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رَّبِّ زِدْنِی عِلْمًا

MY LORD! INCREASE ME IN KNOWLEDGE.

FST- 407. FOOD SAFETY AND LAWS 3(3-0)

***Program*:** **B. Sc. (Hons). Food Science and Technology**
***Semester*:** **IIV (SS + Ex-PPP)**
***Academic Year*:** **Fall -2020**
***Session*:** **2018-2022**

Course Teacher:

Dr. Shahid Mahmood Rana
Associate Professor

INSTITUTE OF FOOD SCIENCE AND NUTRITION (IFSN)
UNIVERSITY OF SARGODHA, SARGODHA-PAKISTAN

FST-407. L # 1. Course Introduction

- Introduction
- Outline
- Course Details
- Lecture Diary
- Exams and Evaluation
- Books

Session	2018-2022
Academic Year	Fall-2020
Course Teacher	Dr. Shahid Mahmood Rana
Program / Class	B. Sc. (Hons). Food Science and Technology
Semester	7th
Section	Self-Support & Ex-PPP
Course Code	FST-407
Course Title	Food Safety and Laws
Credit Hours	3 (3-0)
Paper	Theory
Commencement	Monday: 12-10-2020
Exams	Mid Final

MARKS DISTRIBUTION ??

SEGMENT			MARKS
Mid Term Exam	Viva-Voce	Sessional	Final Term Exam
30	25	20	25
Online Quiz, Written Tests, Assignments + Presentations, Attendance			Sessional
Total Lectures			48
Compulsory Lectures (75 %)			36
1 Credit Hours = 1 Lecture / Week		1 Credit Hours = 20 Marks	
3 Credit Hours = 3 Lecture / Week		3 Credit Hours = 60 Marks	
Compulsory Attendance ≥ 75 %		Compulsory Lectures ≥ 36	
Total Marks 100		Passing Marks 50 (T+P)	
Total Weeks = 19	Mid = 8+1	Final = 8+1	Break = 1

RESEARCH PROJECT / ASSIGNMENTS

- The students will have to collect materials for food safety and laws
- The students will write a **report (MS Word)** about assigned work and **presented (MS Power Point)** in the class.
- All the activities will be online

ASSESSMENT CRITERIA

Mid Term Exam:	**30**
Sessional:	**20**
Assignments /Project Report	(5)
Presentation	(5)
Quizzes	(5)
Written Tests	(5)
Viva-Voce:	**25**
Final Term Exam:	**25**
Total Marks:	**100**

RULES AND REGULATIONS

- The student should have at least 75 % attendance in Theory to appear final term exam.
- The student will be warned on missing three consecutive lectures.
- The student will be **struck off** from the rolls for being absent in six lectures consecutively.
- The attendance status will be noticed on monthly basis.

FST-407. Food Safety and Laws 3(3-0)

- **Objective of course is to give concepts of food safety and risk assessments and to provide knowledge about of food safety systems and food laws.**

COURSE DESCRIPTION AND OBJECTIVES

- Food Safety and Risk Assessment

- Food Safety Systems and Food Laws

CONTENTS

1. Food Safety
2. Characterization of food hazards: biological, chemical and physical
3. Hazards from natural origin
4. Hazards produced during food processing, storage and preparation
5. Hazards associated with nutrient fortification
6. Food Safety systems, GMP, TQM
7. HACCP
8. Pakistan Standards and Quality Control Authority
9. Pure Food Rules
10. Punjab Food Authority
11. International Organization for Standardization
12. National Standard for Drinking Water Quality
13. Food labeling
14. Concept of Halal, Islamic food laws and regulations
15. Consumer laws in Pakistan
16. The World Trade Organization (WTO)
17. Codex Alimentarius

BOOKS

Recommended

1. Awan, J.A. and Anjum, F.M. 2010. Food Toxicology. Unitech Communications, Faisalabad, Pakistan.
2. Schmidt, R.H. and Rodrick, G.E. 2003. Food Safety Handbook. Wiley-Interscience. A John Wiley & Sons Publications.

Suggested

1. PSQCA (Pakistan Standards and Quality Control Authority). 2010. Standards for different food items. PSQCA, Karachi, Pakistan.
2. Rai, V.R. and Bai, J.A. 2017. Food Safety and Protection. CRC Press, Taylor & Francis Group.
3. Gabriela, S. and Kiran, P. 2016. International Food Law and Policy. Springer International Publishing Switzerland.

READINGS

- PSQCA (Pakistan Standards and Quality Control Authority). **2010**. Standards for Different Food Items. PSQCA, Karachi, Pakistan.
- Meulen, B. and Velde, M. 2008. European Food Law Handbook. Academic Publishers, Wageningen, The Netherlands.
- Government of the Punjab. 2008. The Punjab Pure Food Rules-**2007**. The Punjab Weekly Gazette. Government Printing Press, Lahore, Pakistan.

READINGS

- Riaz, M.N. and Chaudhary, M.M. 2004. Halal Food Production. CRC Press Taylor & Francis Group, Boca Raton, Florida, USA.
- Khan, M.S. **1999**. Consumer Laws in Pakistan. Consumer Rights Commission of Pakistan, Islamabad, Pakistan.
- Awan, J.A. and Anjum, F.M. 2010. Food Toxicology. Unitech Communications, Faisalabad, Pakistan.

READINGS

- Shibamoto, T and Bjeldanes, L. 2009. Introduction to Food Toxicology. 2nd ed. Academic Press, London.
- CAC (Codex Alimentarius Commission). 2007. Codex Alimentarius Commission – Procedural Manual. Joint FAO/WHO Food Standards Programme. FAO, Rome, Italy.
- ISO (International Standards Organization). 2005. Food Safety Management Systems – Requirements for an Organization in the Food Chain. Case Postale, Geneva, Switzerland

READINGS

- **Punjab Food Authority**
- **Consumer Courts**
- **https://foodscienceuniverse.com/flr/**

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MY LORD! INCREASE ME IN KNOWLEDGE.

FST-407. L # 2.

- SAFE FOOD
- HEALTH HAZARDS
- FOOD SAFETY
- WHO: KEY PRINCIPLES OF FOOD HYGIENE

FOOD SAFETY

"Food safety is a scientific discipline describing handling, preparation, and storage of food in ways that prevent foodborne illness".

- This includes a number of routines that should be followed to **avoid potential health hazards**
- In this way food safety often overlaps with **food defense** to prevent harm to consumers
- The tracks within this line of thought are safety between industry and the market and then between the market and the consumer

FOOD SAFETY

- Food can transmit disease from person to person as well as serve as a growth medium for bacteria that can cause food poisoning
- In developed countries there are intricate standards for food preparation, whereas in lesser developed countries the main issue is simply the availability of adequate **SAFE WATER**, which is usually a CRITICAL ITEM
- In theory, Food Poisoning is **100 %** preventable

FOOD SAFETY: INDUSTRY TO MARKET

- In considering industry to market practices, Food Safety considerations include the origins of food including the practices relating to food labeling, food hygiene, food additives and pesticide residues, as well as policies on biotechnology and food and guidelines for the management of governmental import and export inspection and certification systems for foods.

FOOD SAFETY: MARKET TO CONSUMER

- In considering market to consumer practices, the usual thought is that food ought to be safe in the market and the concern is safe delivery and preparation of the food for the consumer.

WHO: KEY PRINCIPLES OF FOOD HYGIENE

1. Prevent contaminating food with pathogens spreading from people, pets, and pests
2. Separate raw and cooked foods to prevent contaminating the cooked foods
3. Cook foods for the appropriate length of time and at the appropriate temperature to kill pathogens
4. Store food at the proper temperature
5. Do use safe water and safe raw materials

FOOD RISK MATRIX

Consequence			
	Gain: economic	Food Quality	Food Fraud
	Harm: Public health, economic, or terror	Food Safety	Food Defense
		Unintentional	Intentional
		Action	

FOOD PROTECTION RISK MATRIX

- **Food Defense** is the protection of food products from intentional contamination or adulteration by biological, chemical, physical, or radiological agents introduced for the purpose of causing harm. it addresses additional concerns including physical, personnel and operational security.
- **Food Defense** is one of the four categories of the **Food Protection Risk Matrix** which include: **Food Safety**, which is based on unintentional or environmental contamination that can cause harm; **Food Fraud**, which is based on intentional deception for economic gain; and **Food Quality**, which may also be affected by profit-driven behavior but without intention to cause harm.
- Overarching these four categories is **Food Security**, which deals with individuals having access to enough food for an active, healthy life. food protection is the umbrella term encompassing both food defense and food safety. these six terms are often conflated.
- Along with protecting the **Food System**, food defense also deals with prevention, protection, mitigation, response and recovery from intentional acts of adulteration.

REFERENCES: FOOD PROTECTION RISK MATRIX

- Spink, John; Moyer, Douglas C. (2011-11-01). "Defining the Public Health Threat of Food Fraud". Journal of Food Science. 76 (9): R157–R163. doi:10.1111/j.1750-3841.2011.02417.x. ISSN 1750-3841. PMID 22416717.
- "Food Defense and Emergency Response". United States Department of Agriculture.
- "What Is Food Defense?". National Center for Food Protection and Defense. Archived from the original on 2016-03-03. Retrieved 2015-05-29.

CLASS TASK

- FOOD
- HEALTHY FOOD
- SAFE FOOD
- FOOD DEFENSE
- FOOD SECURITY

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رَّبِّ زِدْنِی عِلْمًا

MY LORD! INCREASE ME IN KNOWLEDGE.

FST-407. L # 3+4.

- **FOOD BORNE ILLNESS**
- **VULNERABLE GROUPS**
- **MICROBES**

WHAT IS A FOODBORNE ILLNESS?

- **Sickness caused by eating food that contains a harmful substance.**
- **Commonly known as food poisoning,**

it is caused by eating food that is contaminated by bacteria or other harmful substances

VULNERABLITY: POPULATION AT RISK

- **EVERYONE is potentially at risk for food-borne illness, but the following groups are at higher risk than others:**
  - **Children**
  - **Pregnant women**
  - **Seniors**
  - **Individuals with compromised immune systems**
    - **Medications that weaken natural immunity**

VULNERABLITY: POPULATION AT RISK

Groups with an increased risk include:

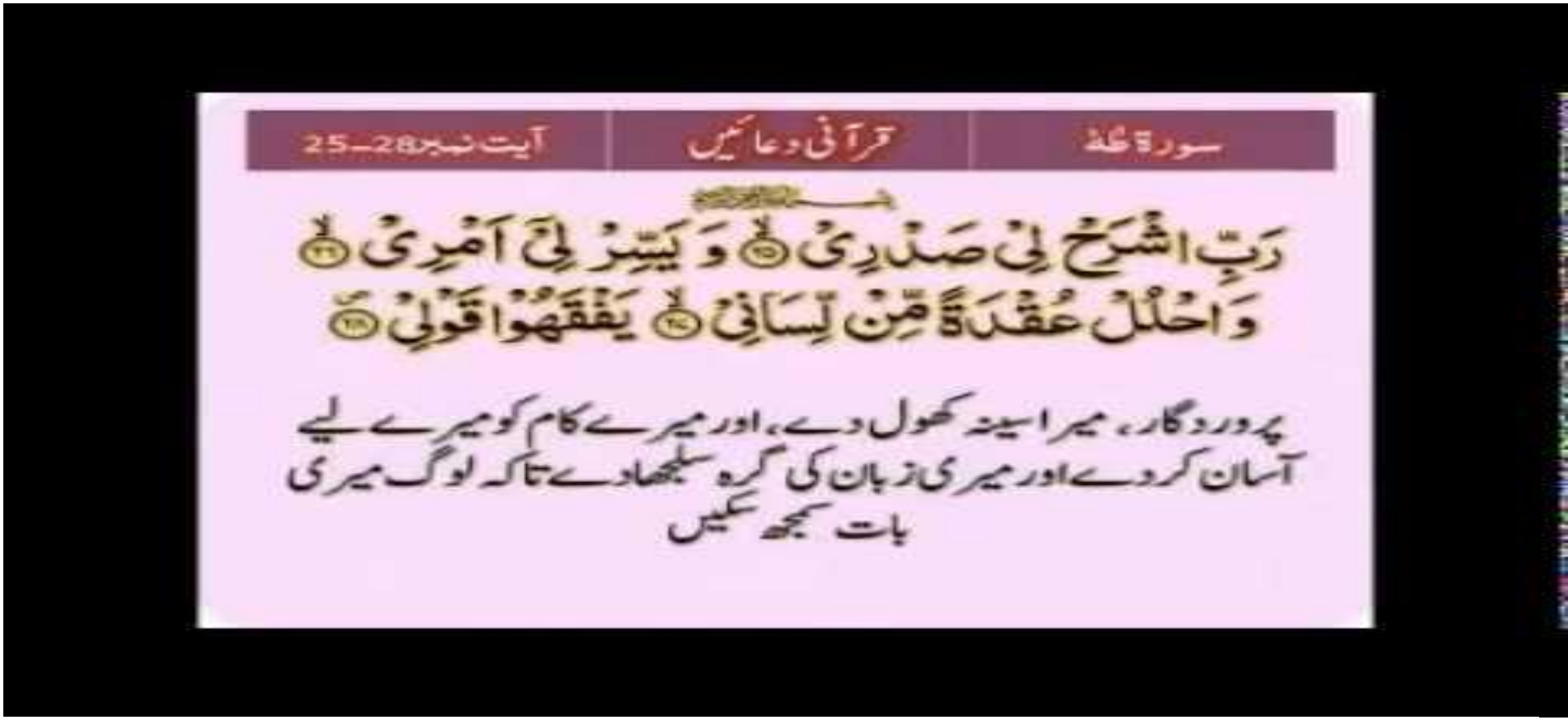
- **Young children**
- **Pregnant women**
- **Elderly men and women**
- **Individuals with autoimmune disorders, liver disease or decreased stomach acidity**
- **Alcoholics – because of possible liver damage/disease**
- **Individuals with reduced immune function due to chemotherapy or radiotherapy, and those taking steroids or antibiotics to treat immune deficiencies**
- **Individuals who are malnourished**
- **Individuals with viruses**
- **Individuals in institutionalized settings**

SOME BACTERIA DISEASES

Bacteria / Disease	Common Sources
Campylobacteriosis	Contaminated water; unpasteurized milk; undercooked meat, poultry and seafood
Botulism	Improperly processed, home-canned and commercially canned foods; vacuum packed or tightly wrapped foods
E. coli	Un-chlorinated water, raw or rare ground beef; unwashed produce; unpasteurized milk
Salmonella	Raw or undercooked poultry, eggs, meat and seafood; unpasteurized milk
Staphylococcus aureus	Prepared foods left too long at room temperature. Meat, poultry, egg products and such mixtures as tuna, chicken, potato and egg salad, cream filled pastries

CLASS TASK

- FOOD POISONING
- FOOD INTOXICATION
- PREVALANCE OF FOOD BORN ILLNESS



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MY LORD! INCREASE ME IN KNOWLEDGE.

FST-407. L # 5.

- FOOD SAFETY
- HOME FOOD SAFETY
- FOUR STEPS TO FOOD SAFETY
  - Clean
  - Separate
  - Cook
  - Chill

FOOD SAFETY DEFINITION

Food safety means keeping food safe to eat by following proper food handling and cooking practices.

SOME BACTERIA DISEASES

Illness	Potential Sources
Salmonella Campylobacter	Poultry Meat Eggs Unpasteurized milk/dairy products Raw produce
Listeria	Raw milk Soft cheese Luncheon meats/hot dogs Raw produce
E. Coli	Raw/undercooked meat Raw produce Unpasteurized milk

FOUR STEPS TO FOOD SAFETY

- Clean
- Separate
- Cook
- Chill

CLEAN

Personal Hygiene

- Wash hands in warm, soapy water
  - 20-second scrub
- Wash before and after preparing food in the kitchen.
- Cover coughs and sneezes

Kitchen

- Clean and sanitize all surfaces and utensils in hot, sudsy water.
- Change dish towels often
- Dispose of garbage promptly

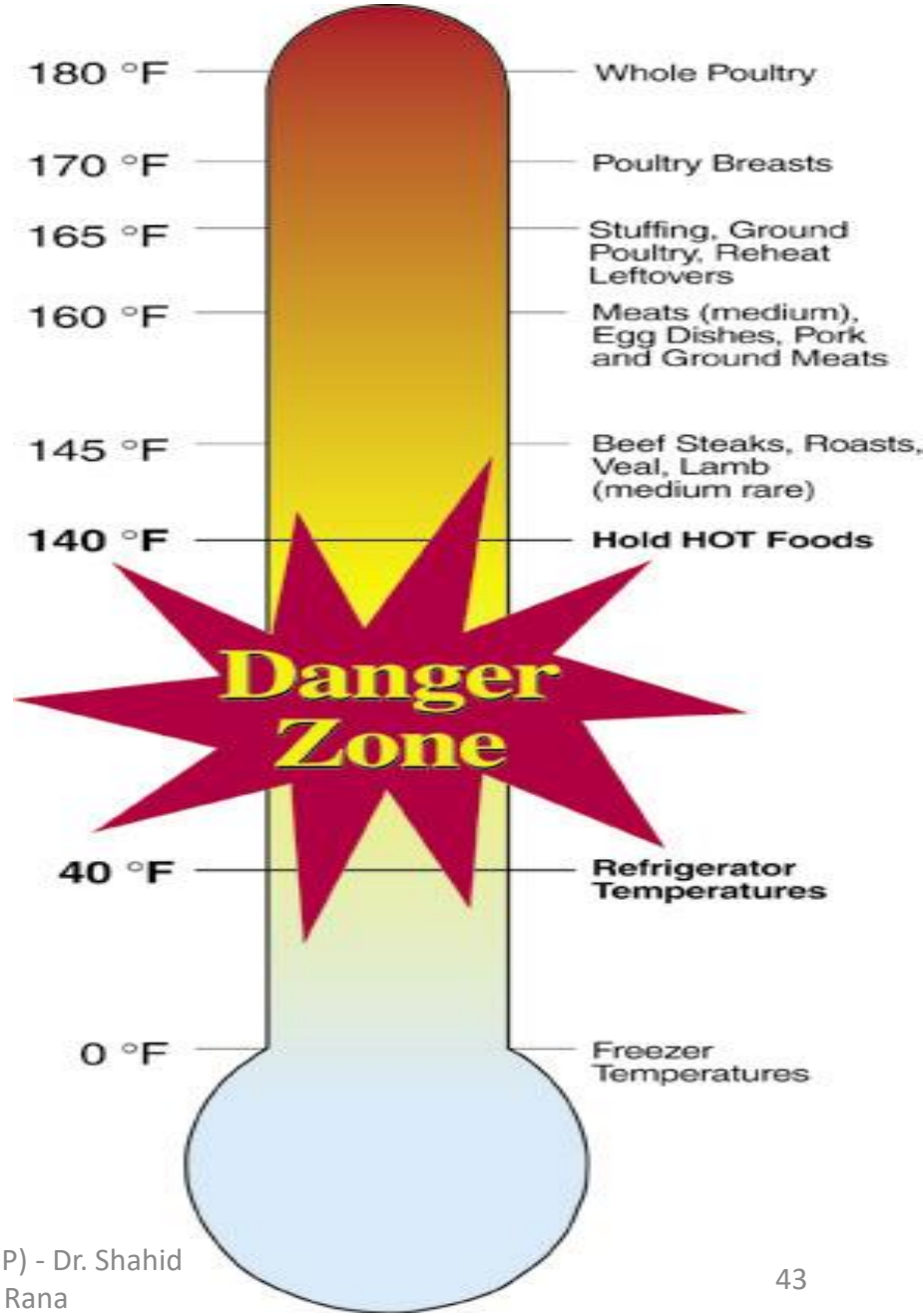
SEPARATE

- **Separate cooked and ready-to-eat foods f raw foods.**
- **Do not taste and cook with the same spoon.**
- **Never use the same utensil, cutting board, or plate for raw and cooked foods.**
  - **This step prevents cross-contamination which occurs when harmful bacteria spread from one food to another.**

COOK

Cooking raw meat, poultry, seafood, and eggs to a safe internal temperature can kill harmful bacteria.

- **Use a thermometer to check food temperatures.**
- **Do not taste uncooked or partially cooked dishes.**
- **Reheat foods thoroughly to 165 degrees F.**



CHILL

- Do not allow foods to sit out longer than **2 hours.**
  - Divide larger amounts of food into small portions to chill faster.
- Refrigerators should be kept at **≤ 40 °F**
- Freezers should be kept at 0 degrees or below
- Thaw foods in refrigerator, cold water or the refrigerator
- When in doubt "Throw it Out!"

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رَّبِّ زِدْنِی عِلْمًا

MY LORD! INCREASE ME IN KNOWLEDGE.

FST-407. L # 6.

- MAJOR FOODBORNE INFECTIONS
- INFECTIONS AND ITS SYMPTOMS
- RISKS TO CONTROL
- 8 CRITICAL BUT SIMPLE STEPS TO ENSURE FOOD SAFETY AT HOME
- PROPER HAND WASHING TECHNIQUES
- NOT ONLY IS IMPORTANT TO WASH HANDS PROPERLY, BUT ALSO TO WASH THEM FREQUENTLY
- CROSS CONTAMINATION

MAJOR FOODBORNE INFECTIONS

- **More than 250 different infections and intoxications are associated with foodborne illness**
- **By far, the majority of illness are caused by**
  - ***E. Coli***
  - ***Salmonella***
  - ***Listeria***
  - ***Campylobacter***
  - ***Staphylococcus aureus***

INFECTIONS AND ITS SYMPTOMS

How does foodborne illness occur?

- **Contaminated foods carry microbes into the body**
- **Some microbes can overcome the body's defenses and cause infections**

What are its typical primary symptoms?

- **Nausea**
- **Vomiting**
- **Abdominal cramps**
- **Diarrhea**

RISKS TO CONTROL

- Improper refrigeration and storage
- Poor personal hygiene
- Cross-contamination
- Contaminated food sources
- Undercooking
- Other time and temperature mistakes

8 CRITICAL BUT SIMPLE STEPS TO ENSURE FOOD SAFETY AT HOME

- Wash hands **often**
- Wash **raw** produce before cutting, cooking or eating
- Wash **utensils** and cutting boards after each use
- Keep kitchen surfaces **clean**
- Keep raw **meat** and ready-to-eat foods separate
- Cook food to proper **temperatures**
- Refrigerate food promptly to below **40°F**
- Pay close attention to **use-by dates**

PROPER HAND WASHING TECHNIQUES

- Warm soapy water is necessary to kill the unseen germs that may be on hands.
- The primary function of soap is to remove dirt and pathogens from hands, but the point is that scrub to release them from hands, and then rinse to send them down the drain.
- It is important to wash all surfaces of hands, up to wrists, between fingers and especially under fingernails.

PROPER HAND WASHING TECHNIQUES

- **To estimate 20 seconds, clean hands through**
- **When rinsing, use the same agitation used for washing.**
- **It is very important not to re-contaminate hands by using a dirty cloth to dry them…even cloths that seem to be clean may harbor harmful bacteria. Always use a paper towel or clean cloth towel to dry your hands – or let them air dry.**

NOT ONLY IS IMPORTANT TO WASH HANDS PROPERLY, BUT ALSO TO WASH THEM FREQUENTLY

Always Wash Hands Before:

- **Prepare food**
- **Eat meals**
- **Feed children**

Always Wash Hands After:

- **Handle raw foods (including meats, eggs, and fresh fruits and vegetables)**
- **Switch food-preparation tasks**
- **Use the restroom or change a diaper**
- **Cough or sneeze**
- **Handle garbage, dirty dishes or cigarettes**
- **Use the phone**
- **Play with a pet**
- **Touch a cut or sore**

CROSS CONTAMINATION

- **Cross-Contamination is the transfer of harmful substances or disease-causing micro-organisms to food by hands, food-contact surfaces, sponges, cloth towels and utensils that touch raw food and then touch ready-to-eat foods.**
- **Cross-contamination can also occur when raw food touches or drips onto cooked or ready-to-eat foods.**
- **Keeping raw and ready-to-eat foods separate helps reduce the risk of cross-contamination.**
- **Ready-to-eat foods do not require additional preparation or cooking. They include:**
- **All food that has already been cooked**
- **Raw, washed, cut fruits and vegetables**

CLASS TASK

- 7 FOOD BORNE ILLNESS WITH MIROBES

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MY LORD! INCREASE ME IN KNOWLEDGE.

FST-407. L # 7. PREVENTATIVE MEASURES FOR FOOD SAFETY

- Good Personal Hygiene
- No Bare Hand Contact With Food
- Purchase Safe Food
- Store Food Properly
- Prepare and Cook Food Adequately
- Clean and Sanitize

GOOD PERSONAL HYGIENE

The most important tool you have to prevent

- **Food borne illness is good personal hygiene**
- Bacteria like ***Staphylococci*** are found on the hair, skin, mouth, nose and in the throat of healthy people.
- According to one estimate, nearly **50 %** of healthy food handlers carry disease agents that can be transmitted by food.
- **Food preparers, food servers (anyone involved with food service to children)**
- **Do not allow people with infected cuts/sores, colds, or other communicable diseases to prepare or serve food**

GOOD PERSONAL HYGIENE

Hand Washing

- **The single most important means of preventing the spread of infection and illness, and cross-contamination**

Proper Hand Washing Procedure:

- **Wet your hands with running water as hot as you can comfortably stand**
- **Apply Soap**
- **Vigorously scrub hands and arms for ten to fifteen seconds**
- **Rinse thoroughly under running water**
- **Dry hands and arms with a single-use paper towel or warm-air hand dryer**

GOOD PERSONAL HYGIENE

Hands should be washed

- Before preparing food
- After using the toilet
- After sneezing, coughing or blowing your nose,
- After touching foods or other items that may be contaminated with bacteria or other harmful substances

NO BARE HAND CONTACT WITH FOOD

Food Preparers

- SINGLE-USE gloves shall be used when working with
  - Ready-to-eat food items (bread, fruits/vegetables, deli meats and cheeses, tuna fish)
  - Raw animal food (chicken, beef)
- **SINGLE-USE Gloves**
  - One pair of gloves may not be used for multiple tasks. When interruptions occur in the operation (ex. food preparer needs to get something from refrigerator/storage room) gloves need to be replaced because they become contaminated with touching door handles, packaging, etc.

NO BARE HAND CONTACT WITH FOOD

Food Servers (food preparer, teacher, helper)

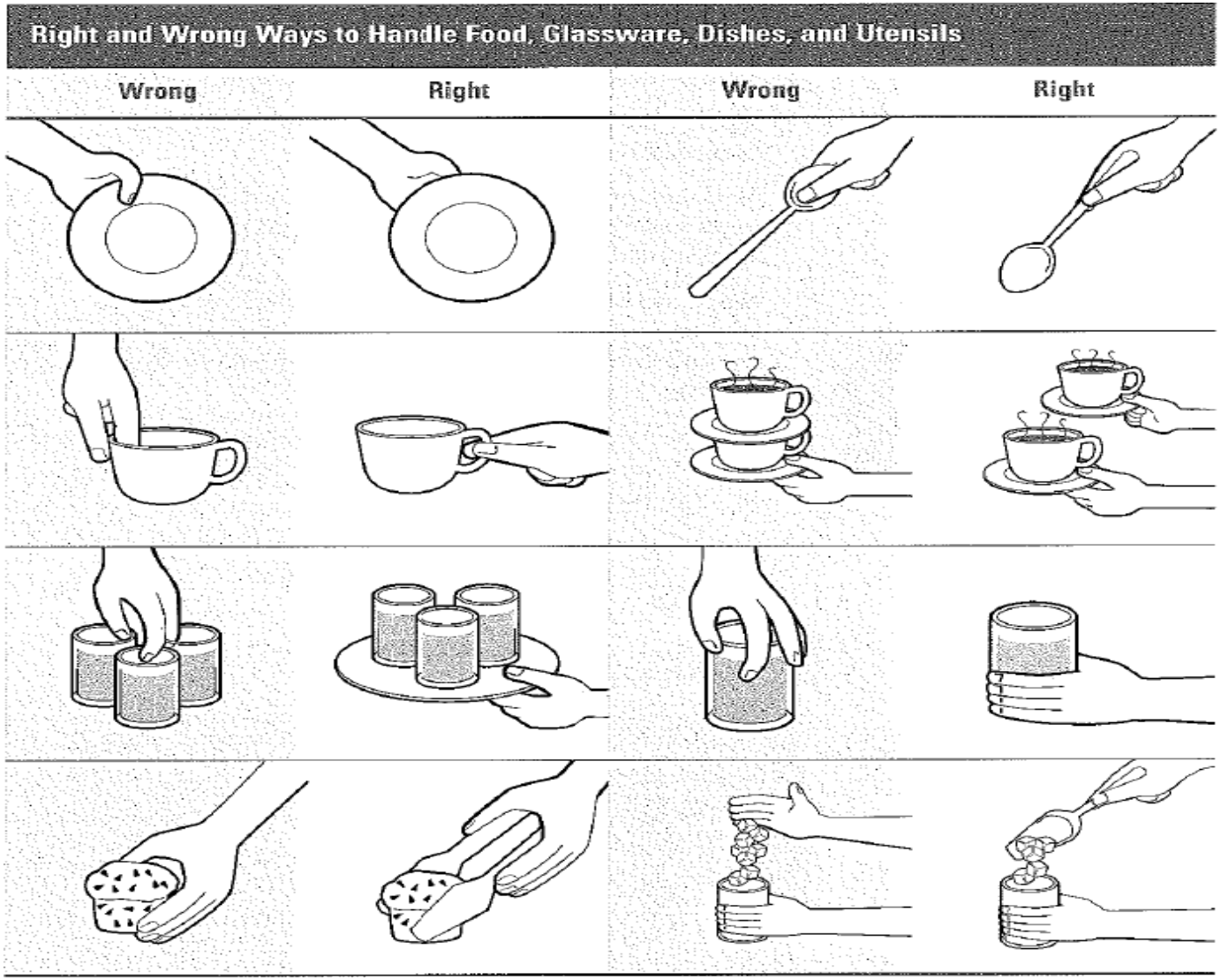
- Use utensils (tongs, serving spoons, spatulas) when serving or handling food
- Use SINGLE-USE gloves
- Have children serve themselves family style with utensils. Kids can also grab food themselves – opportunity to teach

SINGLE-USE gloves

- one pair of gloves may not be used for multiple tasks. When interruptions occur during food service (ex. food server needs to pick up a fork that fell on the floor, help a child push in a chair, touching anything but the prepared food) gloves need to be changed

NO BARE HAND CONTACT WITH FOOD

When handling glassware, dishes and utensils do not touch food contact areas with bare hands



PURCHASE SAFE FOOD

VENDORS

- Buy only from reputable suppliers
- Inspect deliveries carefully
- Sample temperatures of received food items
- Put refrigerated and frozen items away immediately

PURCHASE SAFE FOOD

GROCERY STORE

- Read the label – do not buy food that is past the “sell-by,” “use-by,” or other expiration dates
- Purchase meat, poultry and dairy products last
  - Ground beef should be **cherry-red** or **purple-red** if in vacuum packaging
  - Place meat, poultry and seafood in plastic bags to prevent juices from dripping on other foods in the cart
  - Keep raw meat, poultry and seafood separate from other food items
- Check that all food packages are intact
- Select produce that is fresh, not bruised or damaged

STORE FOOD PROPERLY

- **Keep out of temperature danger zone**
  - Refrigerator 40°F or lower
  - Freezer 0°F or lower

- **Label and date food**
  - Leftover prepared food which was not served must be labeled and dated, refrigerated promptly and used within 36 hours, or frozen immediately for later use
  - Commercially-prepared, ready-to-serve opened food items can be kept up to 7 days when they are properly stored/refrigerated

STORE FOOD PROPERLY

Dry Storage

- Dry food should be stored in sealed containers (zip-type bags, metal, glass or food-grade plastic containers with tight-fitting covers) and shall be labeled
- Clean, dry, ventilated and lighted storerooms or areas protected from contamination by sewage, wastewater backflow, condensation, leakage or vermin

PREPARE AND COOK FOOD ADEQUATELY

Thaw Foods Properly

In Refrigerator 	≤ 40 °F
Under Cold Running Water 	Water must be ≤ 70 °F
Microwave 	Food must be cooked immediately after thawing
Part of Cooking Process 	Food must meet the required minimum internal cooking temperature

PREPARE AND COOK FOOD ADEQUATELY

Cook to Minimum Temperatures

Sample:

165° F

- Poultry
- Stuffing / Casserole
- Hazardous food cooked in microwave (eggs, poultry, meat, fish)

PREPARE AND COOK FOOD ADEQUATELY

Doneness versus Safety

- Doneness is subjective. It is the appearance, texture, color, smell and flavor of food
- Safety is cooking to the required minimum temperature to destroy bacteria. Use a food thermometer to accurately measure

PREPARE AND COOK FOOD ADEQUATELY

Leftovers

- Heat to 165°F and bring gravies and sauces to a rolling boil before serving
- In microwave, beware of cold spots and use a food thermometer to check the temperature in several places

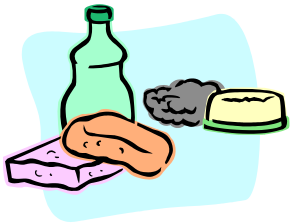
PREPARE AND COOK FOOD ADEQUATELY

AVOID THE DANGER ZONE

- When **cold** food goes above **40° F**
- When **hot** food falls below **135° F**
- **Bacteria** can multiply rapidly in **perishable** food left in the danger zone for **more than 2 hours**
- Throw away perishable food that has been left at room temperature for more **than 2 hours**

AVOID THE DANGER ZONE

CLEAN AND SANITIZE



Any surface that comes in contact with food must be cleaned and sanitized

- **Clean:** **Remove food and other types of soil from a surface**
- **Sanitize:** **Reduce the number of microorganisms on a clean surface to safe levels**
  - ***Bleach Solution: One capful bleach (1 ½ tsp) to one gallon of water***
  - ***Other approved sanitizers***

CLEAN AND SANITIZE

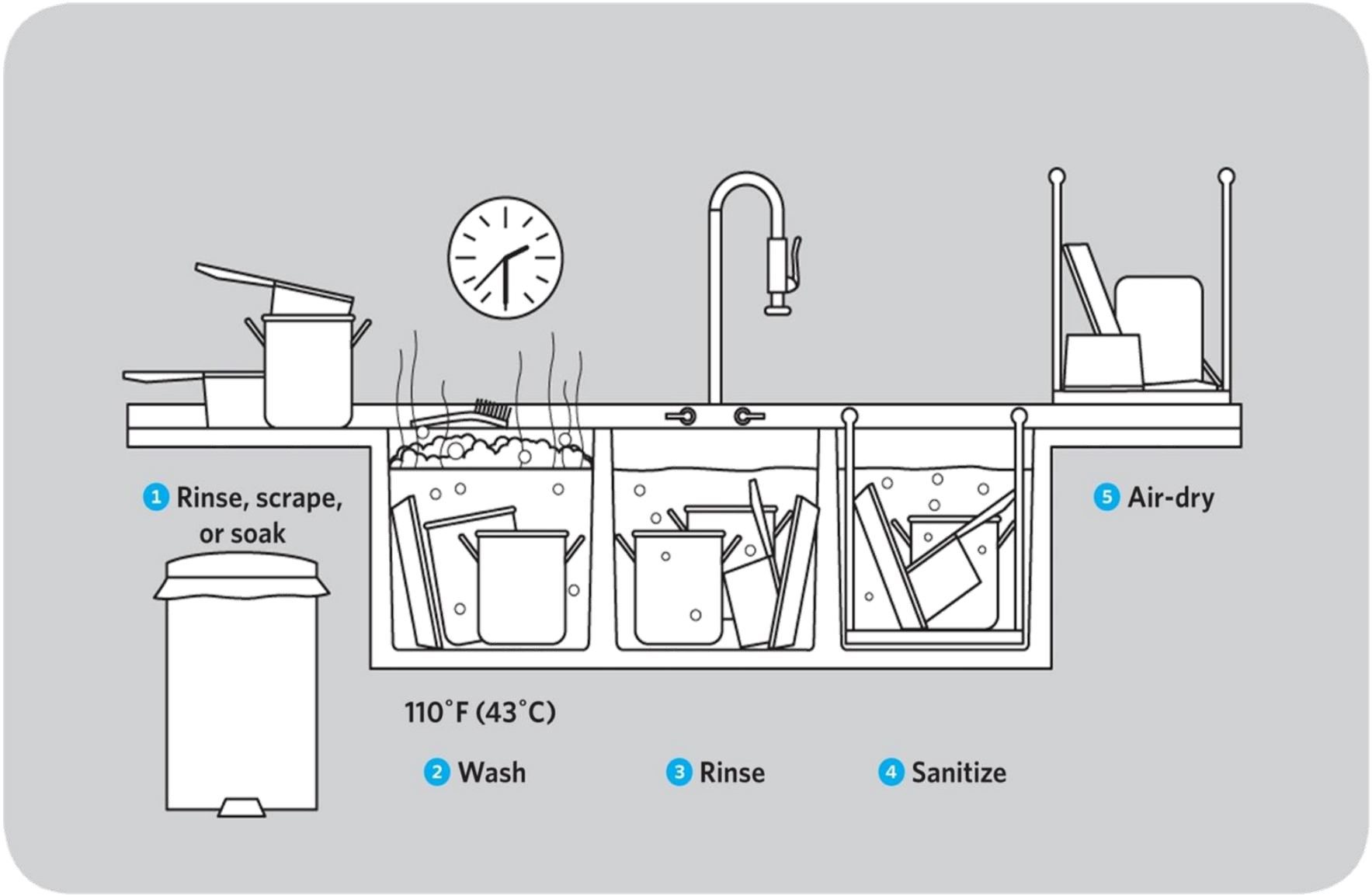
What surfaces?

- Kitchen counters
- Knives, mixing spoons and other utensils
- Mixing bowls and other food preparation containers
- Cutting boards
- Tables children eat on

CLEAN AND SANITIZE

Dishwashing Procedures- Manual (3-compartment sink)

- Rinse, scrape or soak items before washing
- Wash in **110° - 125°F** water, using soap/detergent
- Rinse by immersing in clean, hot water to remove soap/detergent or by spraying soap/detergent off, removing all traces of food and detergent. If dipping the items, change the rinse water when it becomes dirty or full of suds.
- Sanitize for minimum **2 minutes in 1 ½** teaspoons of bleach per gallon of water (or other Department of Health Services approved sanitizer)
- Air-dry Items – upside down so they will drain


1 Rinse, scrape, or soak
110˚F (43˚C)
2 Wash
3 Rinse
4 Sanitize
5 Air-dry

CLEAN AND SANITIZE

- If your center has a **two compartment sink**, you must arrange for all three steps: Wash, rise and sanitize:
  - Purchase a bucket/tub to put your sanitizing solution in and sanitize your dishes in the tub (1 ½ teaspoons of bleach per gallon of water or other Department of Health Services approved sanitizer)

OR

  - Wash and rinse dishes in the two sinks, drain the rinse sink, make a sanitizing solution and sanitize the dishes after

CLEAN AND SANITIZE

Dishwashing Procedures

Commercial

- Dishwasher shall have a visible temperature gauge
- Wash at **130°-150°F** for 20 seconds, rinse and sanitize at **180°F for 10 seconds** or more OR use chemical sanitizer
- All dishes/utensils must be **Air Dry**

Home Type Dish Washer

- After dishwasher is done, sanitize dishes/utensils by **submerging for minimum 2 minutes in 1 ½** teaspoons of bleach per gallon of water (or other Department of Health Services approved sanitizer)
- All dishes/utensils must be **Air Dry**

بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

رَبِّ اشْرَحْ لِیْ صَدْرِیْ ○ وَیَسِّرْلِیْ اَمْرِیْ ○
وَ ا حْلُلْ عُقْدَةً مِّنْ لِّسَانِیْ ○ یَفْقَهُوْا قَوْلِیْ ○

اے میرے رب! میرا سینہ کھول دے اور میرے لیے میرا کام آسان کر دے اور میری زبان کی گرہ کھول دے تا کہ لوگ میری بات سمجھ سکیں

رَّبِّ زِدْنِی عِلْمًا

MY LORD! INCREASE ME IN KNOWLEDGE.

FST-407. L # 8.
BIOLOGICAL HAZARDS & FOOD SAFETY

- Bacteria
- Viruses
- Parasites
- Other Biological Hazards - Prions

BIOLOGICAL HAZARDS

- **Bacteria**
- **Viruses**
- **Parasites**
- **Other Biological Hazards - Prions**

- Biological hazards occur when hazardous or pathogenic organisms are introduced to food and thus pose a food safety concern to consumers
- Biological hazards include bacteria, viruses and parasites of public health significance

BIOLOGICAL HAZARDS

- Biological hazards can be introduced to food from the environment (e.g. soil bacteria, agricultural run-off) or from inadequate sanitation practices and cross contamination during transportation, handling, processing, and storage (e.g., poor food hygiene practices)
- The type and magnitude of microbial growth is determined in part by the nature of the food, package conditions and storage environment

BACTERIA

- Bacteria are single-celled microorganisms that exist in a range of habitats and can be free-living (e.g. in soil, air, water) or symbiotic (e.g. in intestinal tract or mucous membranes of animals and humans) and have a broad range of enzymatic, biochemical and/or pathogenic properties
- The principal bacteria associated with food borne illnesses include:

BACTERIA

- *Bacillus cereus*
- *Campylobacter jejuni*
- *Clostridium botulinum*
- *Clostridium perfringens*
- *Escherichia coli* **0157:H7**
- *Escherichia coli* **0104:H4**
- *Listeria monocytogenes*
- *Salmonella* **spp.**
- *Shigella* **spp.**
- *Staphylococcus aureus*
- *Vibrio cholerae*
- *Vibrio parahaemolyticus*
- *Vibrio vulnificus*
- *Yersinia enterocolitica*
- *Cronobacter sakazakii*

BACTERIA

- Ingesting food contaminated with pathogenic microorganisms and/or their toxic by-products can lead to food-borne illness
- These illnesses can take the form of Infection or Intoxication, or both
- Infectious microorganisms are detrimental to their host through mechanisms which crowd out beneficial microorganisms, use up host resources, and destroy host tissue

BACTERIA

- A Food Borne Illness caused by an infection can take days or weeks to manifest which often makes it difficult to identify the causative agent
- On the other hand, illness caused by intoxication often occurs within hours of consuming the suspect food
- Intoxications are caused by toxins that are produced by the microorganism, either in the food itself or after ingestion

VIRUSES

- In contrast to other microorganisms, active viruses consist of unique sections of DNA or RNA enclosed in a thin coat of protein, and cannot exist independently of their living hosts
- Depending on the combination of DNA/RNA and the protein coating, viruses can be very infectious and often pathogenic
- They reproduce by inserting themselves into a host cell and altering the function of that cell to replicate the component pieces that make up the virus
- Viruses commonly associated with **Food Safety Issues** include

VIRUSES

- ***Bacteriophage***
- ***Enteric virus (other than Hepatitis A and Noroviruses)***
- ***Hepatitis A virus***
- ***Norovirus***
- ***Norwalk virus***
- ***Rota virus***
- Viruses are typically introduced into food either through **poor handling** practices by people infected with the virus (i.e. **poor personal hygiene practices) or via contaminated food ingredients** (i.e. water)

PARASITES

- A parasite is any organism which obtains nourishment from its host organism in order to grow and reproduce
- Unlike symbiotic organisms, which reciprocate by supplying their hosts with other resources the host would not otherwise be able to find, parasites do not supply the host with any resources, usually to the detriment of the host
- Parasites commonly associated with **Food Borne Illnesses** include

PARASITES

- ***Cryptosporidium parvum***
- ***Giardia duodenalis or intestinalis***
- ***Taenia spp.***
- ***Toxoplasma gondii***
- ***Trichinella spiralis***
- ***Entamoeba histolytica***
- ***Entamoeba coli***
- Parasites enter food through similar means as viruses (i.e., poor personal hygiene practices and contaminated ingredients)

OTHER BIOLOGICAL HAZARDS - PRIONS

- Other biological food safety hazards not belonging to the above mentioned categories include **prions**, also known as **proteinaceous infectious particles**, which are infectious agents made of protein
- They are known to cause a number of diseases that affect both **humans** and animals
- **BSE** (Bovine Spongiform Encephalopathy) "**Mad Cow Disease**" is a progressive, fatal disease of the nervous system of cattle

OTHER BIOLOGICAL HAZARDS - PRIONS

- It is also known as a **Transmissible Spongiform Encephalopathy (TSE)**
- Other TSEs include scrapie in **Sheep** and chronic wasting disease in **Deer** and **ELK Stalk**
- **Creutzfeldt-Jakob** disease in **humans** is thought to be caused by consuming cattle infected with BSE, although the exact cause of BSE is unknown, it is associated with the presence of **PRIONS**
- There is no treatment or vaccine currently available for the disease

PRION DISEASES

A prion is a type of protein that can trigger normal proteins in the brain to fold abnormally

Prion diseases or Transmissible Spongiform Encephalopathy (TSE) are a family of rare progressive neurodegenerative disorders that affect both humans and animals

HUMAN PRION DISEASES

- ***Creutzfeldt-Jakob Disease (CJD)***
- ***Variant Creutzfeldt-Jakob Disease (vCJD)***
- ***Gerstmann-Straussler-Scheinker Syndrome***
- ***Fatal Familial Insomnia***
- ***Kuru***

ANIMAL PRION DISEASES

- ***Bovine Spongiform Encephalopathy (BSE)***
- ***Chronic Wasting Disease (CWD)***
- ***Scrapie***
- ***Transmissible mink encephalopathy***
- ***Feline spongiform encephalopathy***
- ***Ungulate spongiform encephalopathy***

CREUTZFELDT-JAKOB DISEASE (CJD)

- It is a universally fatal brain disorder
- Early symptoms include memory problems, behavioral changes, poor coordination, and visual disturbances
- Later dementia, involuntary movements, blindness, weakness, and coma occur
- About 90 % (more than 85 %) of people die within a year of diagnosis
- The disease was first described by German neurologist Hans Gerhard Creutzfeldt in 1920 and shortly afterward by Alfons Maria Jakob, giving it the name Creutzfeldt–Jakob
- Prevalence 1/1000000 per year

ELK / WAPITI

- The Elk, or **Wapiti** (*Cervus canadensis*), is one of the largest species within the deer family, Cervidae, in the world
- One of the largest land mammals in North America and Eastern Asia

ELK / WAPITI

بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

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رَّبِّ زِدْنِی عِلْمًا

MY LORD! INCREASE ME IN KNOWLEDGE.

FST-407. L # 9.
CHEMICAL HAZARDS & FOOD SAFETY

- MYCOTOXINS
- CHARACTERISTICS OF MYCOTOXINS
- MYCOTOXINS STATISTICS
- MYCOTOXIN HEALTH HAZARDS
- SYMPTOMS OF MYCOTOXICOSIS
- MYCOTOXIN EFFECTS ON HUMANS
- MYCOTOXIN EFFECTS ON ANIMALS
- REGULATORY CONTROL
- QUICK TOXIN REVIEW
- MYCOTOXINS ABSORPTION
- FOODS HIGHEST IN MYCOTOXINS
- MYCOTOXINS: HEALTH EFFECTS

CHEMICAL HAZARDS: MYCOTOXINS

- Mycotoxins are **natural** toxins which are produced by **fungi** and can be **toxic** to humans and animals
- They are formed by **moulds** which grow on crops and foods under certain conditions
- There are number of **mycotoxins** present in the environment but only a few are found in foods and they are usually associated with particular field crops like **corn**

CHEMICAL HAZARDS: MYCOTOXINS

The most prominent mycotoxins which cause health concerns in humans are

- **aflatoxin**
- **deoxynivalenol**
- **ochratoxin**
- **fumonisin**
- **patulin**

CHARACTERISTICS OF MYCOTOXINS

- Resistant to heat
- Produced by fungi as secondary metabolites in response to competitive pressures from other fungi/bacteria
- Can have antibiotic properties
- Can cause toxic damage to cells of humans and animals
- Can cause chronic effects such as various cancers, immunosuppression, growth retardation, birth defects, renal dysfunction
- Can have serious long-term effects even at small concentrations
- Usually associated with particular crops (i.e. corn, cereal crops, apples)

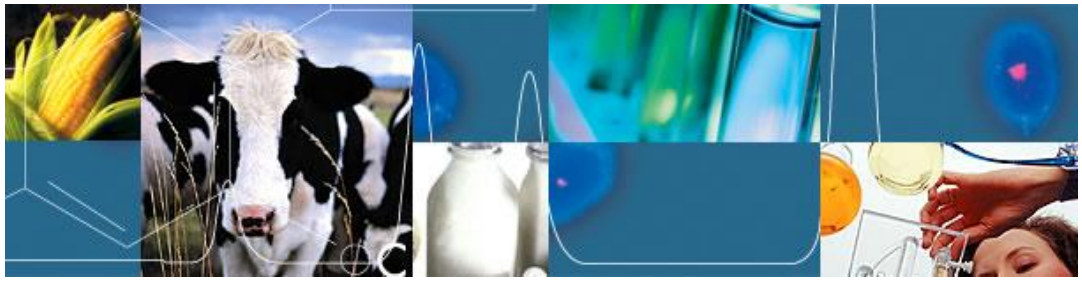
MYCOTOXINS STATISTICS

- **300-400 mycotoxins presently identified, with more becoming evident as new isolation techniques are used.**
- **Most frequent toxins present are aflatoxin, DON, ZEN, fumonisin, and T-2 toxin, to name a few.**

http://www.ars.usda.gov/incme/images/sitelogos/66120507/66120507.jpg

MYCOTOXIN HEALTH HAZARDS

- **Generally lower risk in well developed countries due to improved standards of living.**
- **High intake of affected product, usually in conjunction with limited amounts of other food sources.**
- **Greatest threat comes from long term exposure due to eating spoiled food or meat from animals fed contaminated feed.**



http://www.weber.hu/images/Vicam/products.jpg

SYMPTOMS OF MYCOTOXICOSIS

- Drugs and antibiotics are not effective in treatment
- The symptoms can be traced to foodstuffs or feed
- Testing of said foodstuffs or feed reveals fungal contamination
- The symptoms are not transmissable person to person
- The degree of toxicity is subject to persons age (more often in very young and very old), sex (more often in females than males)and nutritional status
- Outbreaks of symptoms appear seasonally

MYCOTOXIN EFFECTS ON HUMANS

- **Economic loss due to impaired health of stock animals**
- **Illness: symptoms can include cold/flu-like symptoms, sore throats, headaches, nose bleeds, fatigue, diarrhea, dermatitis, and immune suppression, and vary by species**
- **Death**

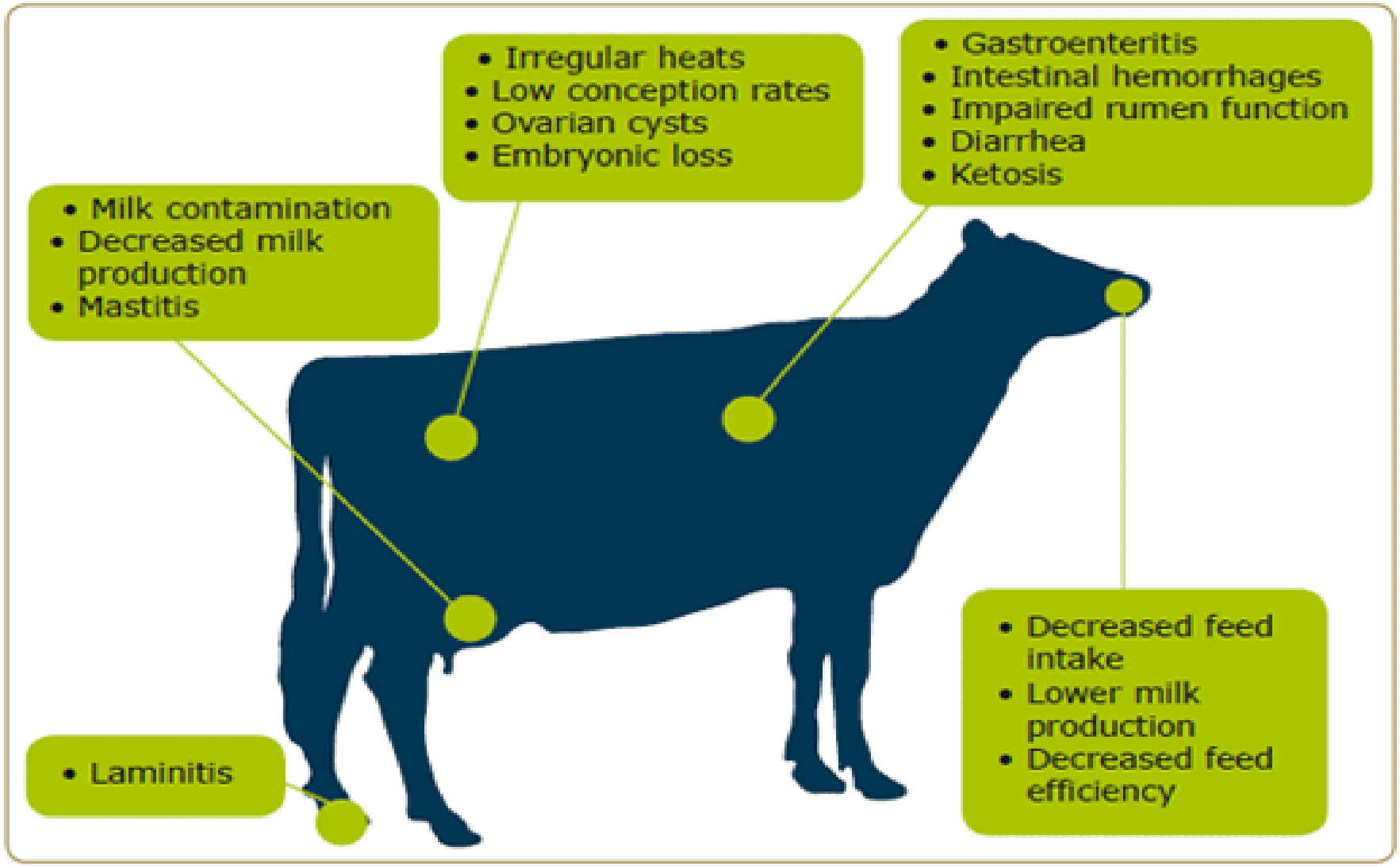
http://toxicblackmold.info/images/moldsickenschildren.jpg

MYCOTOXIN EFFECTS ON ANIMALS

- **Feed refusal**
- **Impaired animal health, resulting in reduced production of eggs, milk, weight gain, etc.**
- **Metabolites are passed through the milk in cheese, dry milk, yogurt**
- **Disease**
- **Death in animals**

http://www.thecattlesite.com/articles/contents/09-02-24Mytotoxin.gif

MYCOTOXIN EFFECTS ON ANIMALS



http://www.thecattlesite.com/articles/contents/09-02-24Mytotoxin.gif

http://www.inoxpa.com/upload/Image/fda.jpg

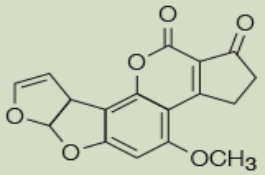
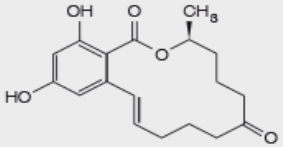
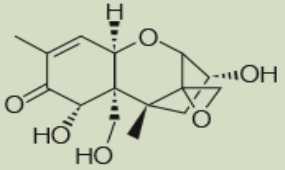
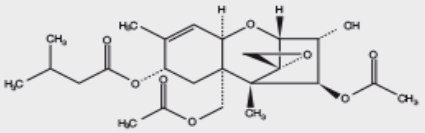
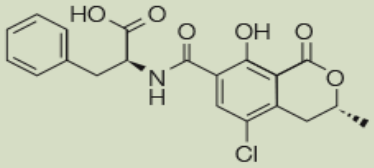
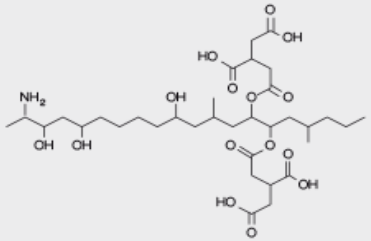
REGULATORY CONTROL

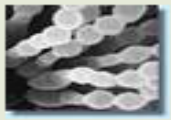
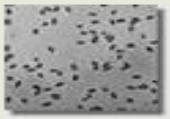
- In **1965**, the Food and Drug Administration (**FDA**) set the first **mycotoxin** limit of **20** parts per billion (**ppb**) for **aflatoxin** in all **foods** and **feed**.
- But, this toxin can appear at varying levels of food production, so multiple testing at different points in the food chain is necessary.
- Using ELISA (enzyme-linked immunosorbent assay) technology, testing can be done cheaper and faster than previously.
- The FDA does not do the testing, various other agencies do, such as the Grain Inspection Packers and Stockyards Administration; but, toxic levels must be reported to the FDA.

QUICK TOXIN REVIEW

Organ System Affected	Toxin(s)
Vascular	**Aflatoxin**
Digestive	**Aflatoxin, T-2toxin, Vomitotoxin**
Respiratory	**Trichothecenes**
Nervous	**Trichothecenes**
Cutaneous	**Tricothecenes**
Urinary	**Ochratoxin A, Citrinin**
Reproductive	**Zearalenone, T-2 toxin**
Immune	**Many**

Mycotoxin	Producing fungi	Commodities affected
Aflatoxin	*Aspergillus flavus*	
	Aspergillus parasiticus	Corn, cotton seed, peanuts, soy
Ochratoxin A	*Aspergillus ochraceus*	
	Aspergillus nigri	
	Penicillium verrucosum	Wheat, barley, oats, corn, others
Trichothecenes	*Fusarium graminearum*	
	Fusarium culmorum	Corn, wheat, barley
Zearalenone	*Fusarium graminearum*	Corn, wheat, barley
Fumonisin	*Fusarium verticillioides*	
	Fusarium proliferatum	Corn
Moniliformin	*Fusarium moniliforme*	Corn

Mycotoxins	Chemical structure	Productivity loss	Immuno toxicity	Frequently related clinical signs	Main affected organ/system
Aflatoxins		+++++	+++++	Hepatitis, poor response to vaccination, unspecific infections, increased susceptibility to diseases	Liver, kidney, immune system
Zearalenone		+++++	++	Hyperestrogenism, reproductive disorders	Reproductive tract - mainly female.
Deoxynivalenol		+++++	++++	Feed refusal, vomiting	Central nervous system, GUT epithelium, liver, immune system
T-2 toxin		+++++	+++++	Oral and epithelial lesions, loss of apetite	GUT epithelium, liver, immune system
Ochratoxin A		+++++	+++++	Nefritis (kidney damage - enlarged kidney), hepatitis	Kidney, liver, immune system
Fumonisins		+++++	+++	Porcine Pulmonary Edema (PPE), Equine Leukoencephalomalacia (ELEM)	Lungs and heart (pig), central nervous system (horse), liver, immune system

Major classes of mycotoxin-producing fungi	Fungi species	Mycotoxins
Aspergillus 	*A. flavus* *A. parasiticus* *A. nomius* *A. pseudotamarii*	Aflatoxin (B_1, B_2, G_1, G_2)
	A. ochraceus	Ochratoxin (Ochratoxin A)
	A. clavatus *A. terreus*	Patulin
	A. flavus *A. versicolor*	Cyclopiazonic acid (CPA)
Claviceps 	*C. purpurea* *C. fusiformis* *C. paspali* *C. africana*	Penitrem A Ergot alkaloids: Clavines (Argroclavine) Lysergic acids Lysergic acid amids (Ergin) Ergopeptines (Ergotamine, Ergovaline)
Fusarium 	*F. verticillioides* *(syn. F. moniliforme)* *F. proliferatum*	Fumonisin (B_1, B_2, B_3) Fusaric acid
	F. graminearum *F. avenaceum* *F. culmorum*	Type A Trichothecenes T-2 toxin, HT-2 toxin, diacetoxyscirpenol
	F. poae *F. equiseti* *F. crookwellense* *F. acuminatum* *F. sambucinum* *F. sporotrichioides*	Type B Trichothecenes Nivalenol, deoxynivalenol, fusarenon-X
	F. graminearum *F. culmorum* *F. sporotrichioides*	Zearalenone
Penicillium 	*P. verrucosum* *P. viridicatum*	Ochratoxin (Ochratoxin A)
	P. citrinum *P. verrucosum*	Citrinin
	P. roqueforti	Roquefortine PR toxin Pentirem A
	P. cyclopium *P. camemberti*	Cyclopiazonic acid (CPA) Pentirem A
	P. expansum *P. claviforme* *P. roquefortii*	Patulin
Neotyphodium (formerly Acremonium)	*N. coenophialum*	Tall fescue toxins: Ergot alkaloids, lolines, peramine
	N. lolii	Tall fescue toxins: Lolitrems, peramine, ergot alkaloid (ergovaline)
Pithomyces	*P. chartarum*	Sporidesmin

MYCOTOXINS ABSORPTION

	% absorbed	
	Swine	Poultry
Aflatoxins	>80%	>80%
Ochratoxin A	65%	40%
DON	55%	5-20%
Fumonisins	3-6%	1%

Main mycotoxins occurring in corn produced in the northeastern U.S.

Mycotoxin:	Predominant toxigenic mold:	Lowest level of concern:	Common effects on animals:
Deoxynivalenol (vomitoxin)	*Fusarium graminearum*	1-3 ppm*	Feed refusal in monogastric animals; severity increases with level. Swine and dogs are the most sensitive species; adult cattle and poultry tolerate > 10 ppm.
Zearalenone	*Fusarium graminearum (Gibberella zeae)*	1-5 ppm	Hyperestrogenism and infertility. graminearum Swine (gilts) are most sensitive; adult cattle tolerate 50 ppm.
Fumonisins	*Fusarium verticilloides; F. proliferatum*	5-10 ppm	Brain deterioration, death (horses); verticilloides; liver damage (horses, swine, cattle, poultry, others).
		>100 ppm	Lung damage in swine

*USDA recommends less than 1 ppm deoxynivalenol in finished food products and less than 2 ppm in unmilled grain destined for human consumption.

FOODS HIGHEST IN MYCOTOXINS

MYCOTOXINS: HEALTH EFFECTS

Mycotoxin	Effect
Fumonisins	Oesophageal cancer in humans, pulmonary oedema, in pigs, neurotoxic disease in horses, liver cancer in rats.
Zearalenone	Infertility, abortion and other breeding problems especially in swine.
Trichothecenes	Feed refusal, degeneration of bone marrow cells, diarrhoea, bleeding and death in pigs.
Aflatoxins	Acute toxicity in humans (over 100 deaths recorded in Kenya in 2005).
Diplonine	Ataxia, paresis, and paralysis in cattle and sheep, as well as stillbirths and nervous disorders in livestock.

a_W VALUES GROWTH OF TOXIGENIC MOULD SPECIES

Mould Species	Minimum a_w value
Aspergillus ochraceus	0.78
Penicillium verrucosum	0.79
Aspergillus flavus	0.80
Fusarium moniliforme	0.87

(WHO, 2000)

Contaminants	Foods
PCBs, dioxins, dieldrin, aldrin, DDT…	Milk, butter, eggs, animal and vegetable fats and oils, fish, cereals, drinking-water…
Lead	Milk, canned/fresh meat, kidney, fish, molluscs, crustaceans, cereals, legumes, fruits, spices, drinking-water...
Cadmium	Kidney, molluscs, crustaceans, cereals, vegetables…
Mercury	Fish, fish products, mushrooms…
Aflatoxins	Milk, milk products, cereals, nuts, spices, cocoa, coffee...
Ochratoxin A	Wheat, cereals, wine
DON	Wheat, cereals
Fumonisins	Maize, wheat
Chlorpyrifos, diazinon, melathion, parathion, aldicarb, captan, dithiocarbamate…	Cereals, vegetables, fruits, drinking-water…
Nitrate/nitrite	Meat, drinking-water…
Inorganic arsenic	Wheat, drinking-water…

بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

رَبِّ اشْرَحْ لِیْ صَدْرِیْ ○ وَیَسِّرْلِیْ اَمْرِیْ ○
وَ ا حْلُلْ عُقْدَةً مِّنْ لِّسَانِیْ ○ یَفْقَهُوْا قَوْلِیْ ○

اے میرے رب! میرا سینہ کھول دے اور میرے لیے میرا کام آسان کر دے اور میری زبان کی گرہ کھول دے تا کہ لوگ میری بات سمجھ سکیں

رَبِّ زِدْنِی عِلْمًا

MY LORD! INCREASE ME IN KNOWLEDGE.

FST-407. L # 10.
WATER AND FOOD SAFETY

- THE MOST CRITICAL COMPONET
- WHO: FOOD SAFETY KEY FACTS
- VICIOUS CYCLE: MALNUTRITION AND INFECTION
- WATER ACTIVITY
- WATER ACTIVITY (a_w) IN FOODS

WATER AND FOOD SAFETY

THE MOST CRITICAL & DETRIMENTAL COMPONENT RELATED TO FOOD SAFETY

?

?

WATER

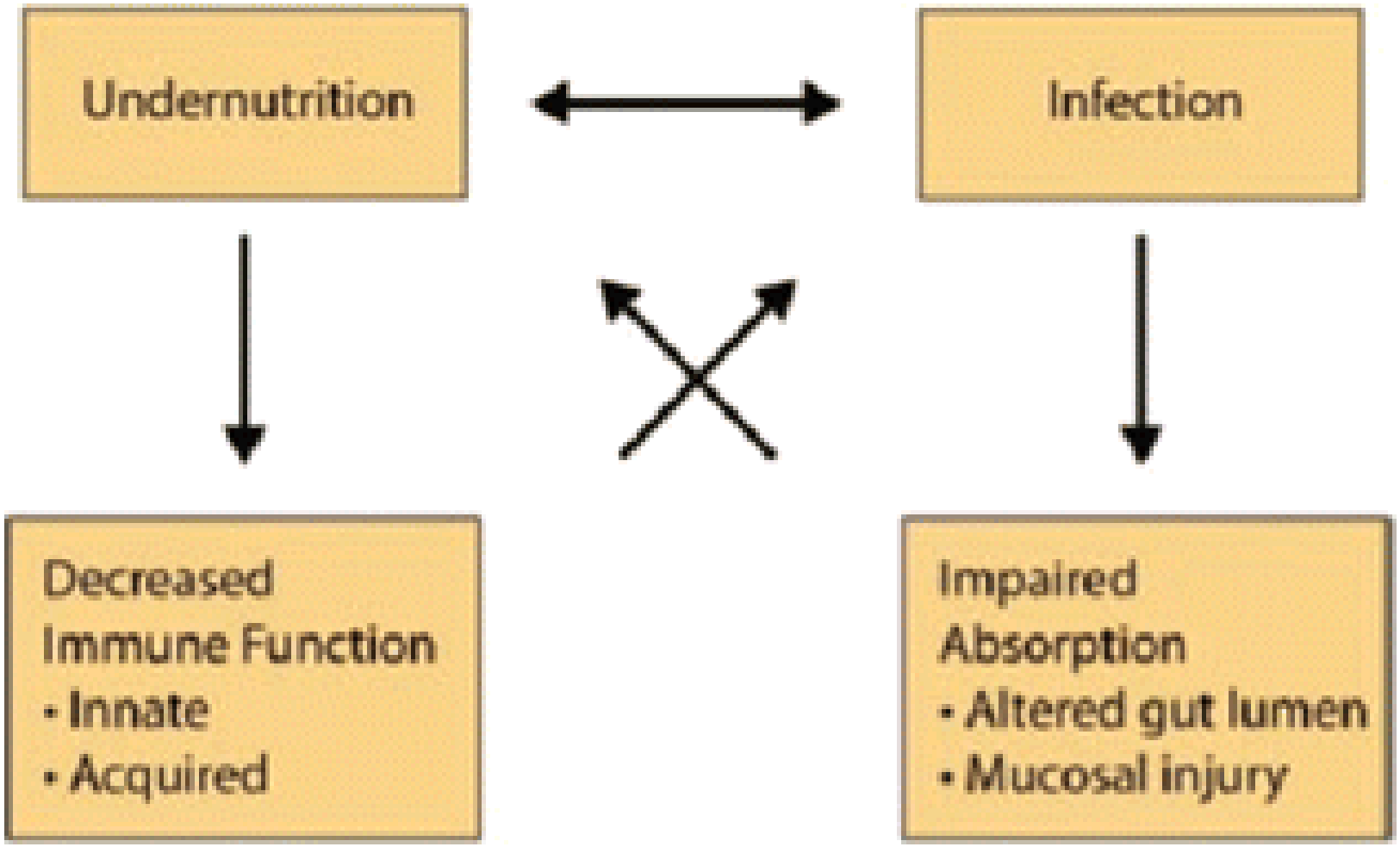
WHO: FOOD SAFETY KEY FACTS

- Access to sufficient amounts of **SAFE and NUTRITIOUS** food is key to sustaining life and promoting good health.
- **Unsafe food** containing harmful **bacteria**, viruses, parasites or chemical substances, causes more than **200** diseases-ranging from DIARRHEA to CANCERS.
- An estimated **600** million-almost **1 in 10** people in the world-fall ill after eating contaminated food and **420 000** die every year, resulting in the loss of **33 million** healthy life years.
- Children **under 5** years of age carry **40 %** of the foodborne disease burden, with **125 000** deaths every year.

WHO: FOOD SAFETY KEY FACTS

- **Diarrhoeal** diseases are the most common illnesses resulting from the consumption of contaminated food, causing **550 million** people to fall ill and **230 000** deaths every year.
- Food safety, nutrition and food security are inextricably (impossible to separate) linked.
- Unsafe food creates a vicious cycle of disease and malnutrition, particularly affecting infants, young children, elderly and the sick.

VICIOUS CYCLE: MALNUTRITION AND INFECTION



WATER AND FOOD SAFETY

CRITICAL & DETRIMENTAL

?

WATER ACTIVITY

a_w

WATER ACTIVITY (a_w) IN FOODS

" The ratio of the partial pressure of water in the atmosphere in equilibrium with the substrate (e.g. a food) to that of the atmosphere in equilibrium with pure water at the same temperature, and is expressed on a scale of **0 -1** where **1** is for pure water".

WATER ACTIVITY (a_w)

$$a_w = \frac{p}{^\circ p}$$

- Partial pressure of water above the solution normalized to the partial pressure above pure water

WATER ACTIVITY (a_w) IN FOODS

- The water activity (**a_w**) of a food is the ratio between the vapor pressure of the food itself, when in a completely undisturbed balance with the surrounding air media, and the vapor pressure of distilled water under identical conditions.
- **a_w** of **0.80** means the vapor pressure is **80 %** of that of pure water. The water activity increases with temperature.
- The **moisture** condition of a product can be measured as the **equilibrium relative humidity (ERH)** expressed in **%** or as the **a_w** expressed as a decimal. e.g.

ERH = 80 % OR **a_w = 0.80**

WATER ACTIVITY (a_w) IN FOODS

- Most foods have a a_w above **0.95** and that will provide sufficient moisture to support the growth of bacteria, yeasts, and mold.
- The amount of available moisture can be reduced to a point which will inhibit the growth of the organisms.

WATER ACTIVITY (a_w)

- Water in food which is not **bound** to food molecules can support the growth of bacteria, yeasts and molds (fungi)
- **a_w** refers to this **unbound** water
- **a_w** of a food is not the same thing as its moisture content
- Although **moist foods** are likely to have greater **a_w** than are dry foods, this is not always so; in fact a variety of foods may have exactly the same moisture content and yet have quite different water activities.

Foods	Water Activity (a_w)
Fresh Meat & Fish	0.99
Bread	0.95
Aged Cheddar	0.85
Jams & Jellies	0.80
Plum Pudding	0.80
Dried Fruit	0.60
Biscuits	0.30
Milk Powder	0.20
Instant coffee	0.20

WATER ACTIVITY OF SOME FOOD PRODUCTS

Food Product	Water activity (a_w)
Raw meat and milk	0.99- 1.0
Luncheon meat	0.95
Boiled ham, sliced bacon	0.90
Dried grains	0.80

MINIMUM a_w & GROWTH OF MICROORGANISMS

Microorganism	Water activity (a_w)
Clostridium botulinum	0.95
Bacillus cereus	0.95
Pseudmonas aeroginosa	0.95
Salmonella spp.	0.95
Staphylococcus aureus (anaerobic) *Candida spp., Saccharomyces*	0.90
Staphylococcus aureus (aerobic)	0.86
Penicillium spp.	0.82
Most spoilage yeast	0.88
Most spoilage molds	0.80
Osmotic yeast	0.70

Minimum water activities at which active growth can occur

Group of micro-organism	Minimum aw
Most Gram-negative bacteria	0.97
Most Gram-positive bacteria	0.90
Most yeasts	0.88
Most filamentous fungi	0.80
Halophilic bacteria	0.75
Xerophilic fungi	0.61
Osmophilic yeasts	0.60

Table 5: Minimum water activity that supports growth of some microorganisms

Microorganism	Water activity
Clostridium botulinum,	0.95
Bacillus cereus,	0.95
Pseudmonas aeroginosa,	0.95
Salmonella spp.	0.95
Staphylococcus aureus (anaerobic), Candida spp., Saccharomyces	0.90
Staphylococcus aureus (aerobic)	0.86
Penicillium spp.	0.82
Most spoilage yeast	0.88
Most spoilage molds	0.80
Osmotic yeast	0.70

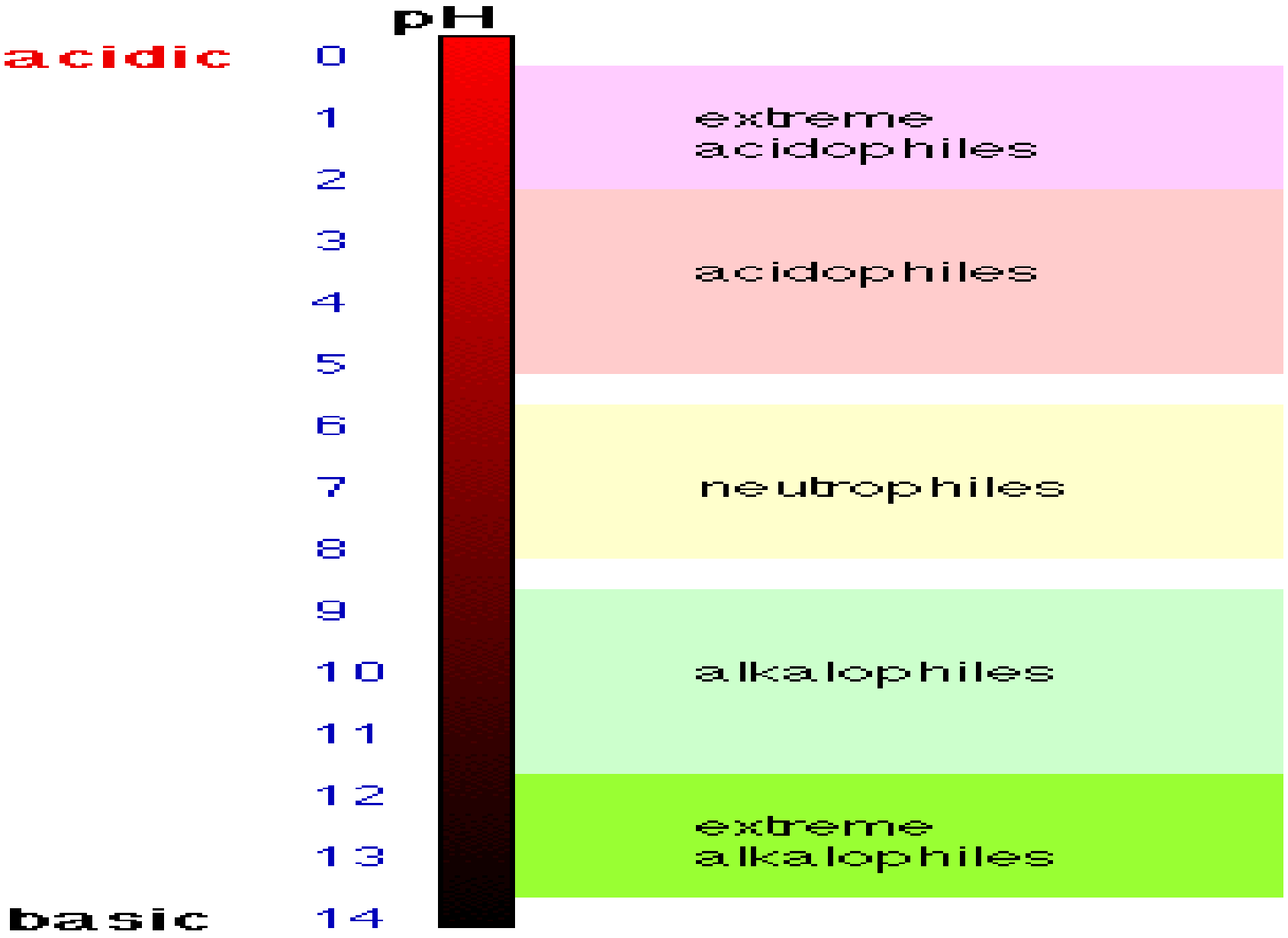
Minimum Permitting M/O Growth

Group	Minimum A_w	
Bacteria	0.91	
Yeasts	0.88	
Molds	0.80	
Halophilic Bacteria	0.75	
Xerophilic Fungi	0.65	
Osmophilic Yeasts	0.60	
Staphylococcus aureus (Survive but No Growth)	0.86	*Lowest Aw for Pathogen Growth
Pseudomonas	0.97	
Vibrio parahaemolyticus	0.94	
Escherichai coli	0.96	

Microbial Growth Ability in Different pH

M/O	pH Range
Molds	0.2-11
Yeasts	1.5-8.5
Salmonella	3.6-9.5
Listeria monocytogenes	4.2-9.6
Yersinia enterocolitica	4.2-9.0
Escherichia coli	4.3-9.0
Clostridium botulinum	4.3-8.5
Bacillus cereus	5.0-9.5
Campylobacter	5.0-9.0
Shigella	5.0-9.2
Vibrio parahaemolyticus	5.0-11
V. Cholerae	5.0-9.5
Cl. perfringens	5.0-8.5

END


pH
acidic
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
basic
extreme acidophiles
acidophiles
neubrophiles
alkalophiles
extreme alkalophiles

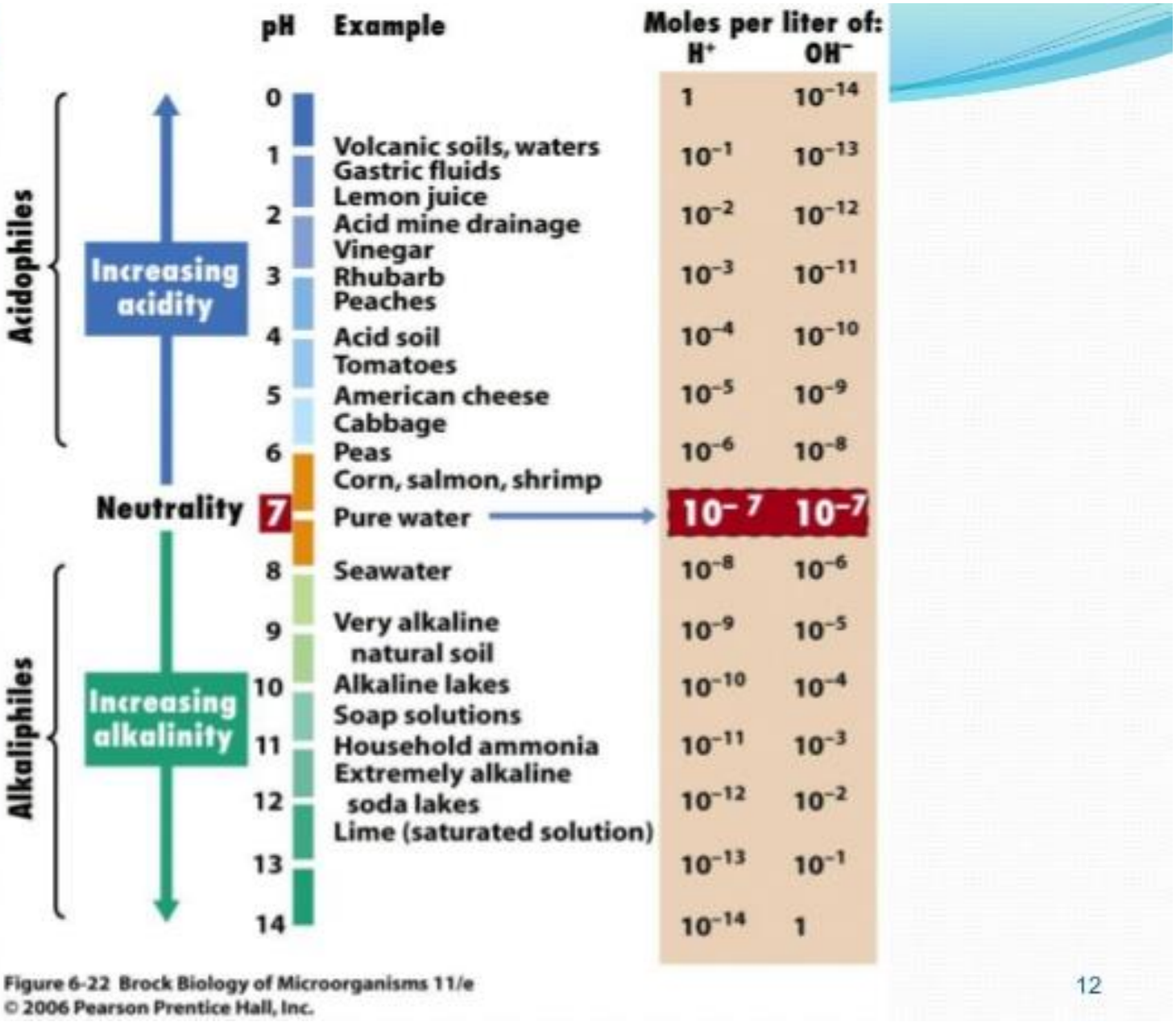
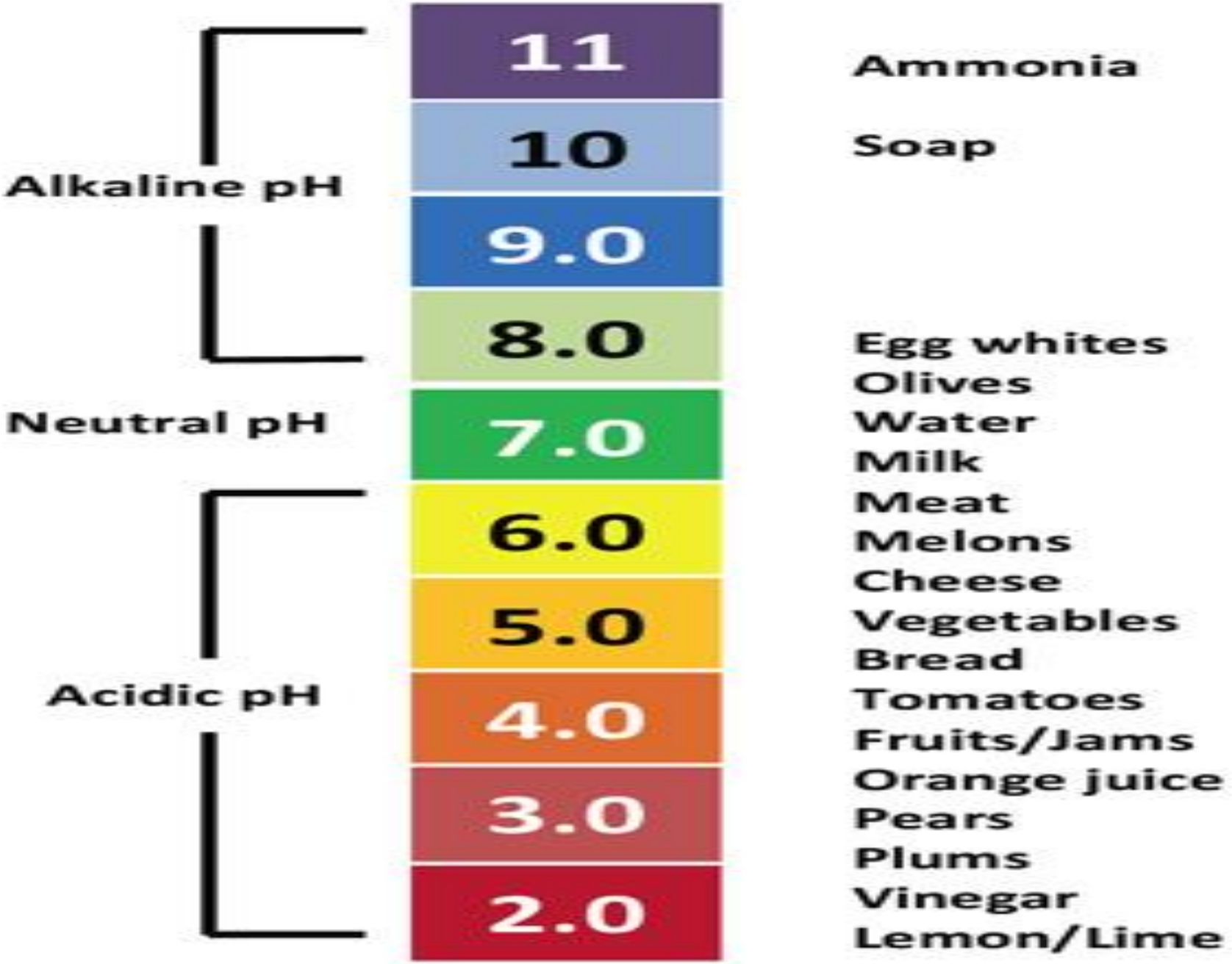
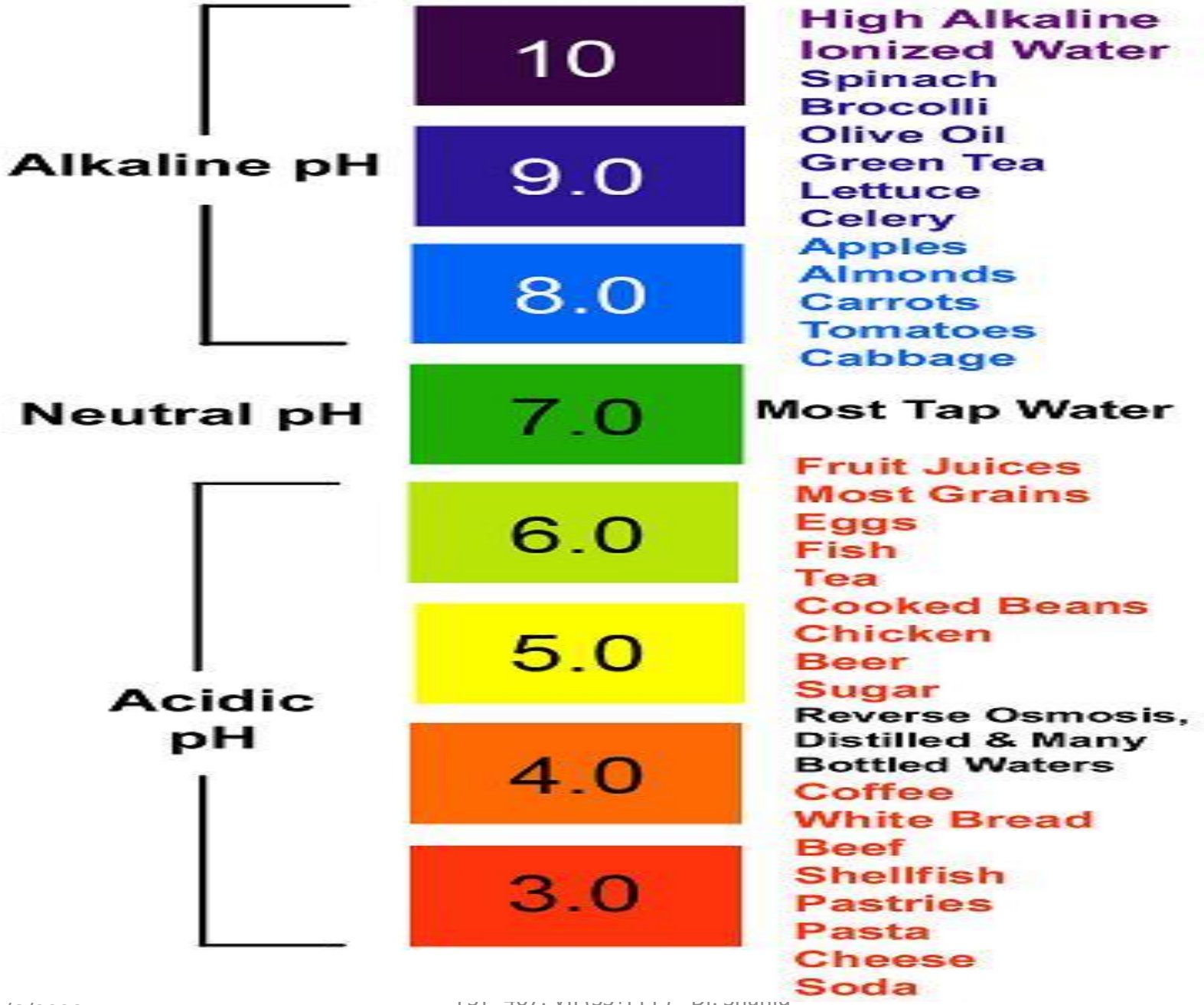
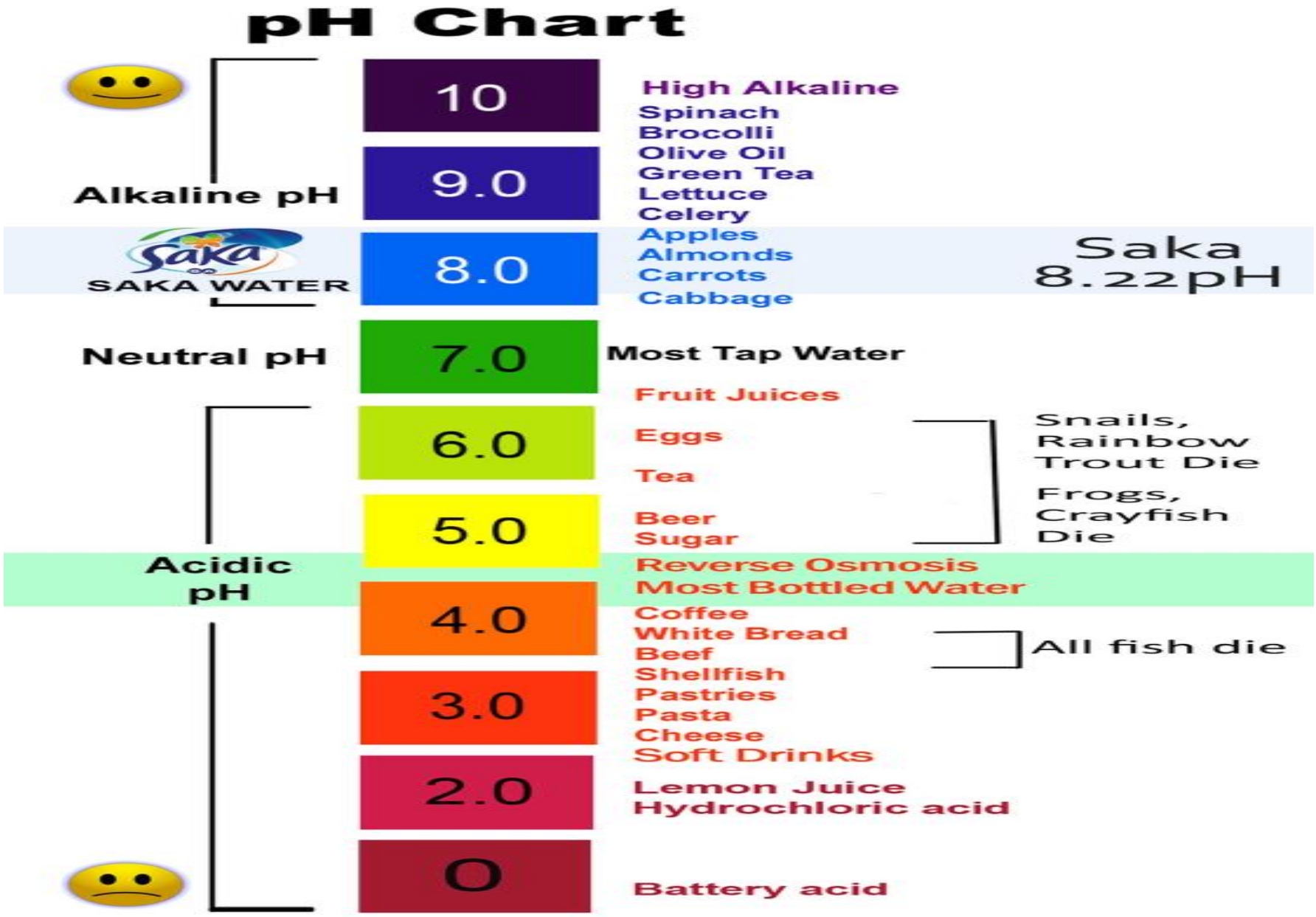


Figure 6-22 Brock Biology of Microorganisms 11/e


Alkaline pH
Neutral pH
Acidic pH
11
10
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
Ammonia
Soap
Egg whites
Olives
Water
Milk
Meat
Melons
Cheese
Vegetables
Bread
Tomatoes
Fruits/Jams
Orange juice
Pears
Plums
Vinegar
Lemon/Lime


Alkaline pH
10
9.0
8.0
High Alkaline Ionized Water
Spinach
Brocolli
Olive Oil
Green Tea
Lettuce
Celery
Apples
Almonds
Carrots
Tomatoes
Cabbage
Neutral pH
7.0
Most Tap Water
Acidic pH
6.0
5.0
4.0
3.0
Fruit Juices
Most Grains
Eggs
Fish
Tea
Cooked Beans
Chicken
Beer
Sugar
Reverse Osmosis, Distilled & Many Bottled Waters
Coffee
White Bread
Beef
Shellfish
Pastries
Pasta
Cheese
Soda


pH Chart
10
High Alkaline
Spinach
Brocolli
Olive Oil
Green Tea
Lettuce
Celery
9.0
Alkaline pH
SAKA WATER
8.0
Apples
Almonds
Carrots
Cabbage
Saka
8.22pH
Neutral pH
7.0
Most Tap Water
Fruit Juices
6.0
Eggs
Tea
Snails,
Rainbow
Trout Die
5.0
Beer
Sugar
Frogs,
Crayfish
Die
Acidic
pH
Reverse Osmosis
Most Bottled Water
4.0
Coffee
White Bread
Beef
All fish die
3.0
Shellfish
Pastries
Pasta
Cheese
Soft Drinks
2.0
Lemon Juice
Hydrochloric acid
0
Battery acid