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IMMUNE RESPONSE TO INFECTIOUS DISEASE AND VACCINES

Viral infections :-

- viruses uses host machinery & products for its survival.
- Therefore, survival of the host cell is imp. for the virus.
- However, the mutation rate in viruses is very high & some of these mutated virus can end up killing the host.
- some characteristics include:
  - → Long latency period before showing symptoms of severe illness
    eg: HIV
  - → Efficient transmission during short-lived illness.
    eg: Influenza during cold season.
  - → few viruses can live in ~~another~~ host than human.
    eg: west-nile virus can live in mosquitoes as well.
- Viral particles are recognised interferons as well as NK cells.
- Upon viral encounter, the host cells processes the virus as endogenous molecules and will be presented on the cell surface by the ~~MHC~~ class I MHC. These antigens will be recognised by T_H cells ~~or~~ and activate B cells (that will secrete Abs & neutralize the circulating viral particles) and Tc cells will neutralize the already-infected host cells → cell-mediated response

humoral response ←

- # However, viruses ~~has~~ have mechanisms to evade host cells:
  - → Evading interferon actions ~~eg~~ - eg: Hepatitis C virus
  - → Inhibits Antigen Presentation - Eg: Herpes simplex virus
  - → Evade complement system by binding to C3B molecule that will inhibit the classical pathway. ~~eg~~

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→ Cause general immunosuppression - eg: EBV produces Viral IL-10 that is analogous to IL-10 which is a regulatory interferon. It affects the overall immune mechanism of the body.

Influenza Virus — FLU (Influenza) :-

* It is a respiratory illness.
* It caused 3 pandemic already with the Spanish flu being the worst.
* Structure: Spherical virion. surrounded by lipid bilayer acquired from host.
  → Two glycoproteins: Hemagglutin (HA) and Neuramindase (NA)
  → Mutations in these glycoproteins can result in ~~new strains~~ variants of these viruses. [eg: H1N1, H1N2, ~~H1~~ H1N5]
  → HA → binds to receptors present on host cell. (Viral entry)
  NA → The newly synthesised viral particles exist the host cells using NA.
* Mutations occur in two ways:
→ Antigenic Drift: Involves a series of point mutations that results in minor changes in HA / NA over time.
→ Antigenic Shift: A ~~A~~ sudden major change occuring in the glycoproteins.
  • Commonly observed during flu ~~fe~~ seasons (cold seasons).
  • can also occur if human genome gets integrated into other animal viral genome.
  eg: swine flue — If a human viral genome can infect a bird & the bird carries another viral genome. The two genomes can get integrated & infect other birds or human.

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* Often individual will not get infected at the end of the flu season if he/she got infected in the beginning due to production of memory cells.
* However, due to mutations observed in the flu virus, the person can get infected by the mutated form of the virus in the next flu season.

Bacterial infections:-

- Bacteria showing intracellular growth activates cell-mediated immunity.
- If bacterial load is low in the host, the innate immune system (macrophages) will take care, however if the load is high, it will be handled by the adaptive immunity.

Evasion of Host Defense Mechanisms -

(i) Infection Process: Attachment to host through Pili or other receptors

Evasion mechanism: Secretion of Proteases that cleaves IgA Abs.

eg: N. gonorrhoeae, Haemophilus influenzae

(ii) Proliferation: • Phagocytosis (Ab- and C3b-mediated opsonization)

Evasion mech.: Prod. of surface structures that inhibit Phagocytic cells

• Complement-mediated lysis & localized inflammatory response

Evasion mech: Generalized resistance of Gram +ve bacteria to to complement-mediated lysis

(iii) Invasion of Host tissue: Ab-mediated agglutination

Evasion mechanism: Secretion of elastase that inactivates C3a and C5a

eg: Pseudomonas

(iv) Toxin-induced damage to host cells: Neutralization of toxin by Ab.
Evasion mechanism: Secretion of hyaluronidase, which enhances bacterial invasiveness.

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eg: Tuberculosis

→ caused by: Mycobacterium tuberculosis

→ It is an in

→ It infects tissue-resident macrophages (Alveoli Macrophages) by inhibiting the formation of Phago-lysozome by proliferating inside the macrophage itself.

→ The bacterial antigen can still be presented by APCs that will be recognised by $CD4^+$ T_H cells. These T_H cells will secrete cytokines that will activate more macrophages.

→ These activated macrophages gathers around site of infection & release lytic enzymes to degrade the bacteria.

→ But it has side effects on the healthy cells as well causing necrosis of the cells around the site of infection.

→ The symptoms of Tuberculosis is ~~main~~ not primarily due to the bacteria due to the enhanced activation of immune response around site of infection.

→ When there are too many macrophages ~~are~~ present around the infection site dies, it calcifies and can be observed in lung scans.

eg: Parasitic Diseases

→ caused by Protozoans and/or ~~Helmanths~~ Helminthes

→ Protozoans are parasites that have more than one host.
eg: Plasmodium
Host - Mosquito, Human

→ Evades ~~by~~ host defense mechanism by locating in multiple ~~loca~~ places in the host body.
eg: In human, Plasmodium is located in Liver and blood.

→ Plasmodium stays in the blood for about 30-40 mins max which is not enough time for immune system activation. Also Liver is not very accessible by immune cells.

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→ Helminthes are worms (Multi-cellular organisms).
→ Immune response against helminthes are IgE mediated.
→ Apart from IgE Abs, it can also be neutralized by complement pathways and macrophages.

Fungal infections:-
- Most of the fungal infections are cutaneous (superficial) in nature.
- Usually doesn't cause inflammation.
- Most cases the innate immunity will neutralize the fungus (skin barriers).
- If infections invades ~~in~~ the ~~in~~ cutaneous barriers, that can cause inflammation.
- Bacteria ~~also attacts~~ keeps fungal infection in check. Therefore, those under long-term Antibiotic usually can suffer from fungal infections.
- Since these infections are often superficial, memory cells are often not produced against them but upon infection, memory cells can be produced.

eg: Cryptococcus neoformans

VACCINES:-
→ Immunization : Active or Passive
→ Passive: Preformed Abs are directly injected to ~~activate~~ host;
No adaptive immunity activated; No memory cells formed; short-lived.
eg: Tetanus Abs vaccine; Transfer of IgG Ab from mother to fetus.
→ Active: ~~Partially~~ Attenuated / dead bacteria used to activate adaptive immunity, memory cells are created; long-lasting.
eg: ~~SARS-COVID vaccine~~ SARS COV-2 vaccine

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-to proliferate

The Reservoir of Pathogens ↓ reduces when a large population ~~of~~ gets immunized by vaccines. This reduces the chance of infection in unvaccinated inviduals or inviduals against whom the vaccines did not work. This is called Herd immunity.

Types of vaccine-

1) Live, Attenuated vaccine

eg: MMR, chick pox vaccine, Oral polio vaccine

- These vaccines are created by infecting the pathogen into a non-human host cells and allowing it to grow mutations that will prevent ~~it~~ its growth in human host.
- Risk: possibility of reverse-mutation causing the virulence to come back.

2) Inactivated, killed vaccine

eg: Hepatitis A vaccine, Flu vaccine, cholera vaccine

- They are ~~denatu~~ killed.
- Only antigenic peptides are present that is used to activate immunity.

3) subunit vaccine

eg: Tetanus vaccine, Hepatitis B vaccine

4) Recombinant vector vaccine

- Genome encoding virulence is ~~et~~ removed.
- Resulting virus is immunogenic (viable) but not virulent.

5) DNA vaccine

~~eg:~~

6) mRNA vaccine

eg: ~~SARS-2 covid vaccine~~ SARS COV-2 vaccine [using spike protein mRNA]