CONCEPT: EXOTOXINS CAUSE DAMAGE TO THE HOST

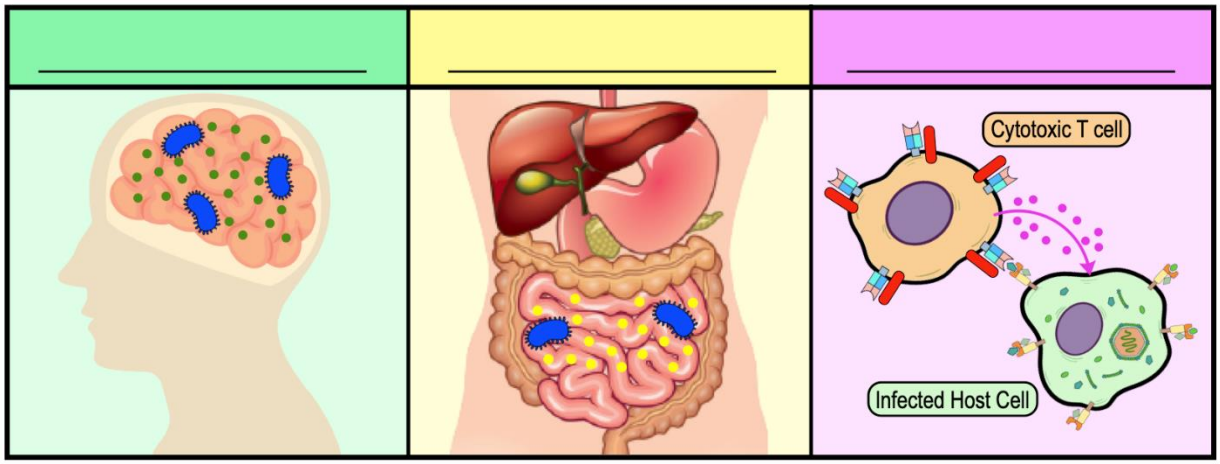
●Damage by exotoxins is highly specific, and they can be grouped based on the type of tissue they infect:

□ **Neurotoxins:** damage tissues of the _____ system, potentially causing paralysis.

□ **Enterotoxins:** damage tissues of the _____ tract causing diarrhea &/or vomiting.

□ **Cytotoxins:** damages different cell types by interfering with cellular mechanisms or by causing cell _____.

□ For example: Cytotoxic T cells produce cytotoxins that kill infected host cells.



●Recall: Exotoxins can also be categorized based on their different structures & functions:

1) *A-B toxins* 2) *membrane-damaging toxins* or 3) *superantigens*

PRACTICE: The components which make up an exotoxin are:

a) Proteins. b) Carbohydrates. c) Lipids. d) Lipopolysaccharides. e) Nucleic Acids.

PRACTICE: *Vibrio cholerae* is the bacterium which causes the disease cholera. *Vibrio cholerae* is a toxigenic bacterium, meaning it creates toxins. The toxin created by *Vibrio cholerae* is and A-B toxin which disrupts the ionic balance of the host's intestinal cell membranes. This results in vomiting, diarrhea, and severe dehydration in infected individuals which could lead to death. The toxin created by *Vibrio cholerae* is an A-B toxin and a _____ toxin.

a) Neurotoxin.
b) Endotoxin.
c) Cytotoxin.
d) Enterotoxin.

PRACTICE: Even though chemotherapy is used as a treatment for cancers it also causes cellular damage. Chemotherapy drugs possess toxins that attempt to target and destroy rapidly dividing cells, such as tumor cells. The toxins found in chemotherapy drugs are _____.

a) Neurotoxins.
b) Endotoxins.
c) Cytotoxins.
d) Enterotoxins.

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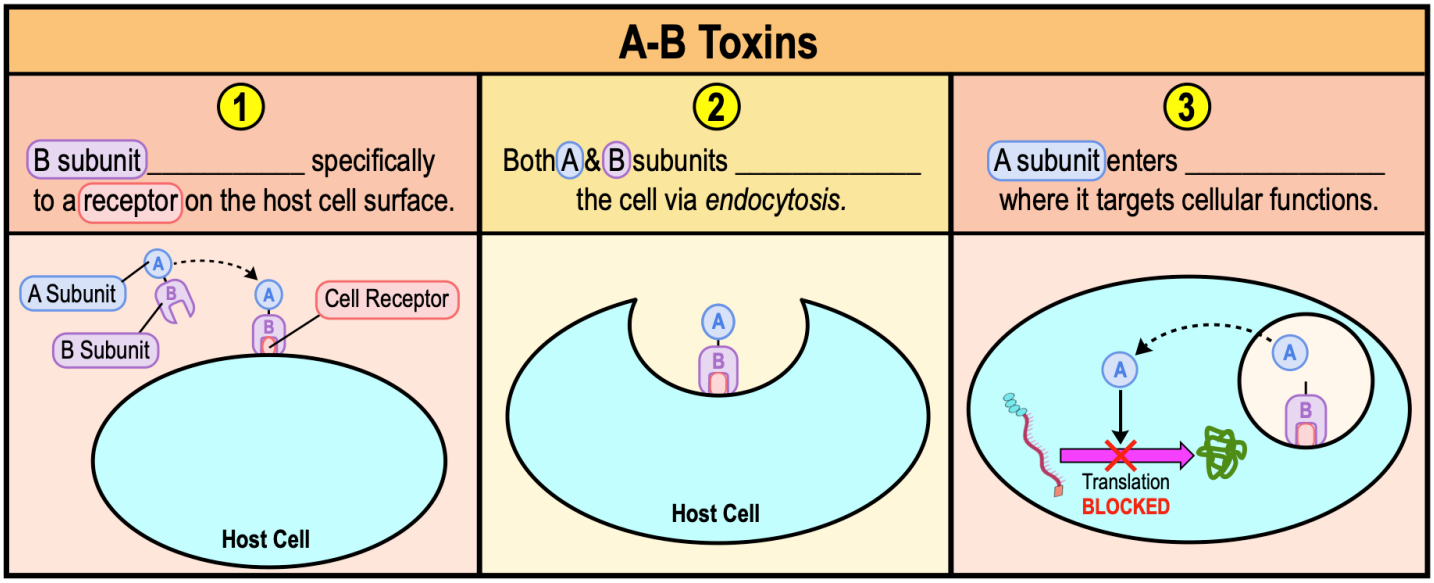
1) A-B Toxins

●A-B toxins are exotoxins that consist of 2 parts:

- □ ____ **(Active) subunit**: usually an enzyme that is responsible for toxic/damaging activity of the toxin.
- □ ____ **(Binding) subunit:** dictates the very specific type of cell the toxin binds to.
  - □ B-subunit can be isolated & recombined with medicines to deliver them to specific cell types.

●A-B toxins infect host cells in a ____-step process:



PRACTICE: Anthrax is a serious illness caused by the *Bacillus anthracis* bacteria. The *Bacillus anthracis* bacteria create a dangerous toxin composed of three protein parts. Each individual part of the toxin does not cause symptoms of disease. However, when the three parts are combined, the toxin causes disease. Scientists know that one part of the toxin allows attachment to the host cells while the other two parts cause disease. The anthrax toxin is an example of a ____ toxin.

a) A-B toxin.
b) LPS toxin.
c) Endotoxin.
d) Adhesin toxin.

PRACTICE: Botox is a common, temporary cosmetic treatment. Botox injections use the botulinum toxin created by *Clostridium botulinum* bacteria to block certain nerves and paralyze muscles of the face to reduce the appearance of facial wrinkles. The botulinum toxin is an example of which type of toxin?

a) Neurotoxin.
b) Endotoxin.
c) Cytotoxin.
d) Enterotoxin.

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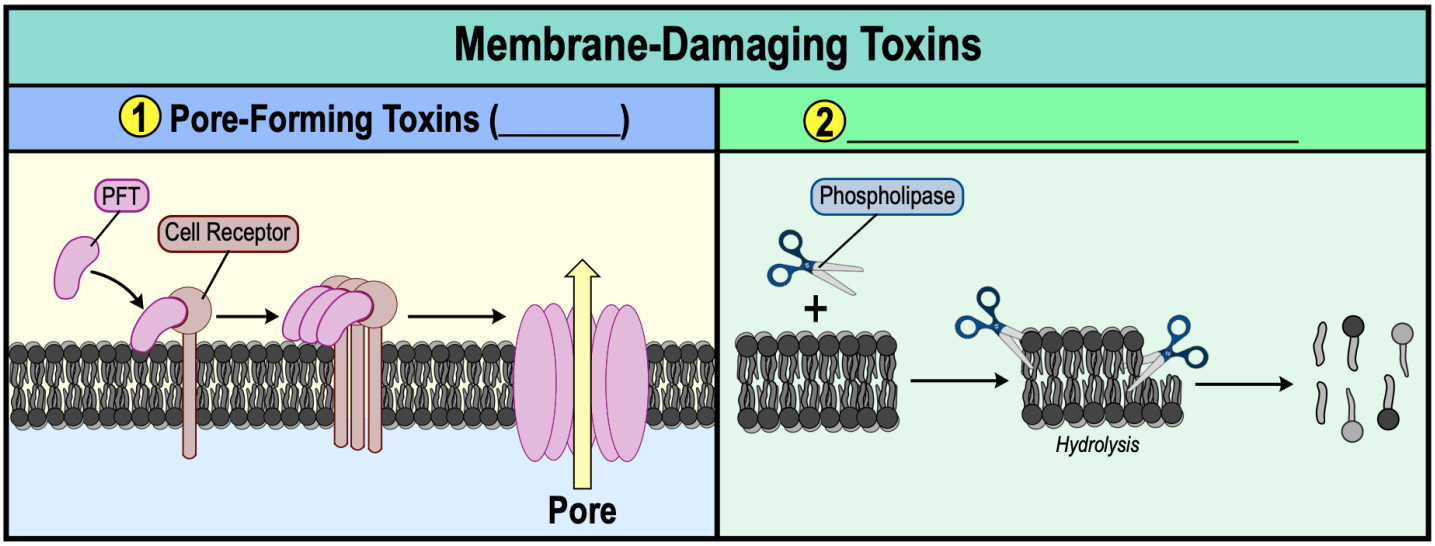
2) Membrane-Damaging Toxins

●**Membrane-Damaging Toxins:** exotoxins that disrupt cytoplasmic _____ & cause lysis of host cells.

●There are ____ types *of membrane-damaging toxins*:

1) **Pore-Forming Toxins (PFTs):** create _____ in the phospholipid bilayer of the host cell causing cell lysis.

2) **Phospholipases:** enzymes that _____ phospholipids in the cytoplasmic membrane.



PRACTICE: *Eisenia fetida* is a species of earthworm which creates the lysenin toxin. The toxin defends the worm against infectious bacteria and fungi. The lysenin toxin forms pores in the membranes of pathogens which leads to apoptosis of the pathogens. The lysenin toxin is a _____.

a) Pore-forming toxin.
b) Exotoxin.
c) Defense mechanism.
d) All of the above.

PRACTICE: Toxoid vaccines are vaccines for toxins made by pathogens. Toxoids are weakened versions of a toxin which do not cause disease but allows our immune system to recognize toxins in the future. Toxoid vaccines for toxic phospholipases C are being researched and tested. What would this vaccine protect patients from?

a) Hydrolysis of phospholipids of host cell membranes leading to apoptosis.
b) Pore formation in host cell membranes leading to apoptosis.
c) Damage to nerve cells and muscle paralysis.
d) Damage to digestive tract and intestinal epithelial cells.

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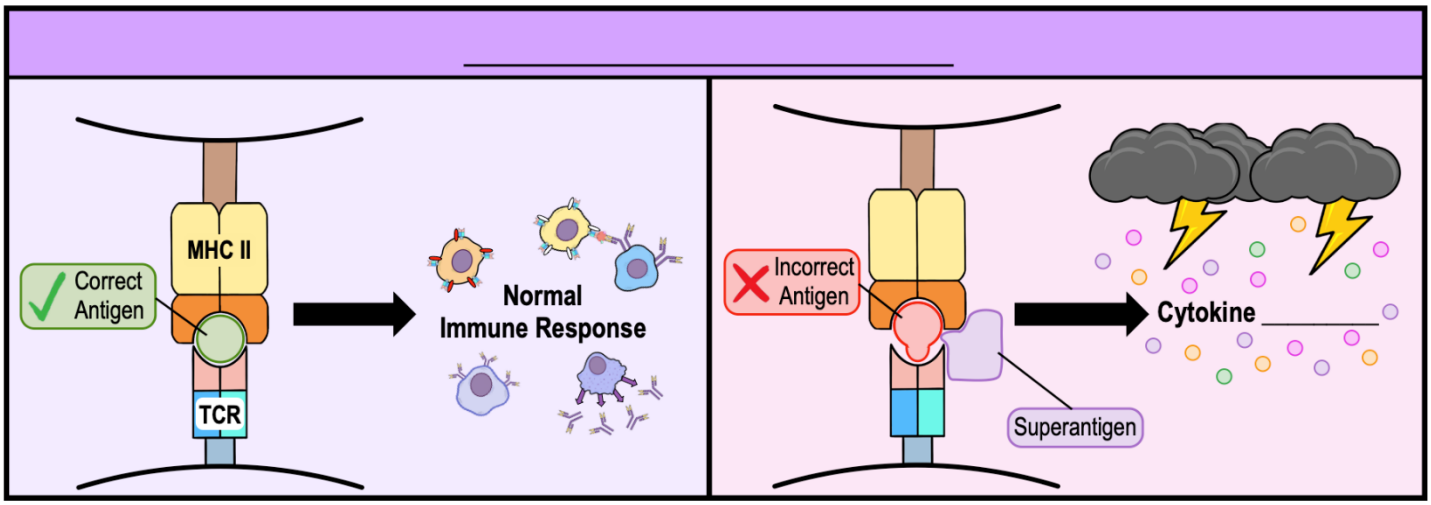
3) Superantigens

●**Superantigens:** exotoxins that *inappropriately* stimulate T_H cells, leading to the overproduction of _____.

□ Binds MHC II on APCs, causing T_H cells to recognize & respond to antigens they normally would NOT.

□ Leads to excessive proliferation of T_H cells & massive _____ of *cytokines* called a **"cytokine storm".**

□ Cytokine storms can be _____**-threatening** & cause *fevers*, *inflammation*, & *shock*.



PRACTICE: Which is ***true*** about superantigens?

a) They are exotoxins.
b) They bind to MHC II antigens on APCs.
c) They enhance antibody production.
d) They enhance B cell production.
e) A and B.
f) C and D.

PRACTICE: A superantigen:

a) Is incredibly efficient at stimulating the production and response of T cells in the host.
b) Is produced by APCs to increase their ability to bind and present antigens.
c) Is an exceptionally large antigen molecule.
d) A protein that activates B cells to release large amounts of antibodies in defense against a pathogen.

PRACTICE: Some individuals infected with the SARS-CoV-2 virus have elevated cytokine levels that can lead to acute lung injury, respiratory distress, and even death. The excessive concentrations of cytokines created in response to the SARS-CoV-2 virus is likely:

a) Caused by a portion of the virus being a superantigen.
b) A life-threatening cytokine storm.
c) Caused by the virus releasing AB toxins.
d) A and B.
e) B and C.