Bacteria of public health importance in fish and fishery products

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What is public health?

As per Centre for Disease Control, Atlanta "Public health is the science of protecting and improving the health of people and their communities. This work is achieved by promoting healthy lifestyles, researching disease and injury prevention, and detecting, preventing and responding to infectious diseases. Overall, public health is concerned with protecting the health of entire populations. These populations can be as small as a local neighbourhood, or as big as an entire country or region of the world".

What is zoonoses?

As per World Health Organization, Geneva "A zoonosis is **an infectious disease that has jumped from a non-human animal to humans**. Zoonotic pathogens may be bacterial, viral or parasitic, or may involve unconventional agents and can spread to humans through direct contact or through food, water or the environment".

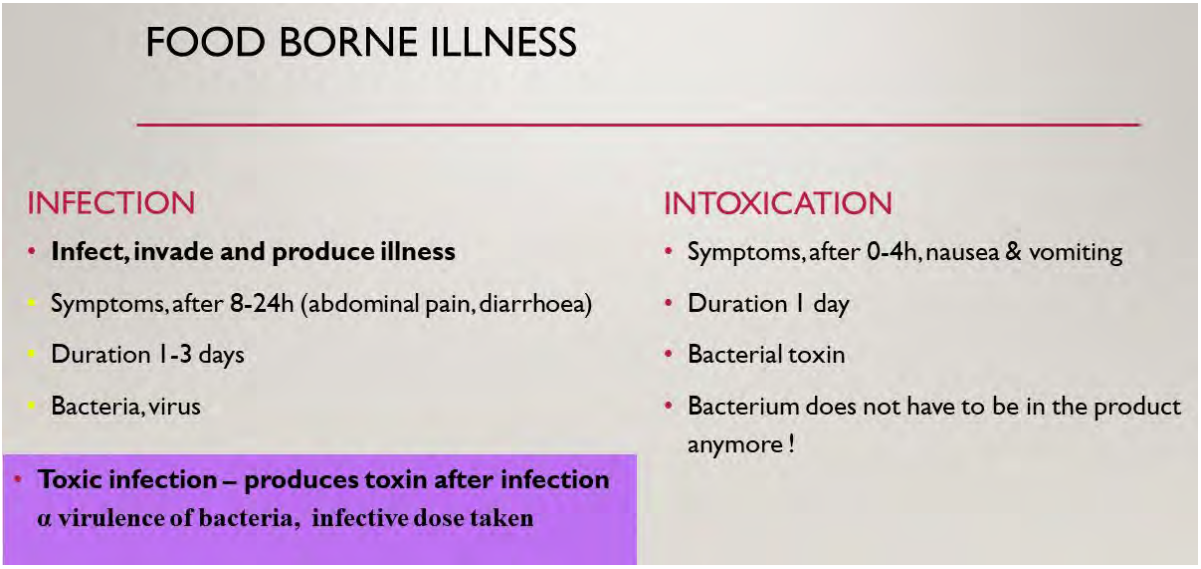
What is Zoonotic pathogen?

An infectious agent capable of spreading from animal to human or vice versa are called zoonotic pathogen. A zoonotic pathogen may be bacterial, viral or parasitic. It spreads from animals to human through direct contact or through food, water or the environment

What is foodborne pathogen and seafood borne pathogen?

Foodborne pathogens (viruses, bacteria, parasites) are **biological agents that can cause a foodborne illness event**. A foodborne disease outbreak is defined as the occurrence of two or more cases of similar illness resulting from the ingestion of a common food. Foodborne agents which are implicated through consumption of seafood (Fish and fishery products)

What is foodborne illness?



How the seafood borne pathogens enters the seafood production chain?

Living organisms that multiply frequently and spread rapidly and very tiny in nature that cannot be seen in naked eye are microorganisms or microbes. Majority of the organisms

are existing as beneficial flora in each and every niche and contributing to the basic biogeochemical cycle of the life. However, some of the microbes do exists as pathogenic to either human or animals including the fish/shellfish. Examples are Bacteria (e.g., *Staphylococcus aureus*, Streptococcus pneumoniae), viruses (e.g., Measles, Mumps), fungi (e.g., *Candida albicans*,), parasites (Coccidia etc) which are pathogenic to human.

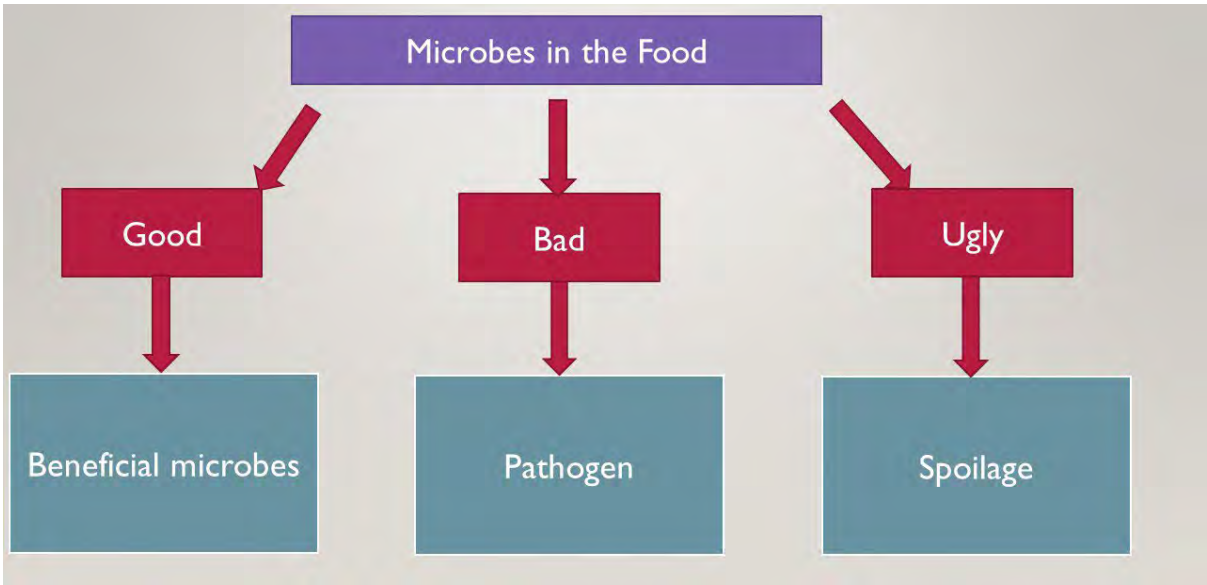


Figure. 1. Categorization of microbes associated with food

In general, to exception of commercially sterile and other pro, pre and synbiotics food products, food have the proximity of getting contaminated to various microbes during entire production and processing chain. The raw food in general has the highest culturable bacterial concentrations, followed by minimally and fully processed foods. Minimally or fully processed food including ready-to-eat food contamination depends on the level of sanitary hygiene followed during the processing and preservation steps.

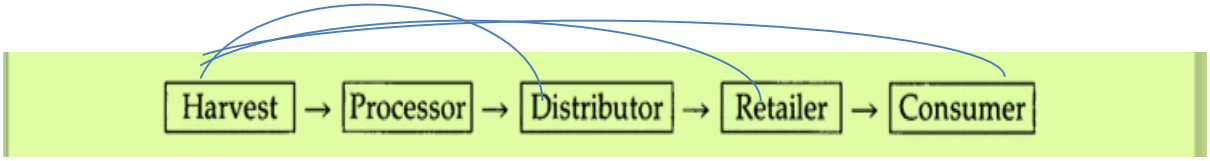


Fig.2. Steps contributes to the entry of microbes in the seafood chain

The food with acceptable microbiological quality range may also serve as the sink for the development of antibiotic resistances through bacteria, bacteriophages, bacterial DNA and mobile genetic elements, some of which may include AMR genes. Hence, the food chain ecosystem may be conducive niches for gene transfer, selection and persistence of AMR bacteria and this route cannot be generally disregarded. In the typical seafood production chain, the fish which are harvested has many distributions step viz., harvest to consumer, harvest to processor, harvest to retailers, harvest to distributors and retailers (Fig.2.). The more the number of handling steps, the more the probability of microbes being contaminated into the food production chain.

In the seafood production chain, the food fish gets harvested either from aquaculture farms or from capture fisheries activities. The harvested food fish gets transported to retail market, hypermarket, or unorganized retail vendors. The harvested food fish may be taken to the fish processing factories within their state or to the neighbouring state and get processed for domestic or export purposes. The major contributing factors which results in the contamination of pathogens in to the seafood are water and ice. In order to break the chain of contamination of these microbial pathogens into the seafood production and distribution channel, the places mentioned in the figure.2 has to be implemented.

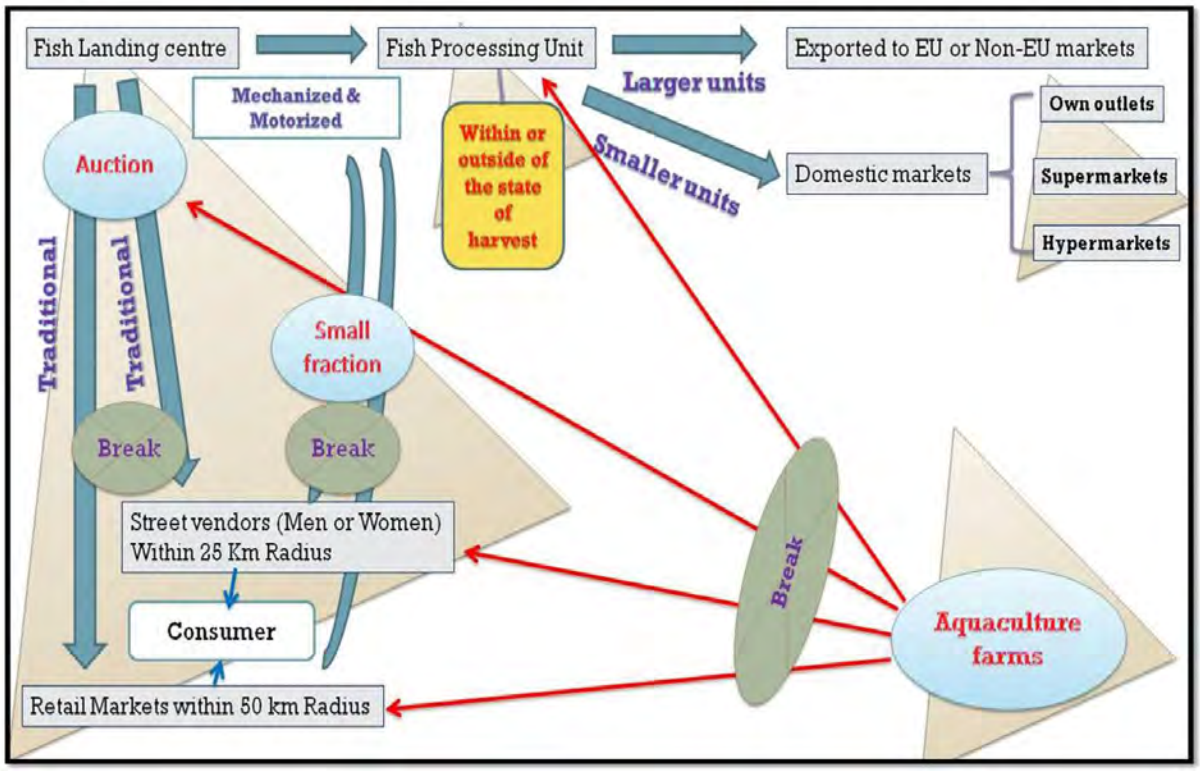


Fig. 3. Typical seafood production and distribution chain with major break point places for preventing contamination of microbial pathogens.

The seafood meant for human consumption either for domestic market or for exports has to be ascertained for predefined quality. In India, the seafood or fish/fishery products meant for domestic consumption is regulated by Food Safety and Standards Authority of India (FSSAI) and seafood meant for export purpose is handled by Export inspection council (EIC).

The end product (fish and fishery products) has to be examined for the absence of hazards. “Hazard in food is defined as anything that could contaminate food and cause illness or injury, or could otherwise violate established food safety program criteria if left uncontrolled”. Hazard in the food is classified into three categories viz., physical, chemical and biological. A physical hazard is any foreign matter unintentionally introduced to food or a naturally occurring object which could cause illness or injury to the person consuming the food item. Natural and manufactured chemicals can cause people to become sick if they have contaminated food at the source or during processing. Chemical hazards can be divided into

two categories: chemical agents and toxic metals. While physical and chemical hazards have potential to cause foodborne illness, the majority of foodborne illnesses result from biological hazards such as bacteria, viruses, and parasites (referred to collectively as pathogens). CDC has identified 31 different pathogens known to cause foodborne illness.

These hazardous microbes are classified once again as severe hazards, moderate hazardous with limited spread and moderately hazardous with extreme spread.

BACTERIAL PATHOGENS OF PUBLIC HEALTH IMPORTANCE – FISH AND FISHERY PRODUCTS

- *Aeromanas spp.*
- Bacterial toxins (*B. cereus*)
- Bacterial toxins (*S. aureus*)
- *Clostridium botulinum*
- Enteroaggerative *E. coli* (EAggEC)
- Entero-pathogenic *E. coli* (EPEC)
- Entero-toxigenic *E.coli* (ETEC)
- Listeria monocytogenes
- Non cholera Vibrios
- Salmonella (non-typhoidal) sp.
- Salmonella (typhoidal) sp.
- Shiga-toxin producing E. coli (STEC)
- Shigella sp.
- Vibrio cholerae 01/0139
- Yersinia sp.

Severe	Moderate hazard: extreme spread	Moderate hazard: Limited spread
• *Clostridium botulinum* types A, B, E, and F	• *Listeria monocytogenes*	• *Bacillus cereus*
• *Shigella dysenteriae*	• *Salmonella* spp.	• *Campylobacter jejuni*
• *Salmonella* Typhi; Paratyphi A, B	• *Shigella* spp.	• *Clostridium peifringens*
• Hepatitis A and E	• Diarrheagenic *Escherichia coli*	• *Staphylococcus aureus*
• *Brucella abortis; B. suis*	• *Streptococcus pyogenes*	• *Vibrio cholerae, non-O 1*
• *Vibrio cholerae* 01	• Rotavirus	• *Vibrio parahaemolyticus*
• *Vibrio vulnificus*	• Norwalk virus group	• *Yersinia enterocolitica*
• *Taenia solium*	• *Entamoeba histolytica*	• *Giardia lamblia*
• *Trichinella spiralis*	• *Diphyllobothrium latum*	• *Taenia saginata*
	• *Ascaris lumbricoides*	
	• *Cryptosporidium parvum*	

Seafood associated foodborne pathogens

- *Salmonella*
- *Yersinia* spp.
- *C. Botulinum*
- *S. aureus*
- *L. monocytogenes*
- ***Vibrio* spp. (*V. cholerae, V. vulnificus, and V. parahemolyticus*)**
- *Aeromonas* sp
- *Campylobacter* sp
- *Bacillus cereus*

Examples of severe hazard are *Clostridium botulinum* types A, B, E, and F, *Shigella dysenteriae, Salmonella* Typhi, *Salmonella* Paratyphi A, B, Hepatitis A and E, *Brucella abortis; B. suis, Vibrio cholerae* 01, *Vibrio vulnificus*, *Taenia solium* and *Trichinella spiralis*. Among these severe hazards, the *Clostridium botulinum* types A, B, E, and F, *Shigella dysenteriae, Salmonella* Typhi, *Salmonella* Paratyphi A, B, Hepatitis A and E, *Vibrio cholerae* 01, *Vibrio vulnificus* are relevant to seafood.

Examples of moderate hazards with extreme spread are *Listeria monocytogenes, Salmonella* spp., *Shigella* spp., Diarrheagenic *Escherichia coli, Streptococcus pyogenes,* Rotavirus, Norwalk virus group, *Entamoeba histolytica, Diphyllobothrium latum, Ascaris lumbricoides,* and *Cryptosporidium parvum*. Among these moderate hazards, *Listeria monocytogenes, Salmonella* spp., *Shigella* spp., Diarrheagenic *Escherichia coli, Diphyllobothrium latum* are very relevant to the seafood.

Examples of moderate hazards with limited spread are *Bacillus cereus, Campylobacter jejuni, Clostridium perfringens, Staphylococcus aureus, Vibrio cholerae, non-O 1, Vibrio parahaemolyticus, Yersinia enterocolitica, Giardia lamblia* and *Taenia saginata*. Among these, *Bacillus cereus, Campylobacter jejuni, Clostridium perfringens, Staphylococcus aureus, Vibrio cholerae, non-O 1, Vibrio parahaemolyticus,* and *Yersinia enterocolitica* are very relevant to the seafood industry.

For the seafood industry, the pathogens such as *Salmonella* sp. *Yersinia* spp., *C. Botulinum, S. aureus, L. monocytogenes, Vibrio* spp. (*V. cholerae, V. vulnificus, and V. parahemolyticus*), *Aeromonas* sp, *Campylobacter* sp and *Bacillus cereus* are very important. Few of the pathogens are emerging in nature and few are endemic to the seafood production system and others are reemerging in nature.

Examination of the biological hazards in the seafood

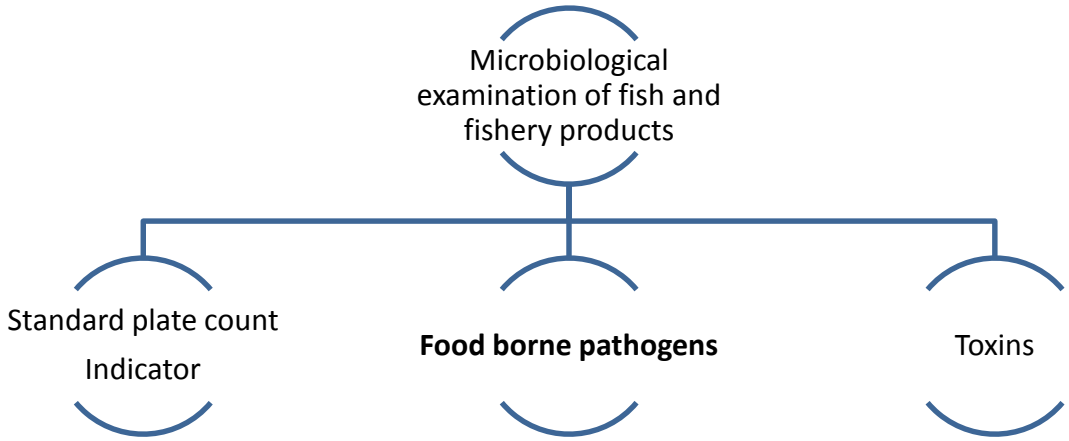


Fig. 4. Microbiological examination of seafood

Microbiological examination of seafood can be categorized into examination for indicator organisms, examination for the pathogens and or its toxins (Fig. 3).

Microbiological examination of seafood has few important steps (Fig. 4)

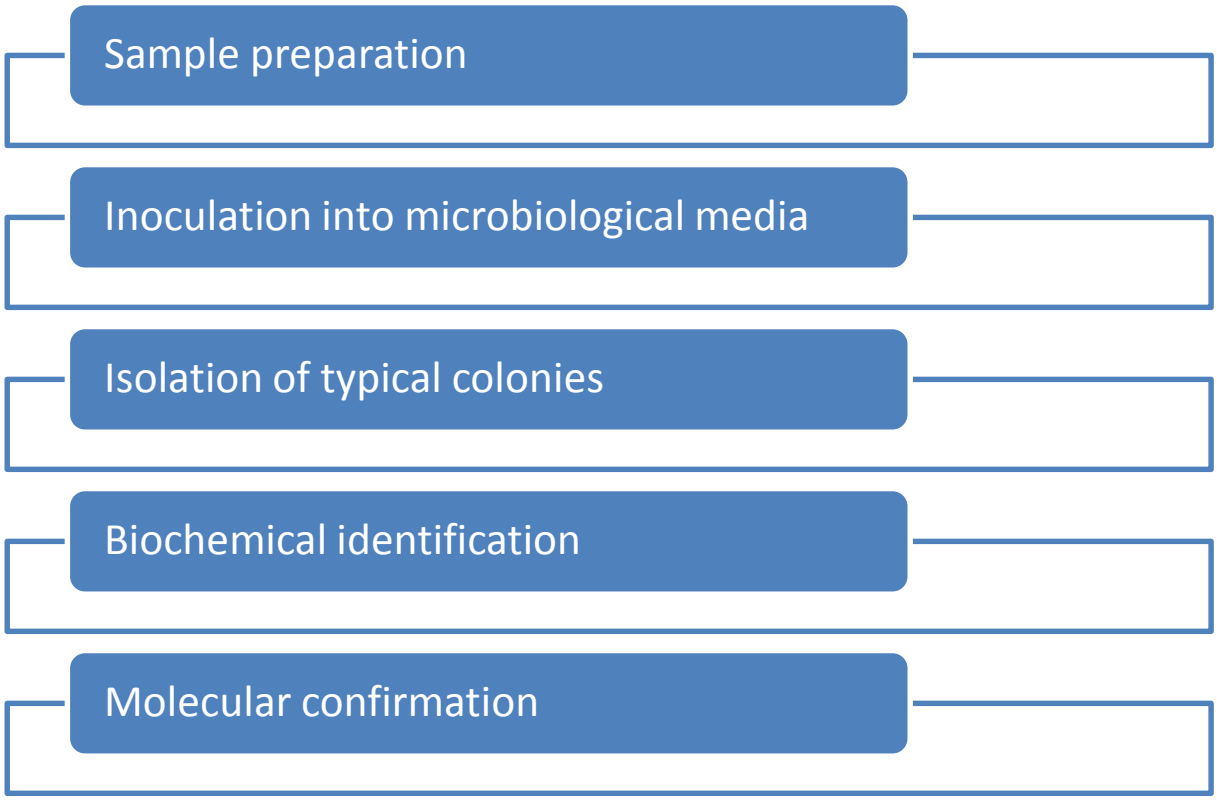


Fig. 5. Basic steps involved in the microbiological examination of seafood

For the microbiological examination of seafood, the laboratory should have these facilities. Sample receiving room, Sample processing room, Media preparation room, Media sterilization room, Inoculation room, Incubation room, Identification room, Decontamination and washing room.

Instrumentation required for setting up of microbiological testing facility for food includes Incubators / refrigerated / Co2/ BOD, Hot air oven, Autoclaves, Homogenizer / Stomacher / Mixer, Colony counter, Water bath, weighing balance, Thermal cycler including gradient, Gel electrophoresis system, Gel documentation system, Biosafety cabinet, Refrigerator centrifuges, Refrigerated shaker incubator and Microscope. A typical work flow in any standard microbiological laboratory is presented in Figure 5.

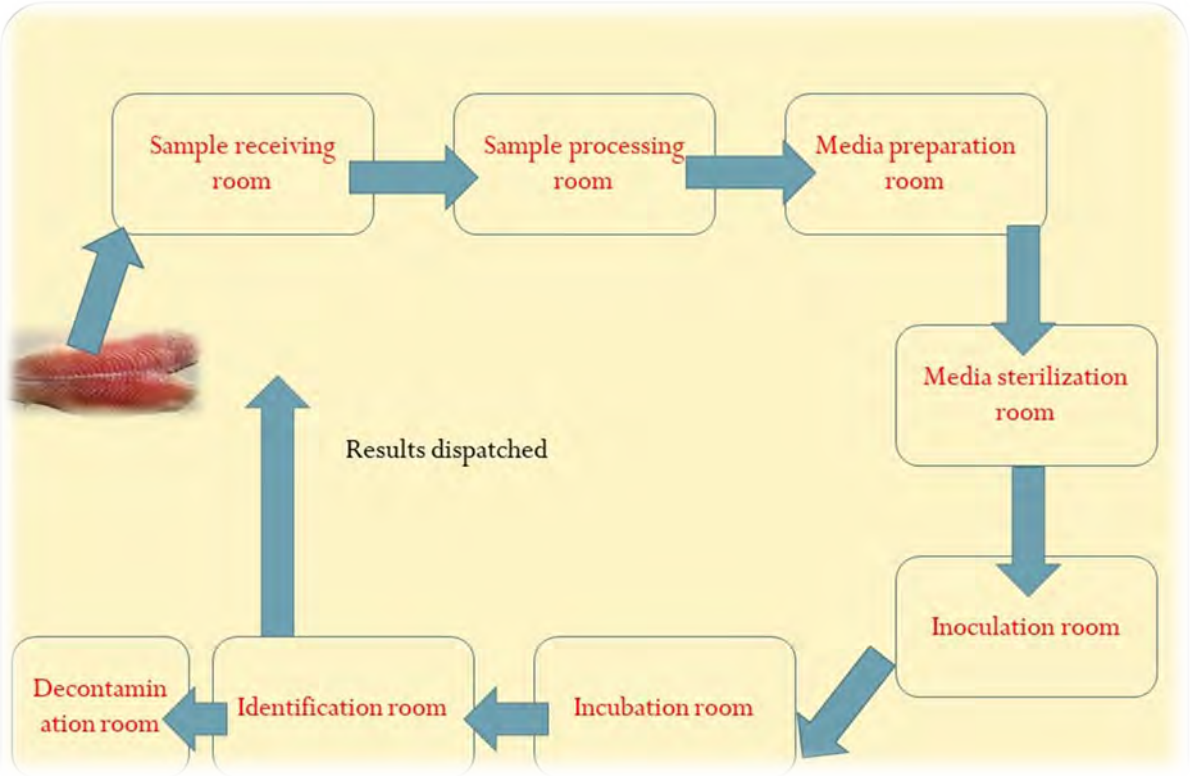
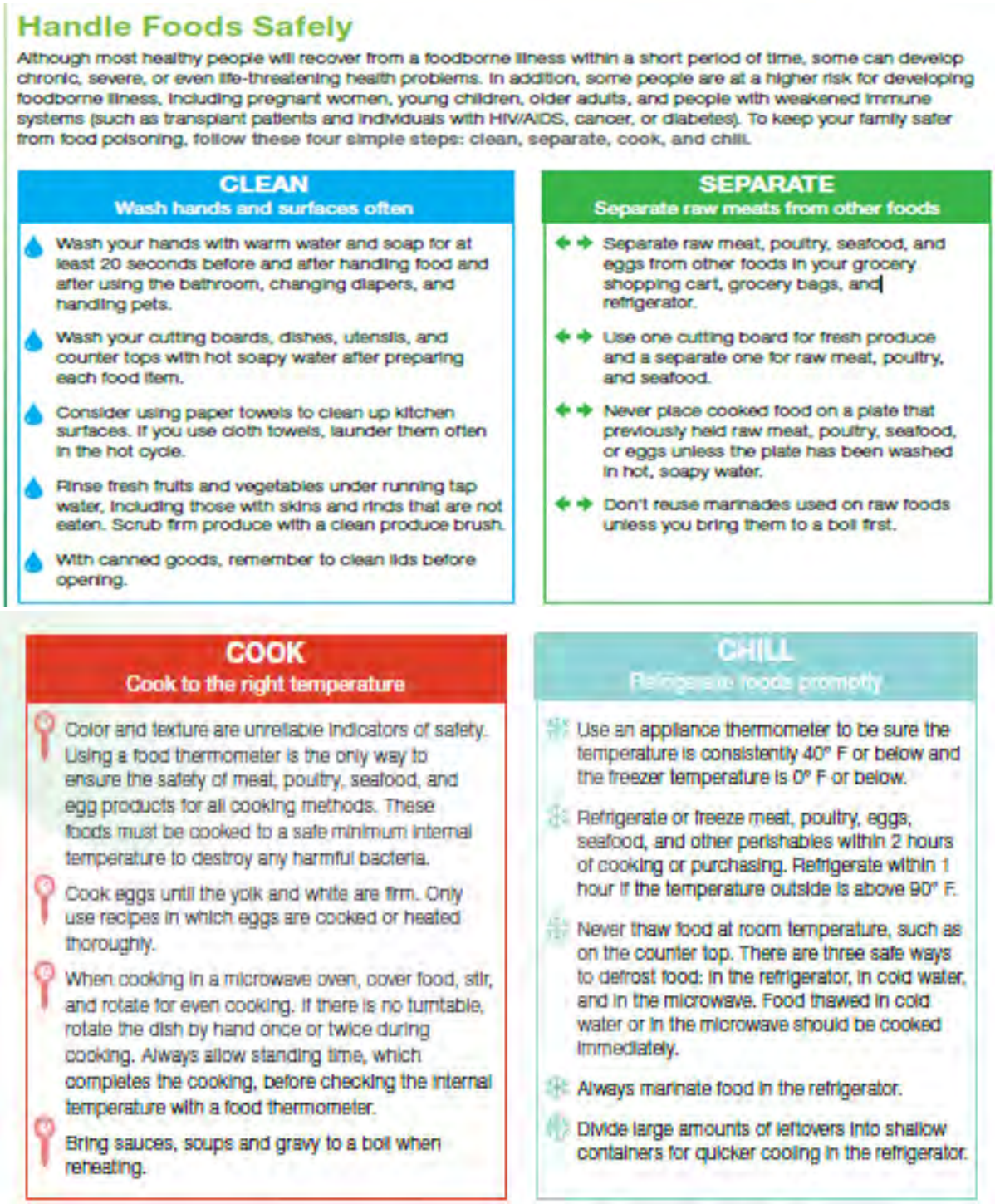


Fig. 6. Typical work flow and rooms involved in the microbiological testing.

For the microbiological examination of seafood (fish and fishery products) the laboratory should follow the exporting or importing countries guidelines viz., FSSAI – India, BAM – USA, ISO guidelines – EU countries and other based on the country's regulatory requirements.

To conclude, Fish and fishery products are most traded commodities across globe, For sustainability – Quality of food has to be maintained, Hazards – Biological hazards has to be controlled, Places where the biological hazard entry can be prevented should be defined in the seafood production system, Layout of microbiology laboratory and instrumentation involved in the testing varies based on the laboratory requirements, and the Guidelines sorting for each matrix testing is highly essential for the laboratory involved in the testing.

Basic control measures for the foodborne diseases?



Handle Foods Safely

Although most healthy people will recover from a foodborne illness within a short period of time, some can develop chronic, severe, or even life-threatening health problems. In addition, some people are at a higher risk for developing foodborne illness, including pregnant women, young children, older adults, and people with weakened immune systems (such as transplant patients and individuals with HIV/AIDS, cancer, or diabetes). To keep your family safer from food poisoning, follow these four simple steps: clean, separate, cook, and chill.

CLEAN
Wash hands and surfaces often

- Wash your hands with warm water and soap for at least 20 seconds before and after handling food and after using the bathroom, changing diapers, and handling pets.
- Wash your cutting boards, dishes, utensils, and counter tops with hot soapy water after preparing each food item.
- Consider using paper towels to clean up kitchen surfaces. If you use cloth towels, launder them often in the hot cycle.
- Rinse fresh fruits and vegetables under running tap water, including those with skins and rinds that are not eaten. Scrub firm produce with a clean produce brush.
- With canned goods, remember to clean lids before opening.

SEPARATE
Separate raw meats from other foods

- Separate raw meat, poultry, seafood, and eggs from other foods in your grocery shopping cart, grocery bags, and refrigerator.
- Use one cutting board for fresh produce and a separate one for raw meat, poultry, and seafood.
- Never place cooked food on a plate that previously held raw meat, poultry, seafood, or eggs unless the plate has been washed in hot, soapy water.
- Don't reuse marinades used on raw foods unless you bring them to a boil first.

COOK
Cook to the right temperature

- Color and texture are unreliable indicators of safety. Using a food thermometer is the only way to ensure the safety of meat, poultry, seafood, and egg products for all cooking methods. These foods must be cooked to a safe minimum internal temperature to destroy any harmful bacteria.
- Cook eggs until the yolk and white are firm. Only use recipes in which eggs are cooked or heated thoroughly.
- When cooking in a microwave oven, cover food, stir, and rotate for even cooking. If there is no turntable, rotate the dish by hand once or twice during cooking. Always allow standing time, which completes the cooking, before checking the internal temperature with a food thermometer.
- Bring sauces, soups and gravy to a boil when reheating.

CHILL
Refrigerate foods promptly

- Use an appliance thermometer to be sure the temperature is consistently 40° F or below and the freezer temperature is 0° F or below.
- Refrigerate or freeze meat, poultry, eggs, seafood, and other perishables within 2 hours of cooking or purchasing. Refrigerate within 1 hour if the temperature outside is above 90° F.
- Never thaw food at room temperature, such as on the counter top. There are three safe ways to defrost food: in the refrigerator, in cold water, and in the microwave. Food thawed in cold water or in the microwave should be cooked immediately.
- Always marinate food in the refrigerator.
- Divide large amounts of leftovers into shallow containers for quicker cooling in the refrigerator.

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