Food safety

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Food Safety

Definitions:

Food: is any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be ingested by humans.

Food safety: to ensure that the consumed food is harmless to the consumer if it is prepared and consumed in a proper way.

Food security means that all people at all times have physical & economic access to adequate amounts of nutritious, safe, and culturally appropriate foods.

Risk: the possibility and severity of a health damaging effect arising from a hazard in the food

It is considered not to be food:

- Living animals
- Crops before harvesting
- Tobacco
- Cosmetics
- Medicaments
- Drugs
- Pesticides and their residues

Hazards:

- Microbiological – food related pathogens and food spoilage microbes, like *E. coli, Salmonella enterica, Staphylococcus aureus, Bacillus subtilis, Bacillus cereus*, etc.
- Chemical – toxins, pesticide residues, veterinary medicine residues, heavy elements.
- Physical – foreign substances (stone, glass shard, metal); radiation.
- Biological – parasites, GMO

From farm to fork concept: traces the different stages of the food chain system and examines the practices and procedures that ensure the safety of the food.
FARM (crop cultivation; husbandry) → food processing → distribution → food trade → household, restaurants (fork)

Food safety in the European Union: the 178/2002 EC regulation = General Food Law
Aims:
–High level protection of human life and health
–Protection of animal health and welfare
–Protection of plant health and the environment
–Protection of consumers' interest
–Free trade of all goods in Europe
–Taking international standards into consideration

Principles:

1. Risk analysis - scientific assessment of risk must be undertaken in an independent, objective and transparent manner based on the best available science.

Components of risk analysis:
–Risk assessment – identification and characterization of hazards on scientific base
–Risk management – political decision to prevent and control risks, establishment of threshold values
–Risk communication – interactive exchange of information and opinion among risk assessors and risk managers, consumers and industry.

EFSA = European Food Safety Authority was established in 2002. It is s an independent European agency and operates separately from the European Commission, European Parliament and EU Member States. Main task of EFSA is risk assessment of
–new foods before selling in the EU
–food additives, flavourings

–packaging materials

–novel foods

–veterinary medicines

– plant protection products

EFSA gives scientific advice to risk managers.

Principle 2: traceability: means the ability to track any food, feed, food-producing animal or substance that will be used for consumption, through all stages of production, processing and distribution.

Tools for traceability:

–Labeling – data for the identification of producer, retailer.

–Individual identification of animals – ear tags. Data from ear tags goes to the bar code of carcasses then to the processed meat packaging.

–Bar code on packaging.

RASSF = Rapid Alarm System for Food and Feed was created in 1979.

- Information exchange in national and EU level
- EC, EFSA, EU members, Norway, Liechtenstein, Iceland and Switzerland
- Quick and coordinated response to risk
- Around-the-clock service

Principle 3: transparency

- Transparency of legislation
- Communication with the consumer
- Free admittance to EFSA documents http://www.efsa.europa.eu
- Aim is to build up a greater public confidence.

Precautionary principle: If there is reasonable ground for suspicion that a food can cause health damage to the consumer, preventing actions can be taken without waiting for scientific proof.
The action must be non-discriminatory – must affect all producers equally.

Principle 5: Protection of consumers' right

- Fair trade
- Promotion of competition on the markets
- Prevent fraud
- Responsibility: Clearly defined responsibilities for all actors in the agri-food chain. Producers – produce of good quality, safe foods. Retailers – taking into account the recommendations of producers regarding storage time and temperature. Consumers - taking into account the recommendations of producers regarding storage time and temperature and mode of consumption, meal preparation (e.g.: "this product can be eaten only after cooking well").
- Strict controls and regular checks: Official controls at EU borders. Strict and regular official controls carried out by the EU Member States' authorities: independent, impartial, well-trained authorities. State-of-the-art techniques and methods. Network of official laboratories.
- Training and education: For people responsible for official controls along the food chain: for food producers, for the consumers - food safety issues in the National Curriculums.

Questions:

1. Who is responsible for food safety?
2. What is the main task of EFSA?
3. What does it mean „from farm to fork?"
4. How should be risk analysis done?
5. What are the components of risk analysis?

6. How can you ensure transparency?
7. How can you train people for food safety?

HACCP = Hazard Analysis and Critical Control Points

It was developed in the USA at 1971 for assuring close 100 % safety of foods used in space program and by the army. Now it is used worldwide in food processing. In the EU the application of HACCP is compulsory for all food processors, food retailers and in restaurants and catering services.

Components:

- Identification and analysis of hazards during production of a special food
- Identification of critical control points (places where control measures are needed to prevent risk)

Principles of HACCP

1. Hazard analysis of risks at all stages of processing
2. Identification of critical control points (CCP)
3. Establishment of limiting values for CCPs
4. Monitoring of the control of CCPs
5. Correction if deviation occurs
6. Verification of effectiveness
7. Documentation

Steps for implementation of HACCP

1. Assembling of the HACCP working team – food engineers, quality management personal, technologists.
2. Proper characterization of the food – physical, chemical properties, process technology, packaging, storage.
3. Intended use of the food – ready-to-eat, needs further preparation by the consumer.
4. Editing flowchart of food processing.

5. Confirmation of flowchart at site – modification, if needed
6. Identifications of hazards
    a. Possibility, degree of health damage
    b. Quality and quantity of the hazard
    c. Survival and growth of microorganisms
    d. Formation of toxins, harmful chemicals or a physical hazard
    e. Circumstances leading to the development of hazards
    f. Possible control measurements
7. Identification of critical control points (CCP)
8. Limiting values for CCPs – temperature, time of heat treatment, pH, a_w, etc.,
9. Monitoring of the control of CCPs – frequency, responsible person, inspection
10. Correction
11. Verification of effectiveness
12. Documentation

Example for HACCP – Production of Feta cheese

Characterization of the food: Feta cheese is a traditional Greek product made from sheep's milk and it is ripened in brine for two month.
Intended use: it is consumed as it is, rarely cooked.

Process flow chart for Feta cheese (Source: Anna McElhatton, Richard J. Marshall: Food safety. A practical and case study approach, Springer)

Collection of milk

↓

Centrifugal separation, standardization

↓

Pasteurization (68 ^{o}C, 10 min)

↓

Storage at 34-36 ^{o}C

↓

Addition of starter cultures

↓

Addition of rennet and $CaCl_2$

(clotting at 35-36 ^{o}C for 50 min)

↓

Cutting of the curd into cubes

↓

Moulding

↓

First salting (12 h)

↓

Second salting (2 days at 15-16 ^{o}C)

↓

Washing with brine

↓

Packaging into barrels, adding of pasteurized brine

↓

Pre-ripening (at 15-16 ^{o}C for 15-20 days)

↓

Ripening - storage (at 2-3 ^{o}C for 2 months

Determination of CCPs:

Questions for the decision:

Q1: Do control measures exist? – Yes – go to Q2. No – but there is a need for control measures. Modify the step.

Q2: Is this step designed to eliminate the hazard or reduced its occurrence to an acceptable level. – Yes: it is a CCP. No- go to Q3.

Q3: Could contamination with the hazard occur in excess of an acceptable level or increase to an unacceptable level? – Yes: go to Q4. No: not a CCP.

Q4: Will a subsequent step eliminate or reduce the hazard to an acceptable level? Yes: not a CCP; no: it is a CCP.

Process step 1: Collection of milk				
Possible hazards	Q1	Q2	Q3	Q4
Microbiological: pathogens (*Listeria, Staphylococcus)*, viruses – not a CCP	Yes	No	Yes	Yes (pasteurization)
Chemical: hormones, toxins, sanitizers, heavy metals, antibiotics – **CCP 1**	Yes	No	Yes	No
Physical: foreign objects – not a CCP	Yes	No	Yes	Yes (filtration)
Process step 2: Pasteurization				
Survival of heat tolerant spores or pathogens - CCP 2	Yes	Yes	-	-
Process step 3: Addition of starters, rennet Process step 4: Curd handling Process step 5: Salting				
Contamination. Growth of contamination microorganisms.	Yes	No	Yes	Yes (ripening)
Process step 6: Ripening				
Contamination. Growth of contamination microorganisms. – **CCP 3**	Yes	Yes		

ISO standards

ISO 9000/9001

- Can be used by profit oriented or non-profit organizations
- Uniform, international requirements which can be used in all sectors of the economy independent form the size of the enterprise.
- Guarantees the permanent high quality of products and services. Leads to satisfaction of consumers.
- Guarantees also high quality of management.
- Well arranged processes, documentation.

ISO 22000

Food safety directive – can be used for all aspects of food processing. It includes: HACCP, ISO 9001, directives of retail organizations.

ISO 14000

Standard for the protection of environment.

Other standards

These standard**s** are published by retail trade groups. Any company wishing to supply its food products to those retailers must meet the required standards. The retailers request that an independent third party approves the quality and food safety system of the supplier – audit and certification.

- BRC (British Retail Consortium) Food Safety Standard – HACCP + ISO 9000 – Asda, Tesco and Sainsbury's.
- EFSIS Safe and Legal Standard– for small food factories – HACCP + GMP + GHP + ISO 9000
- IFS = International Food Standard – post farm stages of food processing, French, German and Italian retail federations - Aldi, Lidl and Metro.

Questions:

8. What is HACCP?
9. What is a CCP?
10. List some limiting values for CCPs!
11. What is a flowchart?
12. List some international standards used for food safety!

The first component of the "from farm to fork" food chain – the farm

Farm = Agriculture

- Crop cultivation
- Animal husbandry
- Fishing, fishery

Crop cultivation – risks

Plant derived food or feed – no difference from food safety point of view.

Source of risk:

1. Soil (water) – chemical, microbiological hazards
2. Propagation material – seeds, seedlings
3. Plant growing – plant protection, irrigation, fertilizers
4. Harvest
5. Storage

1. Soil, water

1. Chemical hazards

Heavy elements (metals) – reaction with cell proteins (with the SH groups*)*. Heavy metals can enter the plants body from environmental pollution (pesticides, paints, batteries, industrial waste), or from natural sources (arsenic in groundwater). Some plants tend to accumulate these elements; they can be use for soil remediation but are dangerous for human consumption.

- Mercury (Hg) – damaging of the central nervous system. Mainly found in fresh or sea water after pollution and also in the flood basin (cyanide and Hg pollution on the Tisza in 2000). Fishes accumulate it.

- Lead (Pb) – anemia (inhibition of hemoglobin synthesis), in children mental development is retarded. From lead water pipes get into drinking water. From car fumes driving with leaded petrol (used until 2001 in the EU).
- Cadmium (Cd) – kidney and liver damage, carcinogenic.
- Arsenic (As) – toxic, carcinogenic. Natural sources: where groundwater is in contact with volcanic rocks containing arsenic reach chemicals. It is used in pesticides and for timber preservation.

Pesticides - Protecting crops from pests, enhancing crop yields, reducing losses

- herbicides – against weeds
- fungicides – against phytopathogen molds
- insecticides – against insects

Classic pesticides – mostly banned in Europe but still in use in developing countries.

- Persistent in the environment
- Systemic effect
- Accumulation in deeper plant tissues
- Cheap

New-type pesticides

- Non-persistent in the environment – hydrolysis in the environment
- Specific site effects – inhibition of one or several metabolic pathways by inhibition of special enzymes
- Adaptation and resistance can be developed – active substances have to be frequently renewed
- More costly compared to the classic ones

There are differences in the use of pesticides between developed and developing countries.

Developed countries

- New laws restricting the use of agrochemicals
- Lower concentration limits

- „Green" products
- Banning classic pesticides
- Use of new chemicals

Developing countries

- Intensive use of cheap, classic pesticides
- Higher
    - Environment contamination
    - Public exposure
    - Public health risk

Fertilizers and industrial pollution:

Nitrogen fertilizers in excess amount: nitrate can accumulate in plants
Ingested nitrate in the stomach will be oxidized to nitrite. Nitrite can bond to hemoglobin and methemoglobin will be formed. Methemoglobin is unable to bind to oxygen. This will lead to oxygen insufficiency especially in infants.

Pollutions

- PCBs and dioxin (polychlorinated biphenyls) – hydraulic fluids, coolants, pesticide components – persistent organic pollutants – carcinogenic, neurotoxic effects, endocrine disruption
- PAH (polycyclic aromatic hydrocarbons) – produced by incomplete combustion of organic matter – carcinogenic, mutagenic effects

Microbiological, biological hazards in soil

Microbiological hazards

- Using feces or sewage as fertilizer – *E. coli, Salmonella spp*.
- Spores of plant pathogens – *Fusarium* species – mycotoxin producers

- Endospores of pathogen bacteria – *B. anthracis, Clostridium sp*.

Biological hazards on the grazing land:

- Helminthes eggs (parasites)
  - *Toxocara spp.*
  - *Taenia spp.*
  - *Trichinella spp*.

2. Propagation material – seeds and seedlings

- Chemical hazard – steeping of sowing seeds with fungicides – not for human consumption
- Botanical adequacy – no foreign seeds (for example corn-cockle, a weed of wheat has toxic seeds)
- Healthy seeds and seedlings – resistance against plant pathogens

3. Crop cultivation

Dressing with manure or fertilizers

- Proper storage and treatment – aerobic, anaerobic microbes, human pathogens could be found in manure
- Avoid over use of fertilizers – nitrate accumulation in plants!

Plant protection*:*

Active agents in pesticides – important features:

–solubility in water - water soluble agents could reach groundwater and wells or freshwater sources

–mobility in the soil – in general fungicides are not very mobile, they can accumulate in the soil

–degradation to more toxic substances – some soil microorganisms or the human liver could transform the active molecules of pesticides to more toxic substances than the parent molecule

Natural toxic substances in plants or mushrooms – some plants cannot be consumed in raw form just only after proper processing (mostly heat treatment is required)

- Lectines = phytohemagglutinins: in beans, cereals, potato – harmful effect when consumed raw or improperly cooked (ricin, in soybean agglutinin)
- Alkaloids: solanin in potato – harmful over 200 mg – proper pealing
- Cyanogenic glucosids: in stone fruits – release of cyanide (0,5 – 3,5 mg/kg bw lead to death). Do not eat bitter almond!
- Morphine: in opium = dried latex of poppy (seedpods, straw), MRL in poppy seeds: 30 mg/kg.
- Oxalic acid: spinach, rhubarb – binding of Ca and Fe – unusable for human body
- Toxins in mushrooms: Amanita species: amatoxin, muscarine, etc. – poisoning can lead to death

4. Harvest and storage

Harvest:

- Keep to the obligatory waiting time after spraying pesticides.
- Avoid contamination with soil – spores of molds can infect stored crops leading to mycotoxin production.
- Avoid damaging of fruits – site of infection. Possible contamination with mycotoxin producing molds.

Storage

- Proper temperature - freezing, refrigeration or moderate temperature
- Low humidity – inhibition of mold's spore germination

- Modified atmosphere - difficult
- Selection of decayed crops – prevention of further deterioration

Mycotoxins are toxic substances produced by molds. Many are heat resistant. The best is to prevent contamination with mold spores or inhibition of mold growth in foods.

Aflatoxin: produced by *Aspergillus flavus, A. parasiticus* – they live in soil

- High humidity, high temperature is needed for mycotoxin production.
- Types: B1, B2 – most potent, G1, G2 – *A. parasiticus,* M1, M2 – in milk
- Immune suppressor; carcinogen effect (liver)
- In maize, corn, soybean, rice, peanut, sorghum

Ochratoxin: *Aspergillus, Penicillium* species

- Cereals, coffee bean, dried fruits, red vine can contain.
- Carcinogenic, immune suppressor effect, toxic to kidney.

Patulin: *Penicillium, Aspergillus* species

- Antibiotic effect but toxic to humans
- Apple and other fruits – especially in damaged fruits
- WHO recommendation 50 μg/L in apple juice
- Heat stable, resistant to acidic pH. Antioxidants can destroy it.
- Edema in the GI tract

Fusarium toxins

•*F. verticilloides, F. culmorum, F. graminearum*

- Growing conditions: 22-26 ^{o}C
- Toxin production: 6-12 ^{o}C; moisture at the time of flowering
- Cereals being frequently infected: wheat, oak, barley, rye, maize
- zearalenon (F-2) – estrogenic effect; aborts and infertility, early puberty in humans

- trichotecenes: T-2, deoxinivalenol (DON), nivalenol, fusarenon X; inhibition of protein synthesis, irritation of GI tract, stomach ulcer, refusal of feed
- fumonisines: mainly in maize; death of swine and equine, damage to human kidney and liver, esophageal cancer

Husbandry – sources of risk

1. Feed – plant, animal origin
2. Veterinary – medicaments
3. Animal welfare

1.1. Plant derived feed – forage and fodder

- Do not spray sewage or dung water during grazing;
- Isolate diseased animals – they can secret pathogens
- Feed crops – botanical adequacy ≥ 95%
- Growing - same hazards as for food plants
- Storage – avoid mold growth.
- Labeling for feed: meet the requirements for traceability. Name and address of producer and retailer; composition, date of production, best before time.

1.2. Animal derived feed

- Meat, blood and bone meal, whey and milk powder – high protein content. Use only after heat treatment – microbial contamination. In many European countries they are banned.
- Single cell protein products – extracted from yeasts, bacteria, algae – considered to be safe.

It is not allowed to use:

- Leather
- Rests from households, restaurants, catering services without heat treatment
- Ruminants can not be fodder with animal derived feed – hazard of BSE
- Slaughtering by-products of ruminants must be eliminated.

2. **Veterinary -** prevention and cure:

Medicaments – only authorized ones can be used
Antibiotics – accumulation in the meat, milk, honey, eggs -no slaughtering or using animal products until evacuation.
Not allowed to use: chloramphenicol, nitro furan, thyroid hormones, medicaments for central nervous system, growth hormones

Immunization of livestock
- Vaccination against epidemic diseases
- Disease control – Salmonella in poultry
- Animal health monitoring

Zoonosis – infectious diseases; transmission from animals to humans, rarely from humans to animals.

- **Tuberculosis** – *Mycobacterium bovis* – cattle meat or milk. *Mycobacterium tuberculosis* - direct infection to humans. Because of vaccination Hungary is free from this disease from 1980.
- **Brucellosis** – *Brucella suis* – swine, *Brucella abortus* – cattle. *B. melitensis* – sheep and goat. Animals: aborts; humans: fever, chest pain, abdominal pain (*B. melitensis* can lead even to death). Mainly from sausages made from venison. Occupational disease of vets and farmers.
- **Leptospirosis**: *Leptospira pomona* – swine – aborts, death. Occupational disease of vets and farmers – fever, liver and kidney failure, icterus, meningitis. It is spread by the urine of rodents (mice, rats, vole). Rodent control is compulsory on livestock farms.
- **BSE**: mad cow disease is a prion disease. In humans: a variant of Creuzfeldt-Jakob disease, transmitted by eating contaminated beef. Prion is a misfolded protein – in the brain plaques are formed leading to mental disorders and death. Prion remains viable over 600 ^{o}C. New methods of cattle butchering were introduced. Feed additives made from ruminants were banned.
- **E. coli** – member of the gut microflora, facultative pathogen. Get into human body with feces contaminated food.
    - Enteropathogenic (EPEC) *E. coli* strains: diarrhea of infants.
    - Enterotoxigenic (ETEC) *E. coli* strains: diarrhea of infants, children, travellers'. Produces enterotoxin.
    - Enterohaemorrhagic (EHEC) *E. coli* strains: produce verotoxin (shiga toxin) and cause bloody diarrhea. O157H7 serotype can lead to death.
- **Campylobacter enteritis** – *C. jejuni, C. coli* – sources of infection: poultry, cattle, swine, sheep, raw milk, cutting boards contaminated with raw meat. Susceptibility is general. Diarrhea, abdominal pain, fever.

- **Salmonellosis:** Serovars of *Salmonella enterica (*most frequent in Europe: *Salmonella* Enteritidis). Endotoxin production. Enteritis and other gastrointestinal disorders. In severe form shock due to loss of electrolytes and liquid. In the EU no Salmonella is allowed in 25 g food.
- **Listeriosis:** *Listeria monocytogenes*: can be found in soil. Disease spreads by raw milk, soft cheeses made of raw milk, ready-to-eat meat products. The bacterium can multiply in the refrigerator. Highly susceptible groups: infants, pregnant women, elderly. Meningoencephalitis, aborts, stillbirth.
- **Staphylococcosis**: *Staphylococcus aureus* – on the skin of animals, humans. Produces heat stable enterotoxin. From meat products, sliced meat, milk, milk products. Nausea, cramps, vomiting. Methicillin resistant form (MRSA) causes severe infection in hospitalized patients.

Virus zoonosis

- **Bird flu**: from wild birds to farm birds. Humans are rarely infected but there is a concern about spreading across the globe. Prevention: avoid encounter of wild and domestic birds.
- **Foot-and-mouth disease**: highly infectious for hoofed animals (cattle, pig, sheep, goat). Humans are rarely infected, mainly farmers with direct contact to ill animals. Export of live animals and animal products from affected areas is forbidden until disease elimination.

3. Animal welfare

- Proper farming (number of animals pro m^2 is limited)
- Providing healthy and nutritious feed and clean drinking-water
- Continuous veterinary control, avoidance of causing unnecessary pain
- Relax before slaughtering

Requirements for stock-farming

- Good hygiene – regular lime-coating of pens.

- Adequate treating of feces and urine and manure.
- Regular pest control (rodents).
- Reduction of stink and noise.
- Traceability – individual or group labeling of animals (ear tags).
- Registration.
- Continuous muster roll – births and death, diseased animals, actual number of livestock.

Questions:

13. What can cause lead accumulation in humans?
14. What are pesticides?
15. Why it is not allowed in the EU to feed ruminants with animal-derived feed?
16. What is the limit for Salmonella in the EU?
17. What kinds of diseases are called zoonosis?
18. Why is regular pest control compulsory for stock-farming?
19. How is bird flu transmitted?

Genetically modified organisms (GMOs): the genetic material has been altered in a way that does not occur naturally by cross-breeding or natural recombination. Method: modern biotechnology. In a living cell a new genetic material is incorporated from which a new protein is synthesized and this new gene is inherited to the next generation.

•What type of cells can be modified?

- Microorganisms – vegetative cells
- Plants – any cell – a new plant can be grown from tissue cultures
- Animals – only the zygote

Recombinant DNA technology = „genetic engineering"

Steps to create a GMO (transgenic organism)

- Find the desired gene
- Cut into fragments
- Insert fragments into vector
- Insert vector into host cell
- Isolate cells with the desired gene

Structure of the new gene: Promoter region + coding region + terminator region. In many cases an indicator gene cassette is also inserted (antibiotic resistance, fluorescents dye)

Problems, concerns:

Insertion of the new gene into the host's DNA is random.

- The inserted gene could disrupt or alter the expression of normal genes.
- The antibiotic resistance from the indicator gene could be transformed to other microorganisms (to pathogens).
- Environmental effects: reduced biodiversity of wild type organisms.

Concerns according to food safety

- The new protein(s) can be toxic or allergic
- Potential long term effects are not known

Application of GMOs – microorganisms

- Direct use in food is restricted (in the EU).
- Use of recombinant enzymes and hormones.
    - Recombinant chymosin (rennin) in cheese making – used worldwide
    - Recombinant bovine growth hormone – increased milk production – not legal in Europe
- Overproduction of secondary metabolites used as food additives – citric acid, vitamins, etc.

Application of GMOs - plants

- „First generation" transgenic plants: resistance against herbicides, insects, viruses. Benefits to the breeders.
- „Second generation": delayed ripening, modified lipids, improved nutritional content. Direct benefits to the consumer.
- „Third generation": production of antibodies, anti-cancer compounds, edible vaccines.

Application of GMOs - animals

Rare. Many factors control the desired trait single-gene solutions are unlikely.

Transgenic salmon

–Growth hormone overproduction

–Faster growth

–Concern: release in the environment can cause decrease in the overall fitness of wild salmons.

–Solution: males of recombinant salmon are sterile.

Risk analysis of GMOs based on the substantial equivalence principle.

Substantial equivalence: if a novel crop has similar chemical and biological characteristics to the crop from which it was derived, then it should have equivalent risk as the derived crop.

- The GMO is a food or food ingredient
- Only the product of the GMO will be a food ingredient – safe

Risk assessment of GMOs in food

- Source of new gene – characterization of the donor organism.
- Composition of donor – no toxic or allergenic substances.
- Effects of processing/cooking on the new protein
- Transformation process – detailed descripton.
- Stability of the recombinant DNA – can it spread to non-target organisms?
- Investigation of the protein from the new gene (toxicity, allergenicity)
- Secondary effects on the host DNA
- Human exposure – how many Recombinant DNA will be consumed?

EU authorization (1829/2003 EC Regulation)

- Application to the national authority and then to the EFSA (documentation, safety assessment)
- Approval by the European Commission and the member states
- Authorization is valid for 10 years.
- Labeling of foods containing GMOs (0.9% threshold) is compulsory.

Questions:

20. What is a GMO?
21. What is a first generation GMO plant?
22. What is a recombinant enzyme?
23. What is the principle for risk analysis of GMOs?
24. Is it allowed in the EU to use recombinant lactobacilli for starter cultures?

The second step in the food chain - Food processing

All food processing facilities have to have GMP, GHP, and HACCP. Sources of risks arising during food processing can be found in the raw material or could be newly produced by the processing technology.

GMP = Good Manufacturing Practice – guideline for high quality and safe products.

- Step by step description of the food processing
- Based on process control and validation

GHP = Good hygienic practice – guideline to keep personal and manufacture hygiene at high level.

Biological, microbiological risks:

- Microorganisms used in food processing should have GRAS = generally regarded as safe status. They should not cause any disease or produce toxins.
- Undesirable microorganisms – food spoilers or food borne pathogens.
- Source of undesirable microorganisms:
  - Soil, water – avoid contamination with soil during harvest of crops and during processing – good factory hygiene
  - Air – bacterial and fungal spores can be transported by suspended dust particles
  - Surface of equipments – single species or mixed species biofilm formation. Biofilms are microbial communities adhered to different surfaces and embedded in a matrix. Biofilms are more resistant to sanitizers, disinfectants than single cells. It is very difficult to remove them thus they represent a continuous food safety risk. Food borne pathogens like *Listeria monocytogenes* can be frequently found in biofilms.
  - Animals: bacteria can be found on the skin, in the gastrointestinal tract. By improper slaughtering surface of meats could be contaminated. *E. coli* is an indicator strain for fecal contamination.
  - Hands, clothes, hair of workers: It is compulsory to wear protective clothing and have good personal hygiene.

The most frequently isolated food spoilage bacteria:

From fresh and ready-to eat meat products:

Refrigerated: *Pseudomonas*, *Serratia, Proteus, Hafnia, Enterobacter* species

Modified atmosphere packaging (MAP): *Brochotrix thermosphacta*

Vacuum packaging: *Lactobacillus* species

From fish: *Pseudomonas* species

From eggs: *Pseudomonas*, *Serratia, Proteus, Enterobacter* species and *Coliforms*

From milk and milk products: *Pseudomonas*, *Enterobacter, Enterococcus, Micrococcus* species and lactic acid bacteria, molds and yeasts

From fruits and vegetables: *Pseudomonas* species, yeasts and molds

From cereals: *Serratia* species, *Bacillus subtilis,* molds

From soft drinks (carbonated or not): lactic acid bacteria, yeasts

Sources of food-borne pathogens:

	Ruminants		Pork	Poultry		Fish, Crustaceans Mollusks	Vegetable, Fruits	Cereals	Water
	Meat	Milk		Meat	Eggs				
Salmonella sp.	+	+	+	+	+	+	+	+	+
E. coli O157H7	+	+	+	+					
Campylobacter spp.	+	+	+	+		+			
Staphylococcus aureus	+	+	+	+					
Bacillus cereus								+	
Clostridium botulinum			+			+	+		
Listeria monocytogenes	+	+	+	+		+	+		
Vibrio cholerae						+	+		+
Hepatitis A						+	+		+
Trichinella sp.			+						
Taenia sp.	+		+						

It can be seen from the table that most of the pathogens are associated with products of animal origin but *Salmonella, Listeria* and *Clostridium botulinum* can also spread with plant derived foods. Best way to prevent food borne infections is the avoidance of contamination during harvesting, slaughtering and processing.

Control of microorganisms in food

We can control the growth of microorganisms by changing the growth conditions in the food. Food is a rich source of nutrients for microorganisms so we can change only other environmental factors like temperature, pH, water activity, oxygen supply.

Control by heat treatment:

Aim: to kill specific pathogens and some spoilage microbes, destroy undesirable enzymes, destroy heat sensitive toxins.

- Low heat processing = pasteurization. <100 ^{o}C; destroys all vegetative cells but not the bacterial spores. Survivors of the treatment can cause post contamination. To avoid this pasteurization is frequently combined with other methods, for example with aseptic packaging (milk, fruit juices).
- High heat processing. >100 ^{o}C, commercial sterility is achieved. The pH of the food influences the temperature used for the treatment: low acid products – higher temperature; high acid products – lower temperature. (UHT milk).
- Microwave heating. Not uniform; remaining cold spots in solid foods.

Control by low temperature

Aim: to prevent or reduce microbial growth, reduce catalytic activity of undesirable enzymes.

- Ice chilling. 0-1 ^{o}C, used for fresh fish, seafood.
- Refrigeration: 4-5 ^{o}C, used for pasteurized milk, dairy products, non-fermented meat products, etc.
- Freezing: -20 ^{o}C, most microbial cells die, survivors represent risk. It is not allowed to re-freeze thawed foods.

Control by reduced water activity

Aim: to prevent or reduce the growth of vegetative cells and germination of spores. Water activity means the available free water for microbial growth.

Minimum A_w for microbial growth:

- Bacteria: 0.95 – 0.97
- Yeasts: 0.62 – 0.90
- Molds: 0.77 – 0.93

It can be seen that bacteria are the most sensitive to reduced A_w. In products with low free water content, like bread, dried fruits or meats yeasts and molds will replace bacteria and become to the main spoilers.

Methods for reducing water activity:

- Natural dehydration by the sun and air. Takes a long time. Raisins, cereals, meat.
- Mechanical drying. Faster but more costly. Vegetables, fruits.
- Smoking – fish, sausage
- Freeze drying. Most of the vitamins and aroma components will not lose. Very costly.
- Salting or adding other solutes to bind water – fish, ham.

<u>Control by low pH and organic acids</u>

Aim: control or reduce undesirable bacteria. Below pH 5 some bacteria die.

Minimum pH for microbial growth:

- Bacteria: 4.4 – 5.6
- Yeasts and molds: 1.5 – 2.4

- Organic acids: dissociated and undissociated form depending on the pK value of the acid. Most organic acids have a pK value around pH 5. The undissociated form is lipophilic, can enter through the membrane, and then in the cell dissociate – release protons – causes sub lethal or lethal injuries. Effect of low pH in the cell: depleted energy production; enzyme inactivation, disturbance of nutrient transport.

<u>Control by modified atmosphere – reducing oxido-reductive potential</u>

Aim: control or reduce undesirable microorganisms.

Growth of aerobes is prevented, anaerobes and facultative anaerobes can grow – lactobacilli, Brochotrix, Serratia.

Control by preservatives

Aim: to kill undesirable microbes. Preservatives can have broad spectrum effectiveness or have effect only on a specific group of microbes.

- Nitrite (NO_2^-): in low-heat processed meat, poultry against *Clostridium botulinum*.
- Sulfur dioxide (SO_2) or sulfites (SO_3^{2-}): beverages, wines. Against molds and yeasts. Can cause hypersensitive reactions in humans.
- Organic acids – acetic, citric, lactic acid. Mode of action see above.
- Bacteriocins of lactic acid bacteria: proteinaceous toxins against other bacteria, like nisin, pediocin. Used in cheese production.
- Natural products: spices, essential oils. Mainly broad antibacterial and antifungal spectrum. In general G+ bacteria are more sensitive to them.

Control by irradiation

Aim: to kill pathogens and spoilage microbes.

Ionizing (γ rays) and UV radiation

Cold sterilization – only physical treatment, nutrients, vitamins are not affected.

Not accepted by consumers.

Mechanism of action: DNA damage, creation of free radicals.

Novel technologies

Growing demand from consumer to minimally processed foods: natural aromas, no loss of nutrients, vitamins.

•Pulsed Electric Fields (PEF)

–Non-thermal treatment. Electroporation of the membrane. Only for liquid food. Reduce vegetative cells. Not effective against bacterial spores and viruses.

•High Hydrostatic Pressure (HHP)

–300 – 700 MPa; damage to cell membrane; damage of non-covalent bonds. Not effective against bacterial spores and viruses. Costly. Require flexible packaging. Only for foods with high moisture content.

Questions:

25. What is GMP?
26. List sources of microbial contamination during processing!
27. How weak acids work against spoilage microorganisms?
28. With which treatment can you achieve sterility in foods?
29. How can you reduce water activity?

Chemical hazards during food processing

- Risk assessment:
  - FAO – WHO Joint Expert Committee on Food Additives (**JECFA**)
  - FAO – WHO Joint Meetings on Pesticide Residues (**JMPR**)
  - EFSA

Aim: to find the ADI concentration in dose – response animal experiments. Short or long term exposure to the questionable material.

Definitions:

- **NOAEL** – no observed adverse effect level.
- **ADI** – Acceptable Daily Intake (May be consumed by humans on daily basis during the entire life span without appreciable risk for the occurrence of adverse effects.

Data evaluation

- **ADI** (mg/kg body weight/day)=NOAEL/SF (safety factor=10x10)
- **ARfD** – Acute Reference Dose – short term exposure to acutely toxic pesticides
- **MRL** (mg/kg foodstuff) – Maximum Residue Level – This value is established by r**isk managers.**
- **Exposure** (mg/kg body weight/day)=consumption (kg food/kg body weight/day) x residue (mg/kg foodstuff)
- **ADI > Exposure; MRL > Residue**

Steps of safety assessment

•Compound characterization

–Pharmacokinetic and metabolic studies

•Fate the compounds in the animal body – absorption, distribution, metabolism, elimination

Sub acute toxicity

Long term toxicity

blood, urine analysis

changes in body weights

organ functions

histopathological studies – abnormalities in tissues

•Reproduction studies - dietary administration to rats during pregnancy. Number of pups born, survival, body weights

•Carcinogenicity - tumor formation in rats

•Mutagenicity - Ames test. *Salmonella typhimurium* strains deficient in histidine biosynthesis are used in this test. The test checks for mutants that can revert to wild-type

•In vitro studies – liver cells – biotransformation of the compound. Sometimes a more poisonous compound is formed.

Sources of chemical risks

- Environmental and industrial pollution
  - –Heavy metals, elements – pesticides, mining, car fumes, natural sources
  - –PCBs – polychlorinated biphenyls (dioxins) – accumulate mainly in animal fat and tissues. From pesticides.
  - –PAHs – polycyclic aromatic hydrocarbons – on the surface of grilled foods, on the waxy surface of plant leaves.
- Agriculture
  - Pesticides and pesticide residues
    - »Systemic pesticides – absorbed by the plant, washing and pealing can not remove
    - »Contact pesticides – on plant surface. Thorough washing, pealing may be enough to eliminate them.
    - »Veterinary medicaments
    - »Nitrate accumulation – improper use of fertilizers

Food technology:

» PAHs – carcinogenic. By smoking, frying, roasting, grilling. On the surface of roasted, grilled foods.
» Nitrosamines – carcinogenic, mutagenic – from nitrite and amines in acidic environment (in the stomach) – sources: cured meats.
» Chloro-propanols – mainly by rapid hydrolization of soy protein with HCl – carcinogenic (soy sauce)
» Acrylamide – formed in starchy food products during high-temperature cooking – may be carcinogenic.

Substances from food producing machinery, equipments – mainly heavy metals

» Enameled ceramics – Pb, Cd – damage to bones, kidney, central nervous system
» Household utensils, tins, tinfoil – Al – may be associated with Alzheimer disease
» Tins, kitchen aids – Sn
» Plated ware, stainless steel – Ni, Cr – contact skin allergy

Chemicals migrated from packages:

Bisphenol from plastics – estrogenic effect

Pesticide residues from paper

Requirements of packaging:

» 1. The food can not be contacted with harmful substances from the environment.
» 2. Any potential transfer of chemicals to foods does not raise safety concerns, change the composition of the food in an unacceptable way or have adverse effects on the taste and/or odor of foods.

Residues of disinfectants and detergents:

Only authorized ones can be used

- Rinsing with potable water or keeping waiting time
- Proper storage and waste management – isolated from food

Food additives

Food additives are substances added intentionally to foodstuffs to improve chemical composition or physical properties. In the European Union EFSA evaluate and re-evaluates the safety of food additives before they can be authorized for use in the EU.
In the European Union (EU) additives are identified by an E number.

E100–E199 (colours)
E200–E299 (preservatives)
E300–E399 (antioxidants, acidity regulators)
E400–E499 (thickeners, stabilizers, emulsifiers)
E500–E599 (acidity regulators, anti-caking agents)
E600–E699 (flavour enhancers)
E700–E799 (antibiotics)
E900–E999 (glazing agents and sweeteners)
E1000–E1599 (additional chemicals)

Food additives have to be always included in the ingredient lists. Product labels must identify both the function of the additive (e.g. color, preservative) and the specific substance used either by referring to the appropriate E number or its name (e.g. E 415 or Xantham gum). Most common additives are antioxidants, colors, emulsifiers, stabilizers, gelling agents and thickeners, preservatives and sweeteners.

Requirements to food additives: no adverse effect to human health. Additives should not mislead the consumer. They should be beneficial for the consumer not for the producer. Use in limited concentration.
In baby food no „carry over" (e.g. fruit yoghurt made with fruit pulp containing preservatives).

Risk assessment of additives:

–Stability in the human body, toxicity, possible accumulation - additives have to leave the human body without any toxic effect.

–Interaction with food ingredients – proteins can bind some additives and modify their structure or function.

–Fate in the GI tract – effect of hydrolyzing enzymes, detoxification in the liver

–Establishment of ADI - EFSA

Questions:

30. What is ADI?
31. To what level have you reduce exposure to a dangerous substance?
32. What are nitrosamines?
33. What are additives?
34. What is the E-list?

Food labeling

Data required for food labeling in the EU

- Exact name of the product
- Name and address of producer and trader
- Net mass or volume
- Best before time
- Presence of GMO in the product
- All ingredients including food additives
- Method of preparation, proper storage after opening

New EU law - Regulation (EU) No 1169/2011

- Minimum font size for mandatory information
- Nutrition information – protein, carbohydrate, fat, fibre, sodium, vitamins and minerals
- Mandatory origin information for fresh meat from pigs, sheep, goats and poultry
- List of engineered nanomaterials in the ingredients
- Clear indication of "formed meat" or "formed fish"
- Clear indication of defrosted products
- Indication of substitute ingredient for 'Imitation' foods

http://ec.europa.eu/food/food/labellingnutrition/foodlabelling/index_en.htm

Mandatory allergens on labeling: cereals containing gluten, crustaceans, eggs, fish, peanuts (if only as cross contamination), soybeans, milk and products thereof (including lactose), nuts (almond, hazelnuts, walnuts, cashew, pecan nuts, brazil nuts, macadamia, pistachio), celery, mustard, sesame seeds, sulphur dioxide and sulphites at concentrations of more than 10 mg/kg or 10 mg/liter expressed as SO_2, lupin, mollusks.

True food allergy is an allergen-specific immune reaction against food proteins. Food hypersensitivity can be developing against small molecules like dyes, sulphur dioxide, etc.

The prevalence of food allergy among adults is 1-2% and higher, 2-5% in children. Prevalence of food hypersensitivity is higher.

Anaphylaxis is the most severe, life-threatening symptom in food allergy. Fortunately it is a rare occasion but without an immediate medical treatment it can cause death of the patient. Anaphylaxis involves a range of symptoms: obstruction of the upper airways, fall in blood pressure, acute swelling and reddening of the skin. In developed countries peanut is the main cause of anaphylaxis.

Questions:

35. Why proper food labelling is important?
36. What food components are mandatory to list on labelling?
37. Why it is mandatory to list peanut among the possible allergens?
38. What kind of nutritional information is mandatory in the EU?

The 3rd step of the food chain: food transport

General requirements: closed vehicles – van, truck, tank truck for liquids, powders.

- Avoid contamination
- Cleanable, disinfectable vehicle
- Separate different types of foods
- Do not transport food and used packaging material together
- Keep the proper temperature – refrigerated foods: 0-5 ^{o}C; frozen foods: - 18 ^{o}C

Responsible person: driver, owner.

<u>Delivery of ready to eat foods</u>

- Closed vehicle or food box
- Proper temperature – chilled foods – 5 ^{o}C, cooked foods - warm
- Delivery in one hour after preparing the meal.
- Good personal hygiene of the drivers.
- Delivery of fresh meal and leftover together is not allowed.

The 4th step of the food chain: food trade

Ordering foods: supplier should have HACCP.

Acceptance of foods: the first CCP in food trade.

Qualitative and quantitative acceptance

- „Use by" time should be valid and not expired
- Good readable labeling
- Intact packaging
- Proper temperature for refrigerated or frozen foods – control it!

•Cleanliness

•Do not accept doubtful goods!

Storage in the storehouse

- FiFo rule – the newer food is placed behind the older one ("first in first out").
- Regular pest control – rodents: closed traps, insects' traps, mosquito net, birds.
- Separate storage of foods and other goods:
  •Not-washed fruits and vegetables,
  •Dry goods – flour, sugar, rice, etc.
  •Refrigerated goods – separate refrigerator or cold-storage room (0-5 ^{o}C)
  •Detergents and disinfectants
  •Cosmetics
  •Frozen foods – in freezer (-18 ^{o}C)
  •Feed for pets

Preparation, pre-packaging for the supermarket:

–Preparation of meats: veterinary control for carcass meat, poultry is required. Preparation means chopping, mincing, bone evolvement. Knifes and other utensils used for preparation must be labeled and not allowed to use in the supermarket. Steps of dish washing: grease solution, disinfection, rinsing with potable water.
–Preparation of ready to-eat salads: two sink – one for the first wash, and other for the second wash. Knifes and other utensils used for preparation must be labeled and not allowed to use in the supermarket.
–Slicing of salamis: Knifes and other utensils used for preparation must be labeled and not allowed to use in the supermarket.
Pre-packaging: address of the packaging department.

In the supermarket

–Separate storage like in the storehouse

–Clean shelves, no insects or rodents

–Separate counter and personal for: carcass meat, poultry, fish, salami and cheese.

–Regular temperature control for chilled, refrigerated food

–Self-service only for packed foods or bulk fruits and vegetables

The conscious consumer

- He/she knows his/her rights.
- Ethical awareness – does not buy goods made with children labor. Looks for fair trade labeling.
- Environmental awareness – reduce discard from packaging, seek after goods prepared by environmental friendly technologies.
- Medical awareness – seek after healthy foods.
- Do not buy unnecessary goods.

Questions:

39. What kind of vehicle is used for milk transport?
40. How much time is allowed to go by between meal preparation and delivery?
41. What it is and where it is used: the FiFo principle?
42. What have you do if the labeling is not readable on the product you have ordered?
43. What does it mean: separate storage?

The last step in the food chain: the table.

1. Restaurants, catering

Requirements:

- Good personal and kitchen hygiene
- Separate clean and polluted areas
- One-way direction of processes
- Avoidance of cross-contamination
- Separate storage
- Regular temperature control of refrigerated foods

In the kitchen:

–One-way direction: kitchen – dining room

–Black and white utensils – black for cooking, white for the guests

–Safe cooking: temperature in the middle of the meat 72 ^{o}C for 2 min – kill *Salmonella*

–Keep cooked food at 63 ^{o}C

–Good personal hygiene

–Labeled utensils

–Food stock from reliable source

–Mandatory food sample from every served food. Keep for 72 h in refrigerator. Proper labeling – type, date, responsible person. If any food poisoning occurs the food samples will be investigated by official laboratories for the presence of harmful microbes or substances.

Canteen kitchen: no cooking allowed only heating up (to 100 ^{o}C)

- Put delivered foods to own pots

- Left over through away
- Good personal and kitchen hygiene

2. Household:

80 % of food poisonings occur at home. To reduce the incidence the WHO created 10 rules.

Golden rules of WHO for food preparation

•**1. Choose foods processed for safety** – trustable food supplier, buy pasteurized milk instead of raw

•**2. Cook food thoroughly** - avoid underdone meals (bloody steak). Raw meat, especially poultry harbor microbes, sometimes pathogens. Cooking kill them. Cook eggs at least for 7 minutes. Temperature in the middle of food has to reach at least 70 ^{o}C. Use food thermometer.

•**3. Eat cooked foods immediately** - cooked foods are very perishable when leaved on the table. At room temperature microbes in cooked food begin to grow. Longer time at ambient temperature – greater risk

•**4. Store cooked foods carefully** - refrigerate leftover in 2 hours or keep leftovers (60°C) but do not leave on the table at room temperature. In leftovers microbes can grow very quickly

•**5. Reheat cooked foods thoroughly** - the best way to heat to 100 ^{o}C (boil). Aim is to kill the microbes which were able to grow under storage. All part of foods must reach at least 70 °C

•**6. Avoid contact between raw foods and cooked foods** - proper storage in the refrigerator: at the top: ready-to eat foods, milk, dairy, in the middle: left over for reheating, at the bottom: raw meat, eggs. Do not use the same cutting board, knife for raw and cooked meats.

•**7. Wash hands repeatedly** - wash hands between different phases of meal preparation. Wash hands before cooking. Wash hands after touching raw meat or eggs. Wash hands after playing with pets. Wash hands after toilet

•**8. Keep all kitchen surfaces meticulously clean** - use detergents or sanitizer agents. Wash kitchen counters throughout. Change washing sponge frequently. Change dishcloth frequently.

•Keep kitchen floor clear. Wash cutting boards under running warm water with soaps

•**9. Protect foods from insects, rodents, and other animal** - Insects and rodents frequently harbor pathogens. Keep food in closed containers. Use mosquito net on windows

•**10. Use safe water** - Clean, microbiologically safe water must use for cooking or drinking. If it is suspicious boil it. Be very careful with water used for baby foods.

Questions:

44. How can you provide one-way direction in a restaurant?
45. At what temperature must you keep cooked food in a restaurant?
46. What does it mean: black and white utensils?
47. How frequently have you to wash hands during food preparation?
48. What is the proper storage in your refrigerator?

Food hygiene

•Requirements: no pathogens, limited number of spoilage bacteria

•Providing appropriate hygiene: GMP, GHP ⇒HACCP

Parts of GHP:

–Personal hygiene

–Factory hygiene

–Cleaning, disinfection, rodent and insect control

–Product control

Definitions

•Cleaning: removal of dirt by chemical or physical means.

•Disinfection: elimination of pathogens in vegetative form.

•Sterilization: elimination of all microorganisms including bacterial spores.

•Sanitization: reduction of microbial contamination.

Factory hygiene begins outdoor. You should have dust-free environment: paved road. Use drainage ditch to avoid stagnant water.

•Indoor environment

–Cleanable, disinfectable floor, wall and ceiling

–Light colored walls

–Moisture-free environment to avoid mold contamination

–Dust free lock of doors and windows

–Regular control of air-conditioners (good environment for *Legionella* bacterium)

– Potable water is required – regular microbiological control

– Proper waste management

–Sewage – unconfined discharge - no logging water

–Solid waste – proper collection, storage and transport

•Isolation of dirty and clean areas – one-way direction

Personal hygiene

Human sources of pathogens: feces, hand, cloth, hair, naso-pharyngeal mycoderm– *Enterobacteriaceae, S. aureus, C. perfringens*

It is not allowed to work with: infectious gastroenteritis, rhinopharyngitis, skin-disease

•Regular medical control is required.

•Regular and proper hand washing, disinfection is required.

After WC use

Before starting new operation

•Working clothes

–Black and white changing room

–Hair covering

–Regular wash – not at home

• Regular training about personal hygiene

Steps for cleaning and disinfection

•Pre-washing to remove the gross dirt – 40-50 °C water

•Cleaning with water and detergent – 60-80 °C

•Intermediate rinsing with water

•Disinfection or sanitizing

•Rinsing with water

Detergents in the food industry

•Inorganic alkalis – active against protein and greases

–NaOH – corrosive, Na-metasilicate – less corrosive

•Inorganic and organic acids – remove incrustations (milkstone)

–HCl, nitric acid, citric acid, sulphuric acid - corrosive

•Surfactants – not corrosive or irritant

–Anionic detergents – alkylbenzen-sulfonates

–Non-ionic surfactants – ethylene oxide

–Amphotheric surfactants – anionic or cationic depending on the pH

Disinfectants in the food industry

•Requirements: not to be toxic, good inactivation capacity, economic, stability under working conditions.

•Factors affecting effectiveness:

–Contact time – short contact time is preferred

–Concentration – low concentration is preferred

–Initial microbial load – the greater is the initial cell number the more disinfectant is required

–Temperature and pH – in general higher temperature and acidic pH increases the effectiveness

–Organic and inorganic substances – organic substances decrease the effectiveness of chlorine,

Halogens

•Hypochlorous acid (HClO)

–Effective against vegetative cells and spores, viruses

- •Oxidation of proteins and nucleic acids
- •Formation of by-products with organic compounds

•Iodine

–Against G+ and G- bacteria, bacterial spores and viruses

–Iodophores – iodine + surfactants

Peroxides

H_2O_2 – oxidant, aseptic packaging of milk and fruit juices

Peracetic acid – CH_3COOOH – effective against G- and G+ bacteria, molds and yeasts, bacterial spores and viruses – for sterilization of stainless steel and glass tanks, piping and tubes

Quaternary ammonium compounds

$^{\bullet}(NR_4)^+X^-$

- Cationic surfactants – no activity on bacterial spores
- Not corrosive, not affected by organic compounds, not irritant
- Use on surface areas – remaining thin layer preventing re-growth

Cleaning procedures

- Mechanical: complete disassembly of the equipment
- Cleaning out place (COP): disassembly only parts of the device
- Cleaning in place (CIP): for systems with closed parts – piping, tanks, pumps, etc.
- High pressure water – splash of microbes into the environment
- Steam cleaning – remove grease and dirt –effective, costly
- Foam cleaning – reach hard to available places

Control after cleaning, disinfection

- Contact test – pushing agar medium on the surface, colony counting after incubation – takes more days
- Swabbing - 10 x 10 cm area. After swabbing spreading on agar plates, colony counting after incubation – takes more days

•ATP bioluminescence test – indicator for the presence of remaining organic contamination. Takes only some minutes. By positive test cleaning and disinfection should be repeated.

Questions:

49. What are the requirements for good food hygiene?
50. What is disinfection?
51. What is cleaning in place?
52. Where can you use peracetic acid?
53. What can you control with ATP test?

References:

Anna McElhatton and Richard, J. Marshall (eds). Food safety. A practical and case study approach. Springer, New York. ISBN-10: 0-387-33509-9.

Europian Commission, Directorate for Press and Communication: From farm to fork. Safe food for Europe's consumers. 2004.
http://ec.europa.eu/publications/booklets/move/46/index_en.htm

Paulik Edit (ed). Public health and preventive medicine. Budapest, Medicina, 2013.
ISBN: 9789632264813

Perry Johnson-Green (ed.) Introduction to food biotechnology. CRC Press, London, 2002.
ISBN: 0-8493-1152-7

Answers to the questions:

1. Shared responsibility: producer, trader, and consumer.
2. Risk assessment.
3. Examination and control at all stages of the food chain from stock material until the end-product.
4. Independent, objective and transparent manner based on science.
5. Risk assessment, risk management and risk communication.
6. By tracking any food, feed, food-producing animal or substance that will be used for consumption, through all stages of production, processing and distribution
7. In the school, through the media, training at the workplace.
8. Hazard Analysis and Critical Control Points. Identification and analysis of hazards during production of a special food. Identification of critical control points (places where control measures are needed to prevent risk)
9. A process step where control measures are needed to prevent risk.
10. Temperature, pH, water activity, oxygen supply.
11. Scheme with all process steps for an individual product.
12. ISO 22 000, BRC, EFSIS, IFS.
13. Anemia (inhibition of hemoglobin synthesis), in children mental development is retarded.
14. Synthetic substances for crop protection against pests.
15. Because of the risk of BSE transmission.
16. Zero cell number in 25 g food.
17. Infections transmitted from animals to humans.
18. Because rodents spread leptospirosis.
19. From wild birds to farm birds.
20. Genetically modified organisms in which the genetic material has been altered in a way that does not occur naturally.

21. Transgenic plant: resistance against herbicides, insects, viruses.
22. Enzyme produced by a transgenic organism.
23. Substantial equivalence: if a novel crop has similar chemical and biological characteristics to the crop from which it was derived, then it should have equivalent risk as the derived crop.
24. No, it is not allowed.
25. Good Manufacturing Practice. Step by step description of the food processing that is based on process control and validation.
26. Water, air, equipment surfaces, hands of workers.
27. The undissociated form of the acid is hydrophobic, can enter through the membrane, and then in the cell dissociate and drops the internal pH causing sub lethal or lethal injuries.
28. Heat treatment at lethal temperatures, irradiation.
29. By drying, salting, and using other solutes to bind available water.
30. Acceptable Daily Intake (May be consumed by humans on daily basis during the entire life span without appreciable risk for the occurrence of adverse effects).
31. Below ADI.
32. Carcinogenic substances derived from the reaction of nitrite and amines in acidic environment.
33. Substances added intentionally to foodstuffs to improve chemical composition or physical properties.
34. The list of registered additives in the EU.
35. To ensure traceability of foods and information for the consumer.
36. All components including additives.
37. In certain countries peanut is the main cause of anaphylaxis.
38. Protein, carbohydrate, fat, fibre, sodium, vitamin and mineral content.
39. Tank trunk.
40. One hour.

41. The newer food is placed behind the older one (“first in first out”). It is used by storage of foods.
42. You must refuse it.
43. You have to separate different kinds of foods and foods from non-food products during delivery, storage and in the supermarket.
44. The way of goods: storehouse, kitchen, dining room. The cook do not enter the dining room, the waiter do not enter the kitchen
45. 63 ^{o}C
46. Black for cooking, white for the guests
47. Before every new phases of meal preparation.
48. At the top: ready-to eat foods, milk, dairy, in the middle: left over for reheating, at the bottom: raw meat, eggs which will be cooked.
49. No pathogens, limited number of spoilage bacteria.
50. Elimination of pathogens in vegetative form.
51. Used for systems with closed parts. The cleaning device is a part of the equipment.
52. For sterilization of stainless steel and glass tanks, piping and tubes.
53. The presence of remaining organic contamination (from food or microbes)