THE UNIVERSITY OF MELBOURNE

FOOD20006

Food Microbiology & Safety

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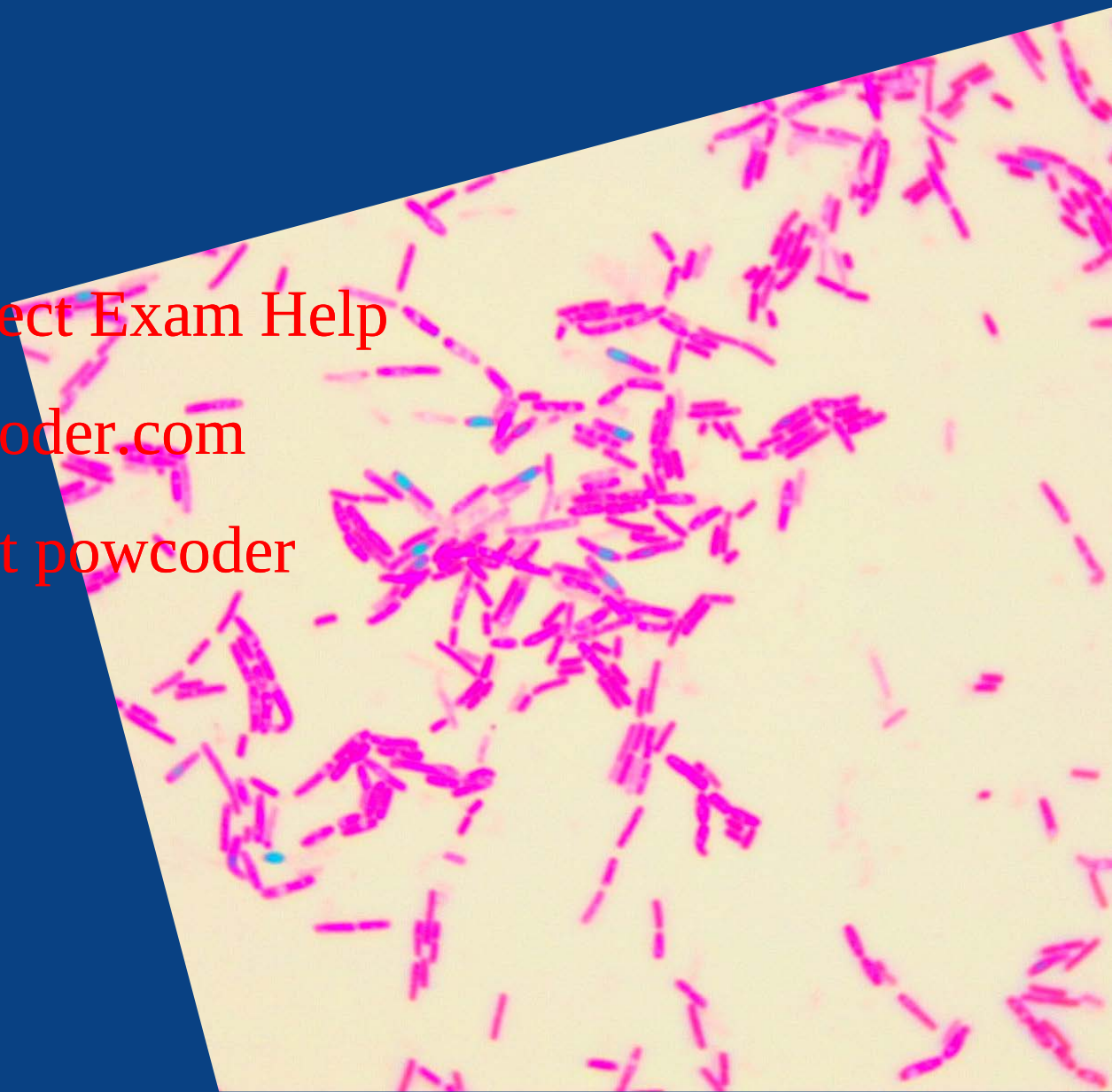


Foodborne diseases

Intoxications

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 disease it causes (example of an intoxication).
- Be able to describe *Clostridium botulinum* and the foodborne disease it causes, botulism (example of an intoxication).

Botulism: *Clostridium botulinum*

Three different types of infections:

1. Food consumption with (pre-formed) toxin produced by *Clostridium botulinum*
2. Infant botulism
3. Wound infection

- Symptoms caused by neurotoxin
- Extremely potent, often leads to death
- Acts on nerve synapses, blocks muscle contraction

Botulism: *Clostridium botulinum*

Neurotoxin (A,B subunits) ingested with food (inactive form)

Proteases in GIT convert it to active form

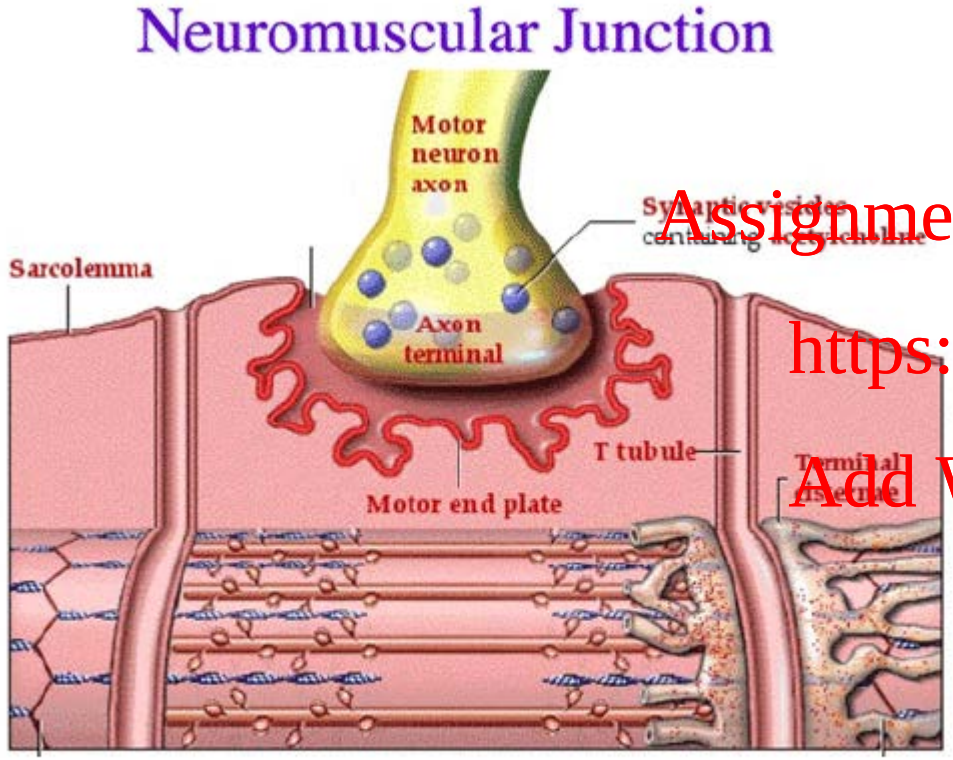
Absorbed in small intestine -> bloodstream -> through body

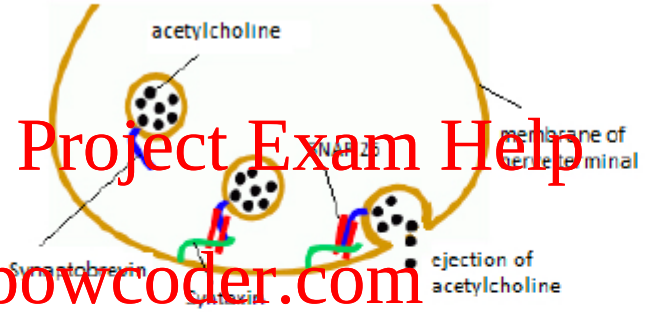
- B-subunit binds to nerve endings at nerve-muscle junction
- A-subunit taken up by nerve cells; metalloprotease; interferes with Acetylcholine release at neuromuscular junction
- **BLOCKS release of acetylcholine -> flaccid muscle paralysis**
- Often 12 – 48 hours after food consumption, but can be just 2 hr

Symptoms:

- Abdominal cramps, vomiting, difficulty swallowing/speaking, double vision, breathing difficulty > respiratory failure -> **DEATH**

Botulinum toxin (botox)





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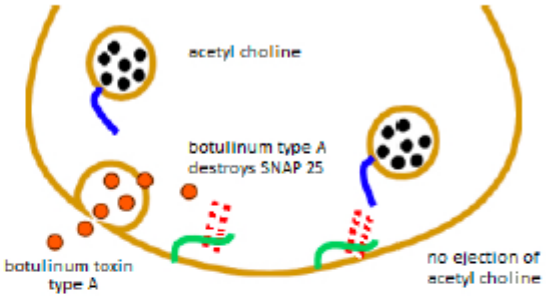

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http://www.chirit.com/en/

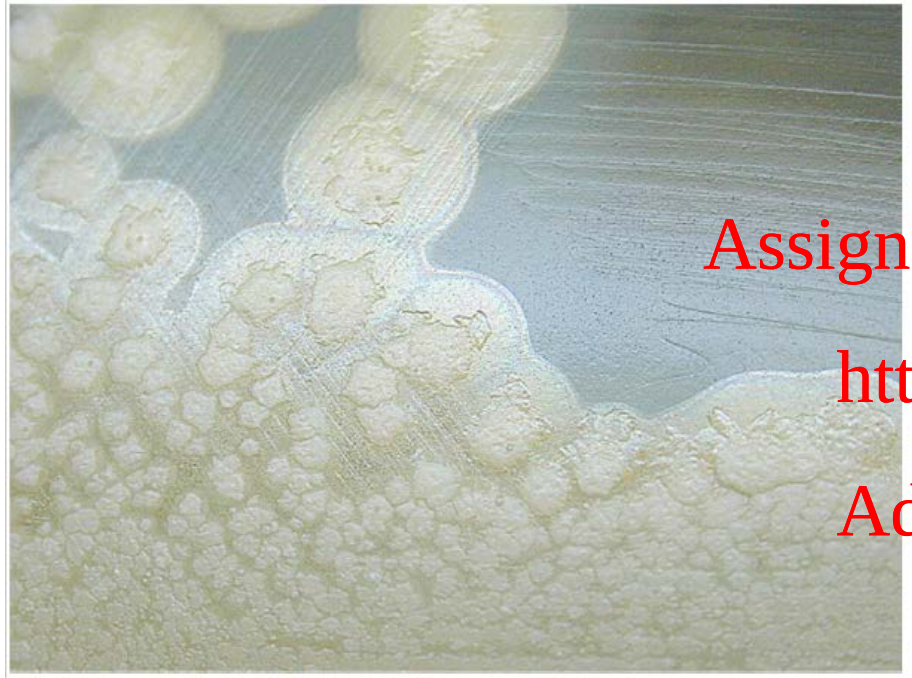
https://drwritings.com/neuromuscular-junction-central-nervous-system-muscle-cells/

Clostridium botulinum (for interest only)

Infant botulism – different to adult disease

- Infants 2-6 weeks old, particularly when non-milk foods introduced (e.g. honey!)
- Gut colonisation with in situ toxin production
  - because *less competitive gut microflora* in infants
  - pH of stomach not as low as in adults
- Ingestion of spores can be via environmental sources or by ingestion of low levels of spores in foods.
  - Note: in adults colonisation does not occur and disease is caused by preformed toxin in foods.
- Symptoms are similar to classical botulism, but harder to recognise because they are so young, and become progressively weaker.

Clostridium botulinum: Gram +ve rods



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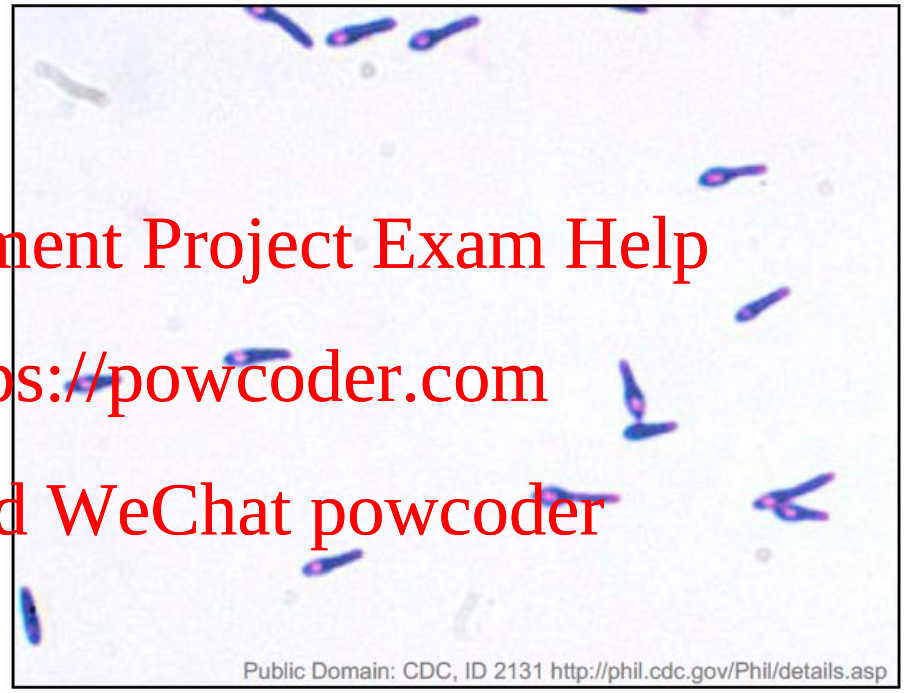
C. botulinum colonies, showing opaque zones on egg yolk agar



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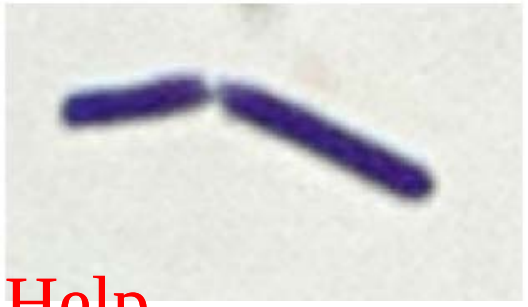
Gram stain of *C. botulinum*, showing the "club-shaped" cells as they form terminal spores that distend the ends of cells.

Clostridium botulinum



Gram positive rods

Anaerobic (obligate)

Spore forming (terminal)

Mainly found in soils, muds (anaerobic)

Sensitive to low pH, low Aw (0.93) and salt

Spores do not germinate when nitrite present

Spores heat resistant (115°C); vegetative sensitive

Neurotoxins (proteins) produced during cell growth

- Heat sensitive! 90°C for 15 min destroys them
- Released from cells when they lyse

Clostridium botulinum

Isolation and identification:

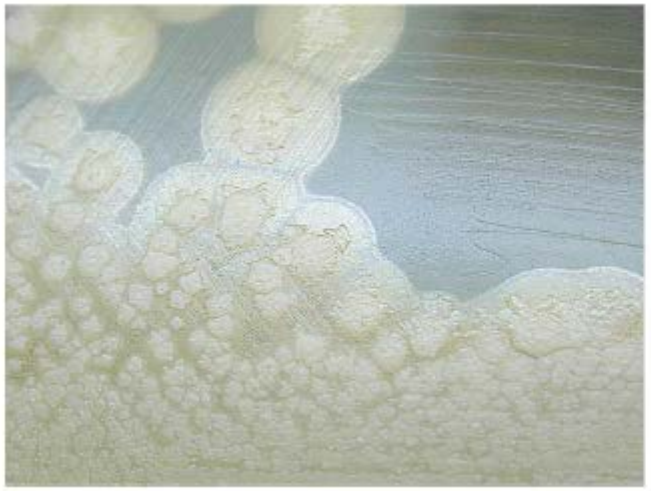
Often found in **low numbers** in food *(toxin so potent)*

Enrichment necessary (e.g. **cooked meat medium**)

Then inoculated onto **HBA** (horse-blood agar)

Finally, tested for **toxin** production/type using specific antisera for each of the 8 types.

Needs to be done under appropriate biosafety level; staff need to be vaccinated.



C. botulinum colonies, showing opaque zones on egg yolk agar

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Clostridium botulinum

Strains of this species are classified into types according to the type of toxin they produce

- 7 types (A – G): A,B,E,F cause human disease
- Usually one toxin per strain (more info)
- Type E strains psychrotropic, grow at 3.3 °C (opt 30°C), and most often associated with fish products

Extremely potent – miniscule amounts kill!

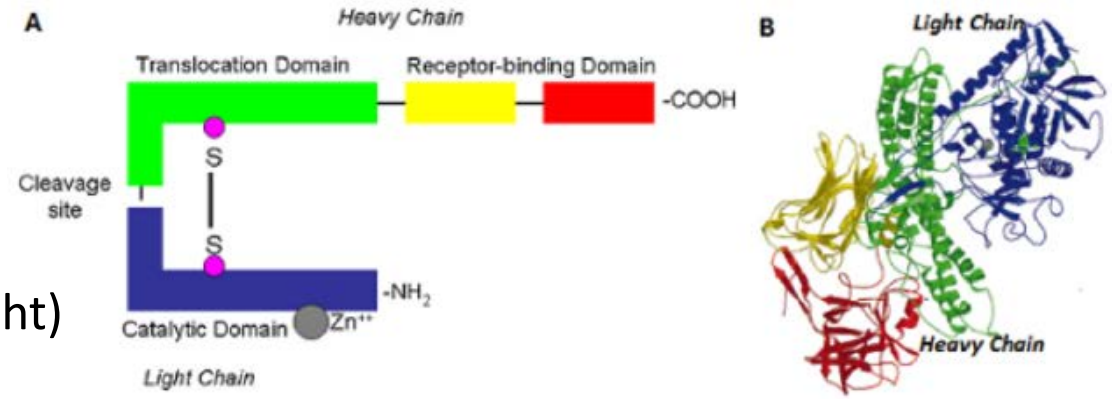
Human median lethal dose (LD50) of 1.3–2.1 ng/kg

Botulinum toxin

Protein with two subunits

3D structure known

A and B subunits (heavy/light)



Botulism: *Clostridium botulinum*

Treatment:

- Antitoxin, mechanical breathing, etc.
- May take months to recover
- Antibiotics no use if food poisoning (only wound infections)

Clostridium botulinum: growth conditions

Optimum conditions for toxin production:

- Anaerobic conditions (e.g. canned food)
- Temperature ≥ 4°C

Preventative conditions:

Any or all of the following (hurdles):

- pH 4.6, Aw 0.93, NaCl 5.5%, low °C
- Cooking before eating (toxin is heat sensitive!)

Botulism: food associations

Steps: food contamination, survival of spores during processing, ability to grow

Most outbreaks are fruits and vegetables: home canned vegetables very common source

Second level – fish products

Glass jars of Jalapeño peppers that were the source of a botulism outbreak in Pontiac, Michigan, April, 1977.

Public Domain: CDC, ID 3355, http://phil.cdc.gov/Phil/details.asp

Botulism: *Clostridium botulinum*

Prevention of botulism:

- Proper time and temperature during home canning of “low-acid” foods
- Commercial processing: 12D concept (chpt 33)

General directions:

1. proper cooking of foods
2. refrigerate after cooking (not stored too long)
3. pH < 5 (+chilled storage)
4. NaCl of ≥ 3.5% (+chilled storage)
5. Aw ≤ 0.97 (+chilled storage)

Botulism

Read the "Analysis of a foodborne botulism case" at the end of chpt 25.

There are many other similar examples you can find in PubMed or in textbooks.

Low-acid foods have a pH level greater than 4.6, which means they are not acidic enough to prevent the growth of botulinum bacteria.

Examples are:
Asparagus
Green beans
Beets
Corn
Potatoes
Some tomatoes*
Figs
All meats
Fish and seafood

USDA Complete Guide to Home Canning
Guide 1 Principles of Home Canning

Copy available in READINGS in Canvas