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MELBOURNE

FOOD20006

Food Microbiology & Safety

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Foodborne diseases (part 1) Intoxications

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Ray and Bhunia Ch 24-25



Intended learning outcomes

- Know the main types microorganisms causing foodborne disease, and understand their significance.
- Understand the main categories of foodborne diseases.
- Be able to describe *Staphylococcus aureus* and the foodborne diseases it causes (example of an intoxication).
- Be able to describe *Clostridium botulinum* and the foodborne disease it causes, botulism (example of an intoxication).

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Main types of microorganisms causing foodborne disease

Non-Biological agents of foodborne disease

- chemicals, heavy metals, pesticides
- particulates e.g. glass or metal particles

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Biological causes of foodborne disease

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1. toxins of non-microbial origin i.e. scromboid
2. infection with viable microorganisms
3. intoxication by pre-formed (microbial) toxins
4. toxico-infection (*Clostridium perfringens*)

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Food poisoning pyramid

Estimating the size of the problem is difficult because **most foodborne illness cases go unreported.**

Estimated reporting rate at between 25:1 and 100:1.

i.e. between: 1 in 25 cases are reported

and 1 in 100 cases are reported

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Why is the rate of reporting so low?

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Depends on numbers of cases (often sporadic, isolated), severity of disease, standard of health care, type of disease, whether it is a notifiable disease, etc.

Illness pyramid

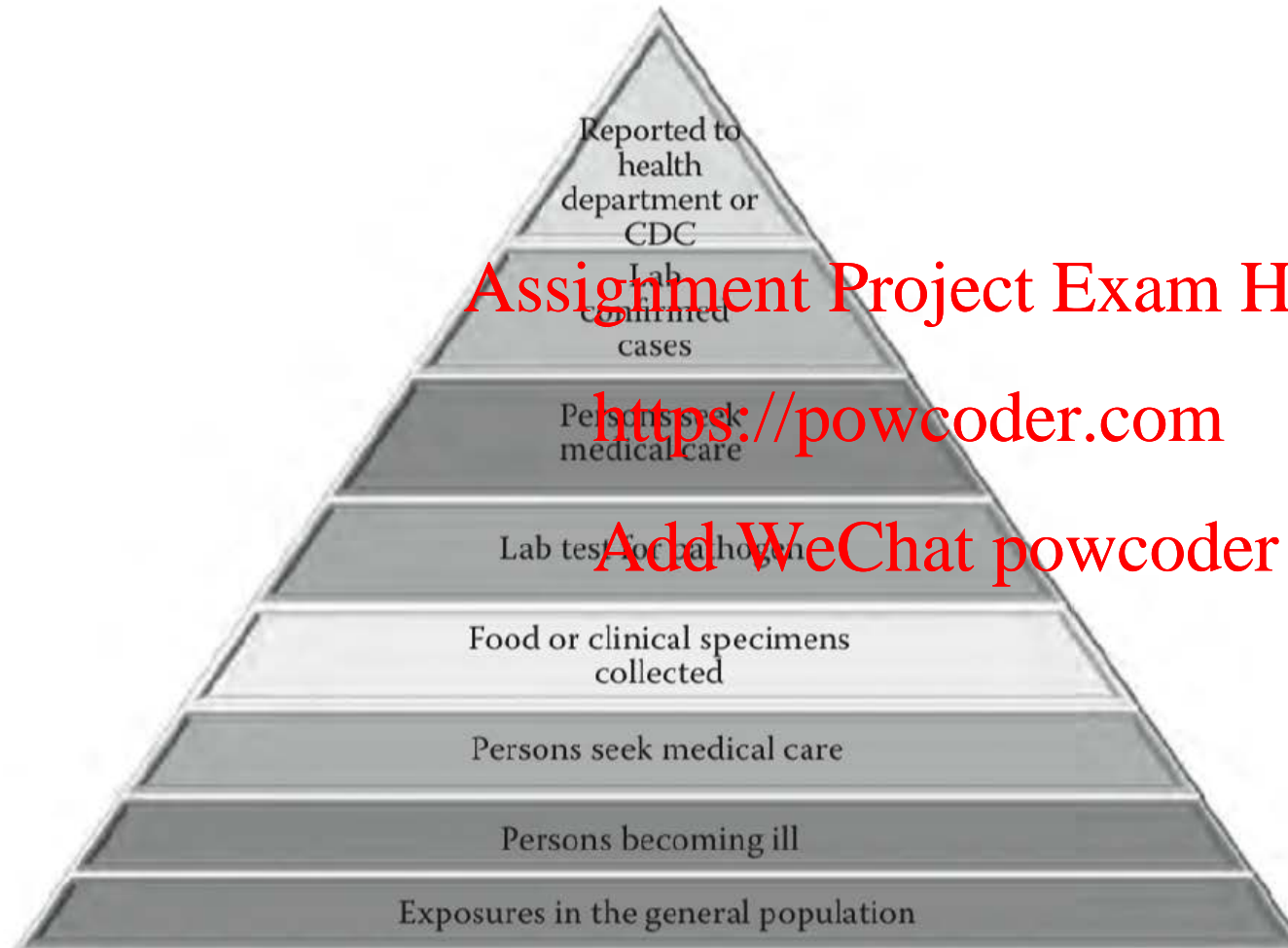
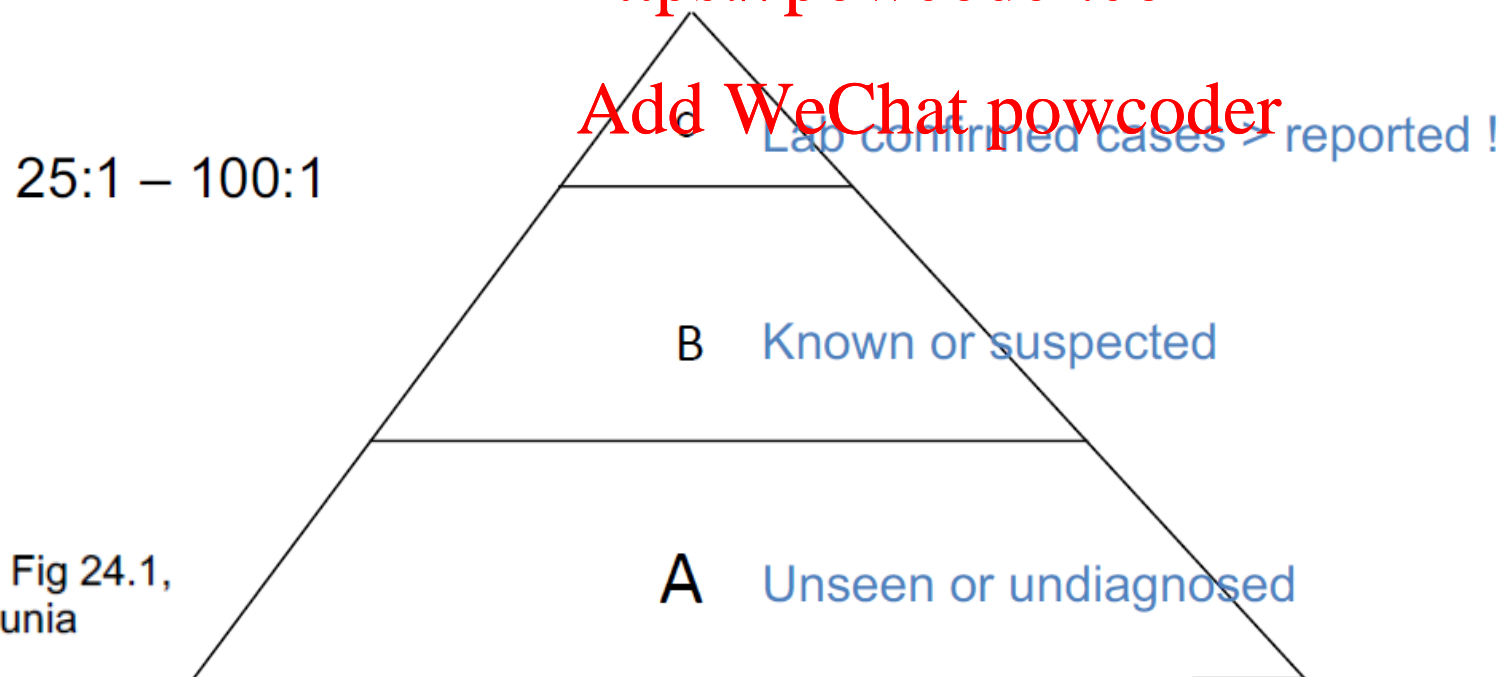


Figure 24.1 Reporting of true burden of foodborne diseases. (Adapted from CDC, FoodNet Surveillance—Burden of Illness Pyramid, http://www.cdc.gov/FoodNet/surveillance_pages/burden_pyramid.htm.)

“Burden of illness pyramid” (CDC)

Illustrating that many foodborne illness cases go unreported:

- A. Unseen or undiagnosed – medical attention not sought or not needed
- B. Known or suspected cases – people seek GP or hospital visit. No specimen taken or results not reported, so no record.
- C. Laboratory confirmed cases and notification – positive isolates reported



Based on Fig 24.1,
Ray & Bhunia



Significance of foodborne disease

Costs associated with foodborne diseases are difficult to estimate, but very high:

e.g. USA \$78 billion/yr (p308 of textbook)

Australia \$1.25 billion/yr

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Incidence values can also be difficult to estimate, but are also high:

“About 4.1 million Australians contract food poisoning each year” (excerpt from the NSW Food Authority - link)

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Web resources: FSANZ (<http://www.foodstandards.gov.au>), FoodNet, FoodSafety

What kills? Yearly incidence in USA

Pathogen	Cases	Deaths
<i>Salmonella</i> spp.	1,027,561	378
<i>Clostridium perfringens</i>	965,000	26
<i>Campylobacter</i> spp.	845,000	76
<i>Listeria monocytogenes</i>	1591	255
<i>Toxoplasma gondii</i>	86,868	327
Norovirus	5461	149

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Foodborne intoxications

1. Preformed microbial toxin produced during growth in food
2. Toxin can be heat stable or labile
3. Ingestion of toxin in food is all that is required
4. Symptoms occur quickly, from 30 mins
5. Symptoms differ with different toxins (enterotoxin vs. neurotoxin)
6. Fever is not a symptom

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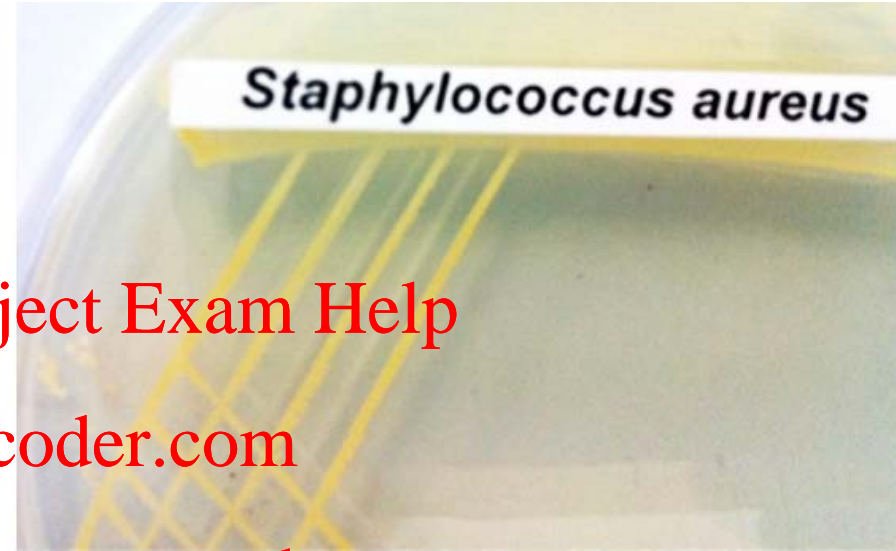
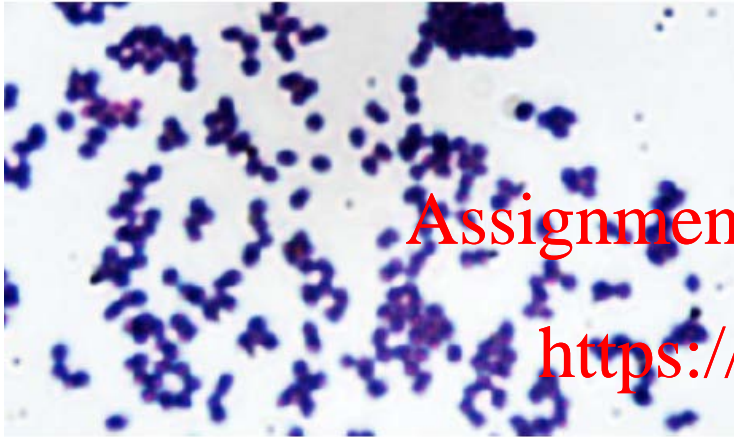
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Here we will describe **two common bacterial examples**:

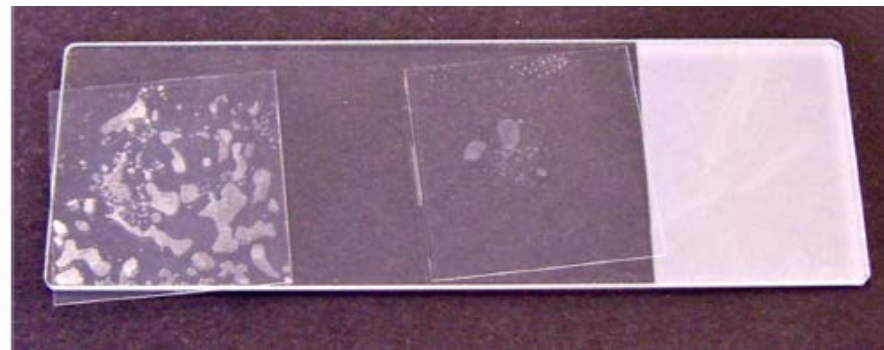
- *Staphylococcus aureus*
- *Clostridium botulinum*

Staphylococcus aureus



Gram stain: Gram +ve cocci

On nutrient agar, **golden** colour



catalase test (left, **+ve**), negative control (right)



Staphylococcus aureus

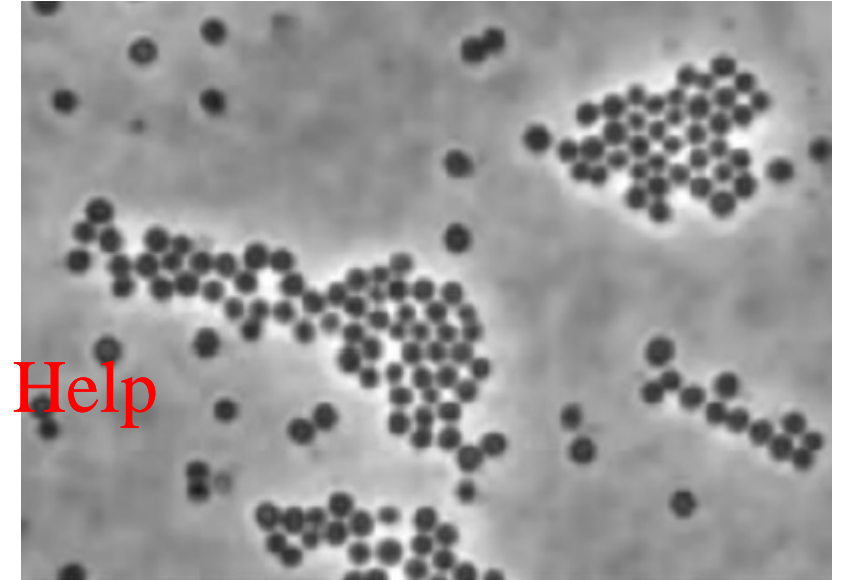
Normal flora of skin/nose/hair of humans, animals, birds. Can also come from skin infections.

Gram positive coccus, grape-like clusters

Non-sporulating (so sensitive to heat)

Carotenoid pigment gives colonies a yellow colour, so gives the species name (*aureus* means 'golden')

Distinguished from the harmless *S. epidermidis* by the coagulase test (produces enzyme that clots serum) – see next slide



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Coagulase test

To distinguish *S. aureus* from *S. epidermidis*

Rabbit serum is incubated with *S. aureus* cells

Enzyme coagulase from cells causes fibrin to clot (gel)

Other species of *Staphylococcus* do not produce coagulase

***remember the test and its purpose**

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Serum has formed a fibrin clot -> solid gel

Control, serum remains liquid

modified from <http://vlab.amrita.edu/>

Staphylococcus aureus

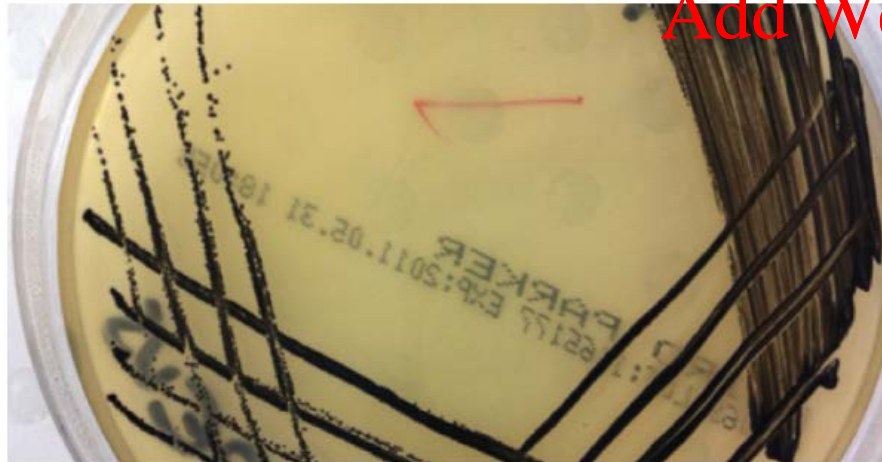
Isolation/ identification:

- Jet black colonies on **Baird-Parker** agar
- Gram +ve cocci, forming clusters
- Coagulase – coagulates plasma
- serological tests for enterotoxins available

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Colonies on **Baird-Parker** medium



modified from <http://vlab.amrita.edu/>



Staphylococcus aureus

Characteristics advantageous to food poisoning:

- mesophiles (optimal between 20-37°C)
- can grow down to Aw of 0.86 (adapted to dry, salty skin)
- can grow at low pH (4.8)
- can grow at high salt and sugar concentrations

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Enterotoxin-producing strains

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- not all strains produce enterotoxins
- 21 different enterotoxins known (serologically distinct)
- **heat stable proteins**, 26-30 kDa, water soluble
 - can withstand 60°C for 16 hours
- **normal cooking not sufficient to destroy enterotoxins**



Staphylococcus aureus food poisoning

Foodborne illness: intoxication, rapid onset

- Ingestion of enteric toxins (no viable cells needed)
- Stimulate vagus nerve in stomach -> induces vomiting
- Symptoms nausea, vomiting
- Rapid, 2-4 hours post ingestion (but can be only 30 min)
- Lasts 1-2 days, rarely fatal

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Types of foods:

- Many types of foods – difficult to recognise that they have spoiled
 - quality still acceptable (no smell, discoloration, etc.)
- e.g. ham, bacon, cream, custard, salad dressings, cheese



Staphylococcal intoxication

Prevention/reduction of disease:

- Organisms are normal flora, so cannot eliminate
- Try to keep contamination low (raw materials, sanitation, personal hygiene)
- Heat treatment of food recommended (kill cells)
- Chilled to $\leq 5^{\circ}\text{C}$ (consider preservative)
- No long duration temperature abuse

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Section “Analysis of an outbreak” is useful revision. Serious symptoms, but few die from this

- But the next example has a very high death rate....



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