

Understanding the Microworld



Learn the behavior.

Understand the control.

A food can be cold enough yet carry a virus. It can be cooked correctly yet need careful cooling. It can look fresh yet contain a toxin. This chapter explains those differences so you can choose a control for the actual hazard.

Your Chapter 2 map	Where to review
Organisms, contamination and symptoms	Page 2
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Study sequence: Watch the lesson, use this guide to clarify the concepts, then take the separate interactive quiz. The quiz explains all answer choices and directs you to the relevant lesson slides and guide pages.

Authority baseline: Corrected FDA Food Code 2022 plus its December 2024 Supplement. The Code is a model for adoption; local requirements govern operations. Public-health guidance and restaurant examples are identified separately.

FOUNDATIONS / LESSON SLIDES 3-6, 22

Identify what can cause harm

Term	Meaning and consequence
Microorganism	A microscopic organism. Many are harmless or useful; the word does not mean every one is a pathogen.
Pathogen	A disease-causing agent. Many bacteria can grow in food; viruses need living host cells to reproduce.
Toxin	A harmful substance, not an organism. Some preformed toxins remain harmful after the producing cells are killed.

Contamination is a route, not a temperature

Hands, raw food, unsafe water, pests, utensils and surfaces can carry contamination. If a raw-poultry utensil touches cooked food, the successful earlier cooking step does not protect against that later transfer. Separate tasks and use the required cleaning, sanitizing and handling controls.

Cold salad example

A salad at 38 F meets the ordinary cold-holding limit but can still carry norovirus transferred by an ill worker. **Discard that contaminated salad.** Cold holding does not remove the virus. Then correct the employee-health and handling failures, including handwashing, ready-to-eat protection and effective cleanup, to prevent another exposure.

Symptoms do not identify the cause

Diarrhea, vomiting, nausea, cramps and fever can have many causes. **Jaundice** means yellow skin or whites of the eyes; it is a memorable hepatitis A association and an important employee report, not a diagnosis made by a manager. Symptoms and diagnoses have separate reporting implications.

Apply the known rule: an employee with vomiting or diarrhea, without an established noninfectious cause, must be excluded. A diagnosis is not needed before applying that symptom rule. Chapter 4 covers the detailed work-status and return requirements.

GROWTH / LESSON SLIDES 7-10

FATTOM explains growth conditions

FATTOM means **Food, Acidity, Time, Temperature, Oxygen, Moisture**. It is a memory aid, not the complete FDA product-classification method. Organisms differ in what they need and tolerate.

Factor	What it means	Do not confuse it with
Food	Nutrients usable by microorganisms. Protein-rich foods are common examples, but cooked rice and beans can also support growth.	An animal-food-only rule.
Acidity	pH describes acidity. 7 is neutral ; lower values mean more acidity. Many pathogens favor less-acidic foods.	A sour taste proving safety.
Moisture	Water activity (aw) measures available water on a 0-to-1 scale. Nearer 1 means more available water.	The exact percentage of water or how wet food looks.

Use the anchors without inventing a rule

A pH number alone is not the complete TCS test. Organisms have different limits, and some survive acidic conditions. The Code TCS definition considers pH, aw, processing and the stated product conditions together. Do not classify a recipe from a broad growth-range shortcut or sour taste.

Two comparisons

Cooked rice can be TCS even without animal protein. A product with aw 0.98 has more available water than an otherwise comparable product at 0.70, but those numbers alone do not establish the whole product's safety.

Daily control: restaurants usually control **time and temperature** most directly. A little lemon juice or an improvised amount of salt does not establish a validated shelf-stable formulation.

GROWTH / LESSON SLIDES 9-11

Control conditions, not guesses

Ordinary TCS holding	Endpoint
Cold holding	41 F or below (5 C)
Hot holding	135 F or above (57 C)

The range between these limits is commonly called the temperature danger zone. Many bacteria grow especially quickly in warmer conditions, often taught as roughly **70-125 F** (21-52 C). That narrower study range is not a holding standard or a universal growth boundary. Some pathogens can grow at refrigeration temperatures.

Growth stage	Meaning
Lag	Cells adjust to their environment.
Log / exponential	Population increases rapidly under favorable conditions.
Stationary	New cells and dying cells roughly balance.
Death / decline	Viable cells decrease; toxins or other hazards may remain.

You cannot look at a pan and know its growth phase. The lag stage is not permission to leave it out. Returning food to the cooler does not erase previous time under unsafe conditions. Apply the actual preparation, cooling, holding or written time-control rule.

Oxygen is not an on/off safety switch

Aerobic: needs oxygen. **Anaerobic:** can grow without it. **Facultative:** can grow with or without it. A vacuum seal reduces oxygen but does not remove water, nutrients or all pathogens. It does not automatically authorize a longer shelf life.

SURVIVAL / LESSON SLIDES 12-13, 29

Why reheating is not a reset button

Form	Meaning	Control implication
Vegetative cell	An active bacterial form.	Correct cooking destroys many vegetative pathogens.
Spore	A resistant survival form made by certain bacteria.	May survive cooking and later germinate when conditions permit.
Toxin	A harmful substance.	Some toxins formed before service withstand ordinary reheating.

Not every bacterium forms spores, and not every toxin is heat stable. **Bacillus cereus** helps explain cooked-rice risk: spores may survive cooking, and abuse can allow growth and formation of the heat-stable vomiting-type toxin.

Worked cooling decision

Rice begins cooling at 135 F. At eight hours it is still 54 F. This misses the final cooling limit: **135 F to 70 F within 2 hours; 135 F to 41 F or below within 6 hours total**. Discard this failed batch and correct the next batch's process. It is not two hours plus six more.

A short recognition map

C. perfringens: bulk meat or gravy and slow cooling.

C. botulinum: reduced oxygen and process failures; never taste suspect food.

Listeria: can grow in refrigeration; applicable date marking and sanitation still matter.

S. aureus: contamination from people or wounds plus growth can lead to heat-stable toxin.

Campylobacter: raw poultry or unpasteurized milk; cooking and preventing transfer matter.

EMPLOYEE HEALTH / LESSON SLIDES 14-17

The Big Six: two viruses

The Big Six is a training nickname for the six pathogens named in Code employee-health provisions.

Viruses: norovirus and hepatitis A. **Bacteria:** Shigella species, STEC, Salmonella Typhi and nontyphoidal Salmonella. A diagnosed infection must be reported; the six do not all share one work-status rule.

Compare	Norovirus	Hepatitis A
Food behavior	Does not multiply in food.	Does not multiply in food.
Common clues	Vomiting, watery diarrhea, nausea and stomach pain.	Fatigue, nausea, abdominal pain; dark urine, pale stools or jaundice may appear later.
Transmission	Very small amounts of feces or vomit can contaminate hands, food, water and surfaces.	Fecal-oral spread from infected people through food or water; shellfish from contaminated water can be a vehicle.
Prevention	Employee health, soap-and-water handwashing, ready-to-eat protection and appropriate incident cleanup.	Employee reporting and work-status controls, handwashing, ready-to-eat protection and safe sources.

Do not substitute one control for another

Hand sanitizer does not replace soap-and-water handwashing for norovirus prevention. Gloves do not replace required illness exclusion. **Discard a salad contaminated by an ill worker.** Cold holding does not remove either virus, and better handling later does not make that salad usable.

Use the written vomiting/diarrhea cleanup procedure and an appropriate effective product according to its label. Routine food-contact sanitizing is not automatically sufficient incident disinfection. Hepatitis A vaccination is public-health prevention, not a universal vaccination requirement in the model Food Code.

RECOGNITION / LESSON SLIDES 18-22

The Big Six: four bacteria

Pathogen	Source or food clues	Illness associations
STEC Shiga toxin-producing Escherichia coli	Ruminant animals; raw or undercooked ground beef; contaminated produce or water.	Severe cramps; diarrhea that can become bloody; possible kidney injury.
Nontyphoidal Salmonella NTS	Animals and people; poultry, eggs, produce and other foods.	Salmonellosis: diarrhea, fever and abdominal cramps.
Salmonella Typhi	Human reservoir; food or beverages contaminated by an infected person or carrier.	Typhoid fever: prolonged high fever, weakness, headache and abdominal symptoms.
Shigella species	Primarily infected people; fecal contamination of prepared foods or water. Flies can transfer contamination.	Diarrhea that may be bloody, cramps and sometimes fever.

Important differences

STEC is not every E. coli. Learn the full name.

Typhi is not NTS. Similar names do not make the source, illness or work-status requirements identical.

Symptoms overlap. Bloody diarrhea is not unique proof of a particular pathogen.

Apply the reportable condition

An employee reports diarrhea before food work and has no established noninfectious cause.

Exclusion is required before anyone identifies a pathogen. Moving the worker to another food station or adding gloves does not replace that rule.

When an employee reports a **Shigella diagnosis**, the PIC must notify the regulatory authority; do not wait for a guest illness report.

Match prevention to the route: safe sources, required cooking, prevention of transfer, hygiene and employee-health controls. Food lists above are useful associations, not exclusive lists.

Parasites and the fish package

Parasites depend on hosts and can reach people through animals, fish, produce or water. **Anisakis** is a parasite associated with raw or undercooked marine fish or squid. It is not histamine or ciguatera toxin.

Fish decision	What must be established
Fish will be cooked	Use the applicable cooking process and safe source.
Raw or undercooked fish requires parasite destruction	Verify the specified freezing temperature-and-time process and records. A product covered by a stated exemption is a different case.
Supplier says it was frozen once	That statement alone does not prove the required parasite-destruction schedule.
Fish is currently held cold	Cold holding does not establish parasite destruction.

Reduced-oxygen packaging: ROP

Vacuum packaging is one type of ROP. It reduces oxygen, not every hazard. Some bacteria can grow without oxygen, so required packaging-process and refrigeration controls still apply.

Keep-frozen-labeled fish

For ROP fish labeled to remain frozen until use, remove it from the reduced-oxygen environment **before refrigerator thawing**. Under the running-water provision, removal is before or immediately when thawing ends, with that method's other conditions still applying.

Still frozen versus already thawed: the lesson example allows correction before refrigerator thawing begins. If fish has already thawed sealed, stop use and evaluate its time-temperature history and disposition. Opening the bag later is not a rescue step. Full thawing and parasite-destruction details return in Chapter 8.

OTHER HAZARDS / LESSON SLIDES 25-28

Fungi and naturally occurring toxins

Hazard or group	Recognition and control
Yeasts	Fungi that may spoil acidic or sugary foods. Gas, fermentation or off odors can be clues. Some yeasts are intentionally used in food production.
Molds	Fungi; some produce mycotoxins. Unexpected mold in soft food such as yogurt calls for discard, not scraping or tasting. Intentional mold-ripened foods are a different case.
Histamine / scombrototoxin	Susceptible fish such as tuna plus temperature abuse. Formed histamine is not removed by ordinary cooking, freezing or washing.
Ciguatera	Certain tropical reef fish and marine-food-chain toxin. Tingling or altered hot-cold sensation can be clues. Species and harvest-source controls matter.
Algal shellfish toxins	Shellfish accumulate toxins from harmful algae. Use required source and harvest controls and records; normal cooking is not the safety control.
Wild mushrooms / plants	Some contain dangerous natural toxins. Wild-picked mushrooms require establishment approval unless a stated Code exception applies. Identification alone does not replace approval. Never taste unknown mushrooms.

Receiving example

Fresh tuna arrives at 50 F with an unknown warm history. Reject it. Ordinary fresh refrigerated fish is received at 41 F or below, and cooking cannot remove histamine already formed. A recent date and a normal smell are not proof of safe history.

Not all fungi are pathogens, and not all naturally occurring substances are safe. A parasite-control process is not a general marine-toxin removal process.

REASONING / LESSON SLIDES 30-32

Read for the controlling condition

This is a study method, not an additional Food Code requirement. Before selecting an answer, identify what the question has actually established.

Read for	Use the distinction
Hazard	Organism, spore or toxin? A kill step is not necessarily toxin removal.
Food condition	Raw, cooked, ready-to-eat, frozen, thawing or held? The state changes the decision.
Stage and timing	Receiving, cooling, holding or handling? A correct earlier step does not cancel a later failure.
Required control	Source, growth control, cooking, parasite destruction, employee health, preventing transfer or discarding affected food? Match the stated problem.

Carry these conclusions forward

FATTOM: six growth factors; time and temperature are the most direct daily controls.

Viruses: food can carry them without viral growth. Discard worker-contaminated food.

Big Six: learn the names; do not invent one work-status rule for all six.

Spores and toxins: ordinary reheating is not a universal rescue.

Seafood: parasite destruction, histamine prevention and harvest-source controls are different decisions.

After a missed quiz item

Read all four choice explanations. Identify the missed condition, return to the referenced slide or guide page, and explain the correct reason without looking at the choices. Then retry. A practice score is feedback, not a certification result or a guarantee of passing.

Next chapter: contamination, allergens and food defense. These topics use the same habit: identify the route of exposure and the control that interrupts it.

REFERENCES / CHAPTER 02

Sources and authority map

Technical baseline: **corrected FDA Food Code 2022 plus December 2024 Supplement**. Source review: September 22, 2026. The Food Code is a model, not automatically the law in every jurisdiction. Public-health explanations and restaurant implementation examples are not extra universal mandates.

FDA Food Code 2022, corrected print edition

Definitions/TCS: 1-201.10. Employee health: 2-201.11-.13. Hands and cleanup: 2-301; 2-501.11. Sources and wild mushrooms: 3-201.11/.16. Receiving: 3-202.11. Parasites: 3-402.11-.12. Thawing: 3-501.13(E). Cooling/holding: 3-501.14-.16. Date marking: 3-501.17. ROP: 3-502.12. Disposition: 3-701.11. Organism rationale: Annex 3. Hazard framework: Annex 4.

December 2024 Supplement

Read with the declared Code baseline. Not every section summarized here was changed by the Supplement.

FDA Bad Bug Book, Second Edition

Organism behavior, symptoms and associations: the listed bacterial and viral chapters; Anisakis; seafood, mushroom and other natural toxins. General guidance, not a diagnostic manual.

FDA Fish and Fishery Products Hazards and Controls Guidance

Parasites, natural toxins, scombrototoxin and reduced-oxygen hazards. Industry guidance informs the explanations; retail decisions use the applicable Code provisions.

CDC: Norovirus Prevention

Soap-and-water handwashing, contamination prevention and effective cleanup. Do not replace Code work-status details with a generic illness timeline.

CDC: Hepatitis A Basics

Transmission, liver involvement, symptoms and vaccination as public-health prevention.

USDA: Introduction to the Microbiology of Food Processing

Growth conditions, stages, acidity, available water and fungi. Scientific teaching background, not a restaurant holding rule.

USDA: Molds on Food

Unintended mold, possible toxins, the yogurt/soft-food discard example and the distinction from intentional mold-ripened foods.