Introduction to Public Health Microbiology

INTRODUCTION

- Microbiology is the science which includes the study of the occurrence and significance of bacteria, fungi, protozoa and algae which are the beginning and ending of intricate food chains upon which all life depends.
- These food chains begin wherever photosynthetic organisms can trap light energy and use it to synthesize large molecules from carbon dioxide, water and mineral salts forming the proteins, fats and carbohydrates which all other living creatures use for food.
- Within and on the bodies of all living creatures, as well as in soil and water, micro-organisms build up and change molecules, extracting energy and growth substances.
- They also help to control population levels of higher animals and plants by parasitism and pathogenicity.

Introduction.....

- When plants and animals die, their protective antimicrobial systems cease to function so that, sooner or later, decay begins liberating the smaller molecules for re-use by plants.
- Without human intervention, growth, death, decay and regrowth would form an intricate web of plants, animals and micro-organisms, varying with changes in climate and often showing apparently chaotic fluctuations in populations of individual species, but inherently balanced in numbers between producing, consuming and recycling groups.
- In the distant past, these cycles of growth and decay would have been little influenced by the small human population that could be supported by the hunting and gathering of food.

MICRO-ORGANISMS AND FOOD

- The foods that we eat are rarely sterile, they carry microbial associations whose composition depends upon which organisms gain access and how they grow, survive and interact in the food over time.
- The micro-organisms present will originate from the natural microflora of the raw material and those organisms introduced in the course of harvesting slaughter, processing, storage and distribution.
- The numerical balance between the various types will be determined by the properties of the food, its storage environment, properties of the organisms themselves and the effects of processing.
- In most cases this microflora has no discernible effect and the food is consumed without objection and with no adverse consequences.

MICRO-ORGANISMS AND FOOD…..

In some instances though, micro-organisms manifest their presence in one of several ways:

1. they can cause spoilage
2. they can cause food borne illness
3. they can transform a food's properties in a beneficial way – food fermentation.

Food Spoilage Preservation

- From the earliest times, storage of stable nuts and grains for winter provision is likely to have been a feature shared with many other animals but, with the advent of agriculture, the safe storage of surplus production assumed greater importance if seasonal growth patterns were to be used most effectively.
- Food preservation techniques based on sound, if then unknown, microbiological principles were developed empirically to arrest or retard the natural processes of decay.
- The staple foods for most parts of the world were the seeds - rice, wheat, sorghum, millet, maize, oats and barley - which would keep for one or two seasons if adequately dried, and it seems probable that most early methods of food preservation depended largely on water activity reduction in the form of solar drying, salting, storing in concentrated sugar solutions or smoking over a fire.

Food Spoilage Preservation….

- The industrial revolution which started in Britain in the late 18th century provided a new impetus to the development of food preservation techniques.
- It produced a massive growth of population in the new industrial centres which had somehow to be fed; a problem which many thought would never be solved satisfactorily.
- Such views were often based upon the work of the English cleric Thomas Malthus who in his ‘Essay on Population’ observed that the inevitable consequence of the exponential growth in population and the arithmetic growth in agricultural productivity would be over-population and mass starvation.

Food Spoilage Preservation…

- This in fact proved not to be the case as the 19th century saw the development of substantial food preservation industries based around the use of chilling, canning and freezing and the first large scale importation of foods from distant producers.
- To this day, we are not free from concerns about over-population.
- Globally there is sufficient food to feed the world’s current population estimated to be 6000 million in 1999.
- World grain production has more than managed to keep pace with the increasing population in recent years and the World Health Organization’s Food and Agriculture Panel consider that current and emerging capabilities for the production and preservation of food should ensure an adequate supply of safe and nutritious food up to and beyond the year 2010 when the world’spopulation is projected to rise to more than 7 billion.

Food Spoilage Preservation…

- There is however little room for complacency. Despite overall sufficiency, it is recognized that a large proportion of the population is malnourished.
- The principal cause of this is not insufficiency however, but poverty which leaves an estimated one-fifth of the world's population without the means to meet their daily needs.
- Any long-term solution to this must lie in improving the economic status of those in the poorest countries and this, in its train, is likely to bring a decrease in population growth rate similar to that seen in recent years in more affluent countries.
- In any event, the world's food supply will need to increase to keep pace with population growth and this has its own environmental and social costs in terms of the more intensive exploitation of land and sea resources.
- One way of mitigating this is to reduce the substantial preand post-harvest losses which occur, particularly in developing countries where the problems of food supply are often most acute.

Food Spoilage Preservation…

- It has been estimated that the average losses in cereals and legumes exceed 10% whereas with more perishable products such as starchy staples and vegetables the figure is more than 20% - increasing to an estimated 25%for highly perishable products such as fish.
- In absolute terms, the US National Academy of Sciences has estimated the losses in cereals and legumes in developing countries as 100 million tonnes, enough to feed 300 million people.
- Clearly reduction in such losses can make an important contribution to feeding the world’s population.
- While it is unrealistic to claim that food microbiology offers all the answers, the expertise of the food microbiologist can make an important contribution.
- In part, this will lie in helping to extend the application of current knowledge and techniques but there is also a recognized need for simple, low cost, effective methods for improving food storage and preservation in developing countries.
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Food Spoilage Preservation….

- Problems for the food microbiologist will not however disappear as a result of successful development programmes.
- Increasing wealth will lead to changes in patterns of food consumption and changing demands on the food industry.
- Income increases among the poor have been shown to lead to increased demand for the basic food staples while in the better-off it leads to increased demand for more perishable animal products.
- To supply an increasingly affluent and expanding urban population will require massive extension of a safe distribution network and will place great demands on the food microbiologist.

Food Spoilage Preservation….
-Current status

- Identification and control of new spoilage bacteria associated with the current changes in food processing and preservation methods
- Spoilage due to bacterial enzymes of frozen and refrigerated foods with extended shelf life
- Development of molecular methods (nanotechnology) to identify metabolites of spoilage bacteria and predict potential shelf life of foods
- Importance of environmental stress on the resistance of spoilage bacteria to antimicrobial preservatives

Food Safety

- In addition to its undoubted value, food has a long association with the transmission of disease.
- Regulations governing food hygiene can be found in numerous early sources such as the Old Testament, and the writings of Confucius, Hinduism and Islam.
- Such early writers had at best only a vague conception of the true causes of foodborne illness and many of their prescriptions probably had only a slight effect on its incidence.
- Even today, despite our increased knowledge, ‘ Foodborne disease is perhaps the most widespread health problem in the contemporary world and an important cause of reduced economic productivity.’(WHO 1992.)
- The available evidence clearly indicates that biological contaminants are the major cause.
- The various ways in which foods can transmit illness, the extent of the problem and the principal causative agents

FOODBORNE DISEASES

- Methods to detect emerging foodborne pathogenic bacteria from contaminated foods
- Application of molecular biology techniques including nanotechnology and biotechnology for rapid detection of pathogenic bacteria in food and environment
- Effective detection and control methods of foodbome pathogenic viruses.
- Transmission potentials of prion diseases from food animals to humans
- Importance of environmental stress on the detection and destruction of pathogens
- Factors associated with the increase in antibiotic-resistant pathogens in food
- Adherence of foodbome pathogens on food and equipment surfaces
- Mechanisms of pathogenicity of foodborne pathogens
- Effect of food or environment related stress on gene regulation and pathogenicity and survival
- Effective methods for epidemiology study of foodborne diseases
- Control of pathogenic parasites in food

Fermentation

- Microbes can however play a positive role in food.
- They can be consumed as foods in themselves as in the edible fungi, yeast, mycoprotein and algae.
- They can also effect desirable transformations in a food, changing its properties in a way that is beneficial.
- Development of strains with desirable metabolic activities by genetic transfer among

  strains.

Fermentation…. Current status

- Development of bacteriophage-resistant lactic acid bacteria
- Metabolic engineering of strains for overproduction of desirable metabolites
- Development of methods to use lactic acid bacteria to deliver immunity proteins
- Sequencing 'genomes of important lactic acid bacteria and bacteriophages for better understanding of their characteristics
- Food biopreservation with desirable bacteria and their antimicrobial metabolites
- Understanding of important characteristics of probiotic bacteria and development of desirable strains
- Effective methods to produce starter cultures for direct use in food processing

MICROBIOLOGICAL QUALITY ASSURANCE

- The food microbiologist's principal function is to help assure a supply of wholesome and safe food to the consumer.
- To do this requires the synthesis and systematic application of our knowledge of the microbial ecology of foods and the effects of processing to the practical problem of producing, economically and consistently, foods which have good keeping qualities and are safe to eat.

The role of food microbiologist

- Determine microbiological quality of foods and food ingredients by using appropriate techniques
- Determine microbial types involved in spoilage and health hazards and identify the sources
- Understand basic mechanism of pathogenesis of foodborne microbes
- Design corrective procedures to control the spoilage and pathogenic microorganisms in Food
- Learn rapid methods to isolate and identify pathogens and spoilage bacteria from food and environment

The role of food microbiologist….

- Identify how new technologies adapted in food processing can have specific microbiological problems and design methods to overcome the problem
- Design effective sanitation procedures to control spoilage and pathogen problems in foodprocessing Facilities
- Effectively use desirable microorganisms to produce fermented foods
- Design methods to produce better starter cultures for use in fermented foods and probiotics
- Know about food regulations (state, federal, and international)
- Understand microbiological problems of imported foods