens in environment

Factors affecting survivability rate of pathogens:

- Competition for food
- Predator-prey relationships
- Antagonism
- Environnemental conditions

In order to eliminate pathogens, faecal containing waste must be treated in a controlled environment, where the above mentioned factors act effectively.

Survivability rate of pathogens

***Survival time (d) of pathogens in day by different disposal/treatment conditions* (Esrey et al., 1998)**

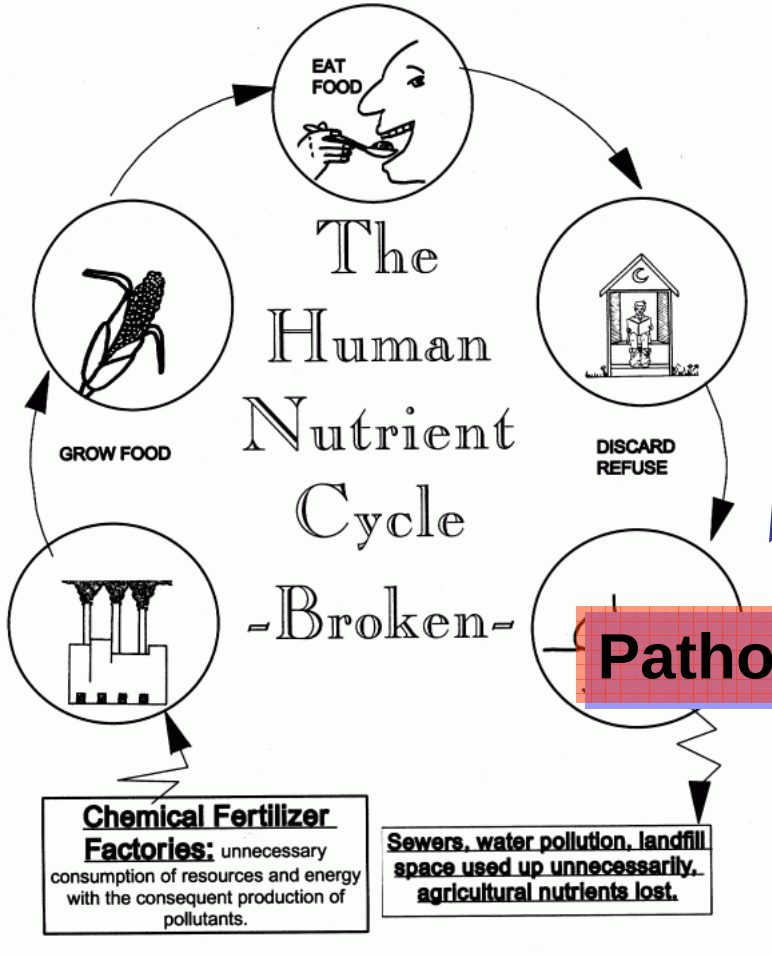
Condition	Bacteria	Viruses	Protozoa*	Helminths**
Soil	400	175	10	Many months
Crops	50	60	not known	Not known
Night soil, faeces, sludge 20-30 ^{O}C	90	100	30	Many months
Composting Anaerobic at ambient temperatures	60	60	30	Many months
Thermophilic composting 50-60 ^{o}C maintained for several days	7	7	7	7
Waste stabilisation ponds Retention time > 20 days	20	20	20	20

* excluding Cryptosporidium parvum

** mainly Ascaris; other parasitic eggs tend to die quicker

Wastewater management and associated hygienic risk

Conventional Sanitation



(Source: Jenkins, 1994)

Human excreta containing pathogens are mixed with large amount of water and discharged into open aquatic environments

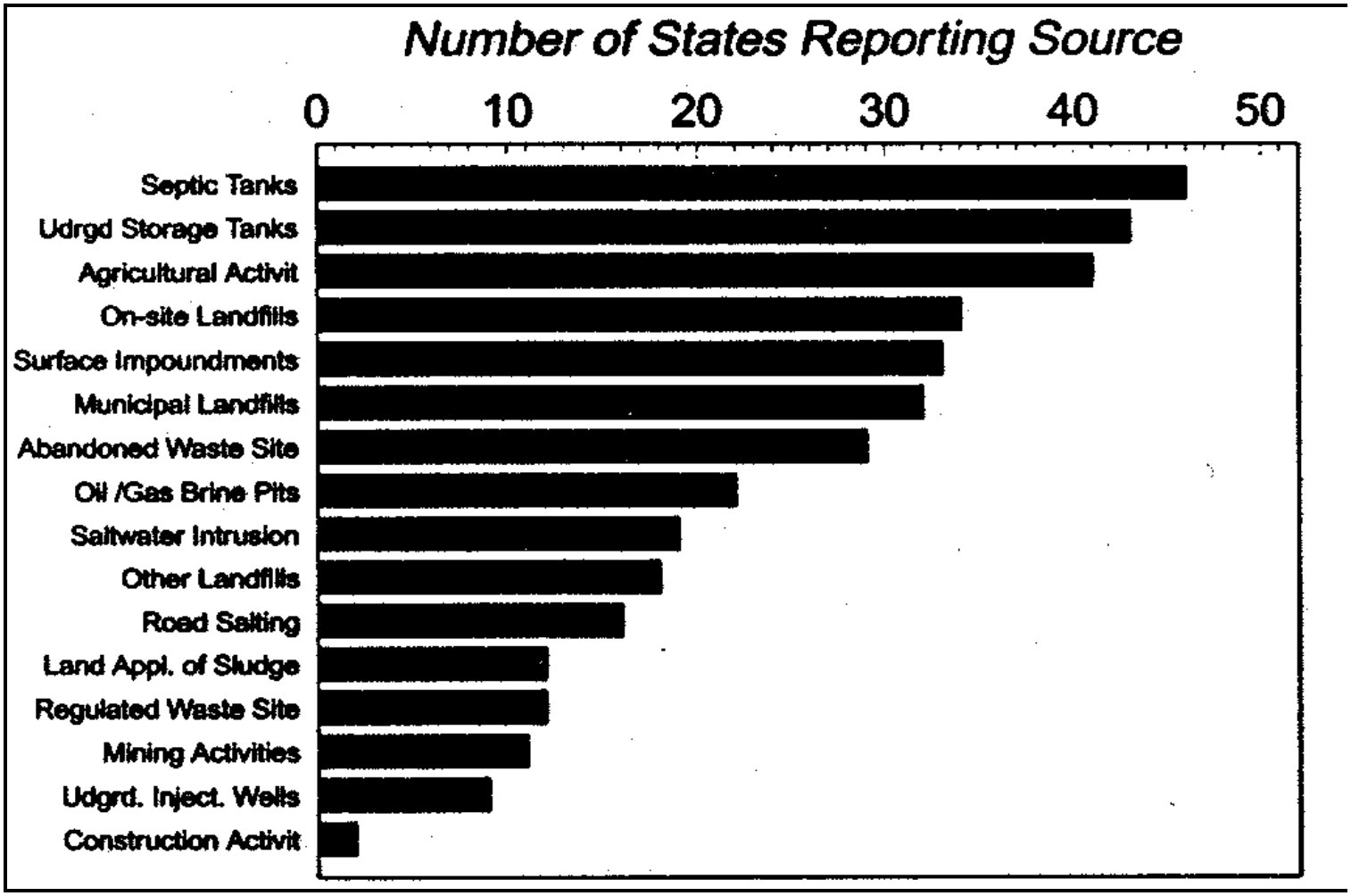
Pathogens

Responsible for 4 million infant and child deaths per year in developing countries

(Source: Lubis, 1999)

Wastewater management and associated hygienic risk

Conventional Sanitation

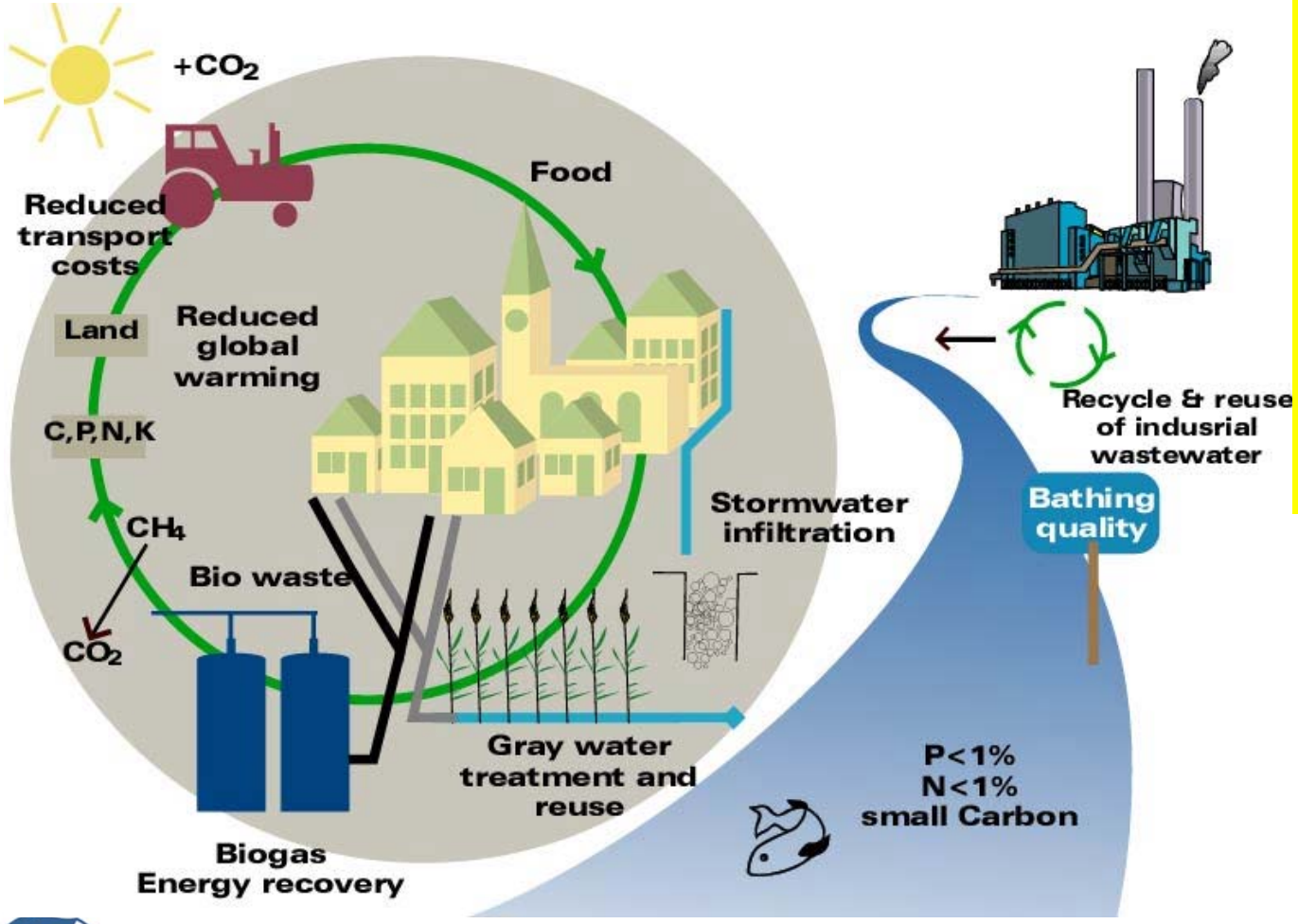


Reported sources of groundwater contamination in the United States

(Source: Jenkins, 1994)

Wastewater management and associated hygienic risk

Ecological sanitation



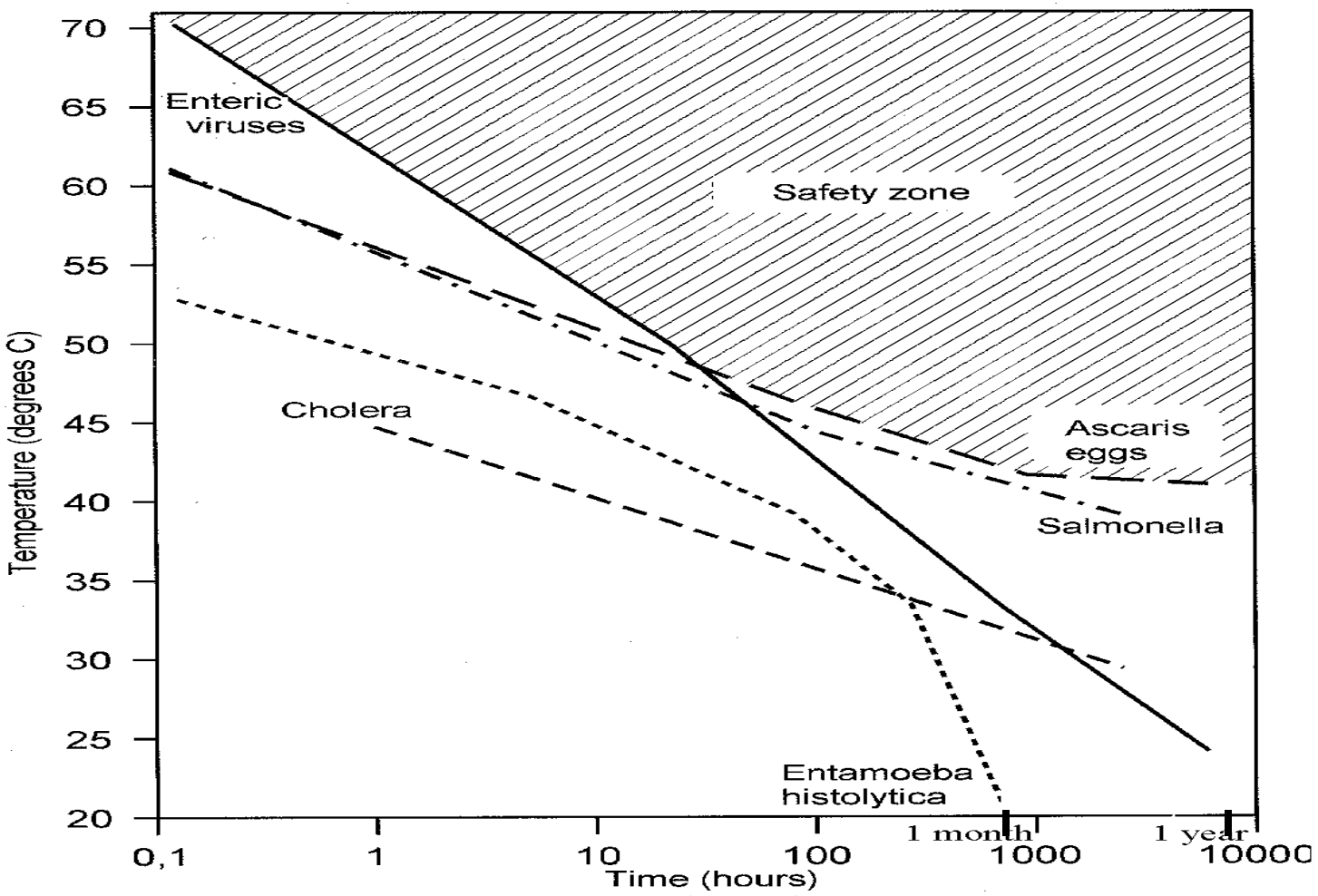
Human excreta are captured at source and kept

in a closed environment and sanitised with

Storage/composting/ dehydration/ anaerobic digestion with heating etc.

Wastewater management and associated hygienic risk

Ecological sanitation



Combination of time and temperature of pathogens elimination. Hatch area represents complete pathogens elimination due to the combined effect of time and temperature (Feachem et al., 1983)

Wastewater management and associated hygienic risk

Ecological sanitation

Pathogens survival by composting (Feachem et al., 1983)

Pathogens	Composting Toilet (3 months retention time)	Thermophilic Composting
Enteric Viruses	Probably eliminated	Killed rapidly at 60°C
Salmonellae	A few may survive	Killed in 20 hrs at 60°C
Shigellae	Probably eliminated	Killed in 1 hr.at 55°C
E.coli	Probably eliminated	Killed rapidly above 60°C
Cholera vibrio	Probably eliminated	Killed rapidly above 55°C
Leptospires	Eliminated	Killed in 10 min. at 55°C
Estamoeba histolytica cysts	Eliminated	Killed in 5 min. at 50°C
Hoohworm eggs	May survive	Killed in 5 hrs. at 50°C
Roundworm(Ascaris)eggs	Survive well	Killed in 2 hrs. at 55°C
Schistosome eggs	Eliminated	Killed in 1 hr. at 50°C
Taenia eggs	May survive	Killed in 10 min. at 59°C

Wastewater management and associated hygienic risk

Ecological sanitation

Pathogens survival by desiccation

Desiccation by **drying** and **adding high-alkaline additives** is the best way to kill pathogens.
There are also other additives such as **saw dusk, dry soil**
Plant ash is the most effective additive to eliminate pathogens.

Pathogens survival by anaerobic digestion

Since, in anaerobic digestion, self heating of the organic material does not take place, **extra heating is required for eliminating pathogens** contained in the faecal materials.

For complete elimination of pathogens, temperatures **above 55 °C** must be maintained for 10 days

Wastewater management and associated hygienic risk

Ecological sanitation

Factors lethal to most of the pathogens:

- high pH (> 9)
- Low moisture contain (< 25%)
- High temperature (> 55 ^{O}C) over more than 10 hours
- Long retention time (> 6 months)
- Ammonia and high salt content
- Limited nutrients (competition for food)
- predator-prey relationships
- antagonism

Wastewater management and associated hygienic risk

Ecological sanitation

For urine mainly **temperature** and the elevated **pH (~9)** in combination with ammonia has been concluded to affect the **inactivation of micro-organisms**. Bacteria like *Salmonella* (i.e Gram-negative bacteria) were inactivated rapidly, whereas viruses was hardly reduced at all at low temperatures (4-5°C)

Inactivation of microorganisms in urine, given as T90-values (time for 90% reduction) in days (Höglund,2001)

	Gram-negative Bacteria	Gram-positive Bacteria	*C.*parvum	Rhesus rotavirus	S. typhimurium phage 28B
4°C	1	30	29	172[a]	1 466[a]
20°C	1	5	5	35	71

A SURVIVAL EXPERIMENTS PERFORMED AT 5°C.

Wastewater management and associated hygienic risk

In practice, complete elimination of pathogens may not be possible in any kind of sanitation. Secondary barrier such as personal, food and domestic hygiene must be included to destroy the pathogens completely. Therefore, hygiene awareness and proper education are the crucial points for on-site faecal waste management.

Risk management through guidelines

Guidelines and **recommendations** for the handling and reuse of wastewater can work as a tool to minimise risks.

It is recommended:

sanitised faecal matter is covered after application and not used as fertiliser to vegetables, fruits or root crops that are consumed raw, excluding fruit trees.

At household level, urine can be used directly, but in a large-scale system it should be **stored for a month at 20°C prior to apply in agriculture**.

For vegetables, fruits or root crops that are consumed raw, a withholding period of one moth should be additionally applied i.e. **one month should pass between fertilisation and harvest** minimise health risk.

Risk management through guidelines

The World Health Organisation (WHO) guidelines for wastewater reuse in agriculture:

For restricted irrigation, the treated wastewater should contain **no more than one human intestinal nematode egg per litre**. For unrestricted irrigation, the same **helminth egg** value, and additionally **no more than 1000 faecal coliform bacteria per 100 ml** of treated wastewater.

Similar principles were applied to the derivation of guidelines for the use of excreta in agriculture. The treated sludge contains **no more than one helminth egg per kilogram** and **no more than 1000 faecal coliforms per 100 g.**

Risk management through guidelines

In **USA, EPA** guidelines for bio-solids are classified as **class "A"** (pathogens below detectable level) or **class "B"** (pathogens detectable, but do not pose a threat to public health).

In **Germany** bio-waste Ordinance (Ordinance on the Utilisation of Bio-wastes on Land used for Agricultural, Silvicultural and Horticultural Purposes) requires that **end product must be free of Salmonellae.**

In **ecological sanitation** heavy metals are not a big concern, since human excreta contain approximately the same amount of heavy metals as food. Therefore, there is no risk of heavy metal accumulation in soil due to these fertilisers.
The issue of pharmaceutical residue in excreta has to be addressed here, indeed.

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