**Immunology**

**Lec. 4**

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**Vaccination and Immunization**

Early vaccination trials of Edward Jenner and Louis Pasture are the foundations of immunology. **Edward Jenner** inoculated an 8 years old boy with fluid from a cowpox pustule and later intentionally infected the child with smallpox, the child did not develop smallpox.

**Louis Pasture** succeeded in growing the bacteria that was thought to cause fowl cholera in chickens. Injections of the fresh culture grown bacteria into chickens caused cholera in them, but injected the chickens with an old bacterial culture, the chickens became ill; but they recovered. Pasture then grew a fresh culture of bacteria, but he did not get fresh chickens for his experiment, so he inoculated the fresh bacterial culture into chickens, which have recovered from a previous inoculation of the bacterial culture. He noticed that the chickens did not develop the disease. This observation led Pasture to think that aging has weakened the virulence of the bacteria, and hence such attenuated bacterial strain might be used to protect against infectious diseases. He called the attenuated strain a vaccine.

Pasture first vaccinated one group of sheep with a heat-attenuated anthrax bacillus; then he challenged the vaccinated sheep and another group of unvaccinated sheep with virulent anthrax bacillus culture; all the vaccinated sheep lived while all the unvaccinated sheep died.

**Vaccine** is a non-pathogen immunogen that, when given to a host, induces protective immunity against a specific pathogen.

**Vaccination**: Is an artificial technique used to induce active or passive immunity in order to protect human beings from certain specific microorganisms, this induction of the immune system can appear either by stimulation of antibody secretion or induction of cell mediated immune response.

**Immunization**: Is the process of producing a state of immunity to infectious microorganism. Immunization in one individual prevents the occurrence of disease in that individual and immunization of population groups leads to the eradication of disease. As a result of immunization, diseases like poliomyelitis, diphtheria and tetanus have disappeared in developed nations. Smallpox is the first human disease eradicated from world.



Immunization is of two types:

1- **Active immunization**: Protection produced by the person’s own immune system. Usually, permanent. A vaccine containing antigens of a particular disease- producing microbe is introduced into the body. This leads to the development of specific memory cells against the Ag of the microbe. If the live microbe enters the body, the specific memory cells (induced by vaccination) will immediately recognize the microbe and kill it before it can produce disease.

2- **Passive immunization**: -Protection transferred from another person or animal. Temporary protection that wanes with time, the administration of serum containing antibodies against an infectious agent to protect an individual from developing a disease. However, the injected antibodies are degraded over a period of time and hence the protection is only short lived.

Passively given antibodies:

1- Directly react with the infectious agents and eliminate them.

2- Do not induce the activation of T- cells and B- cells, so memory cells not induced after passive immunization.



**Classification of vaccine**

1- **Live attenuated vaccines** (attenuate means to reduce the force)

The microbe is alive and can multiply in the host; but the microbe has lost the ability to produce disease.

a- BCG (Bacillus Calmette- Guerin) – *Mycobacterium bovis* is grown in a medium containing increasing concentration of bile for long period -vaccine and is used against the disease tuberculosis caused by bacteria *Mycobacterium tuberculosis.*

b- Polio virus causes a disease called poliomyelitis in children (A virus is grown in in vitro cell cultures under abnormal conditions for long periods).

**2-Killed vaccines** - Pathogenic bacteria or virus are killed by heat or chemicals and used as vaccines. Since the microbes are already killed, they cannot produce disease, but they act as antigens when inoculated into the body. (The immune system does not worry whether the microbe is a live or not; they look to them as foreign substance, so the immune responses are induced).

The heat/chemical treatment used to kill the microbes usually does not cause any change in the antigen structure, so, when killed vaccine are given, specific T and B –cells are induced against the Ag. Such as Cholera vaccine, Rabies vaccine, Influenza virus vaccine.

**3- Toxoids** - Are bacterial toxins inactivated by chemicals, but still they retain their antigenicity. Toxoids of some bacteria produce dangerous disease like toxins of bacillus produce the disease tetanus. Tetanus bacteria are grown in vitro culture medium, the tetanus exotoxins produced during the growth of bacteria are purified from culture, then mixed with formaldehyde to inactive the toxins. When toxoid is given as vaccine, it does not produce disease, the toxoid is immunogenic. Hence when tetanus toxoid is given as vaccine, immune responses against tetanus toxins are induced, Anti-tetanus toxin antibodies will neutralize the tetanus toxins and prevent the development of tetanus disease.

**4- Genetic vaccines** - In 1992 an entirely new vaccine was reported by **Tang et al**., in which experimental animals were immunized by a naked DNA, which encoded a poly-peptide antigen. The vaccinated animals developed both humoral and cell mediated immune response against polypeptide coded by DNA. Genetic vaccine is different from the traditional vaccines, the traditional vaccines consist of either the whole microbe (killed/live attenuated) or some of the microbial antigens (neutralized toxins/cell wall constituents), but the genetic vaccine consists of a part of the gene of the microbe. The traditional vaccines induce either humoral or cellular immune response and require refrigeration, while the genetic vaccine induces both humoral and cellular immune responses and do not require refrigeration for storing the vaccine.