Anticancer mRNA Vaccine

For Prelims: mRNA vaccine, mRNA-4157/V940, cancer, Covid-19, Programmed Death-1, types of vaccines.

For Mains: Types of Vaccine and Significance

Why in News?

Recently, the results of a trial of **messenger Ribonucleic Acid (mRNA-4157/V940) vaccine** made by Moderna and MSD (Merck & Co.) **when taken along with an immunotherapy drug Keytruda** has shown **promising results against advanced melanoma,** a kind of skin **cancer.**

What is mRNA Vaccine Therapy for Advanced Melanoma?

- **About:**
  - It is a **personalised cancer vaccine** i.e., tailor-made for every patient.
  - To build the vaccine, researchers **took samples of patients' tumors and healthy tissue.**
    - After analysing the samples to **decode their genetic sequence and isolate mutant proteins associated only with the cancer,** that **information was used to design** the vaccine.
  - The personalised cancer vaccine **uses the same** m-RNA technology that was used to **produce the** Covid-19 **vaccine**.
    - mRNA vaccines **use mRNA to teach** our cells how to **make a protein that triggers an immune response inside our bodies.**
- **Mechanism:**
  - It **allows the body's immune system** to seek and **destroy cancerous cells.**
  - The personalised cancer vaccine **works in concert with Keytruda, to disable a protein called** Programmed Death 1 (PD-1), that **helps tumors to evade the immune system.**
  - When injected into a patient, the **patient's cells act as a manufacturing plant, producing perfect copies of the mutations** for the immune system to recognise and destroy.
  - Having been **exposed to the mutations** without the virus, the **body learns to fight off the infection.**
- **Efficacy:**
  - The vaccine showed a **44% reduction in the risk** of dying of cancer or having the cancer progress.
  - The **combination of mRNA-4157/V940 and Keytruda** was generally **safe and demonstrated the benefit compared with Keytruda alone** after a year of treatment.

What are Different Types of Vaccines?

- **Inactivated Vaccines:**
  - Inactivated vaccines use the **killed version of the germ** that causes a disease.

    - Vaccines of this type are created by **inactivating a pathogen, typically using heat or chemicals such as formaldehyde or formalin.** This destroys the pathogen's ability to replicate, but keeps it **"intact" so that the immune system can still recognize it.** ("Inactivated" is generally used rather than "killed" to refer to viral vaccines of this type, as viruses are generally not considered to be alive.)
    - They usually don't provide immunity (protection) **that's as strong as live vaccines.** So, you may need several doses over time (booster shots) in order to get ongoing immunity against diseases.
        - **They are Used to protect:** Hepatitis A**,** Flu **(shot only),** Polio **(shot only),** Rabies**.**
- **Live-attenuated Vaccines:**
    - Live vaccines use **a weakened (or attenuated) form of the germ** that causes a disease.
    - Because these vaccines are so similar to the natural infection that they help prevent, they create **a strong and long-lasting immune response.**
    - The limitation of this approach is that **these vaccines usually cannot be given to people with weakened immune systems.**
    - **Live vaccines are used against:** Measles**,** Mumps, Rubella (MMR combined vaccine), Rotavirus, Smallpox among others.
- **Messenger (m) RNA Vaccines:**
    - mRNA vaccines **make proteins in order to trigger an immune response.** mRNA vaccines have several benefits compared to other types of vaccines, **including shorter manufacturing times** and, because they do not contain a live virus, no risk of causing disease in the person getting vaccinated.
    - The vaccines are used to protect against: Covid-19.
- **Subunit, Recombinant, Polysaccharide, and Conjugate Vaccines**:
    - They use **specific pieces of the germ** - like its protein, sugar, or capsid (a casing around the germ). They give a very strong immune response.
    - They can also be used on people with weakened immune systems and long-term health problems.
    - These vaccines are used to protect against: Hib (Haemophilus influenzae type b) disease, **Hepatitis B**, HPV (Human papillomavirus), **Pneumococcal disease** among others.
- **Toxoid Vaccines:**
    - They use a toxin (harmful product) made by the germ that causes a disease. They **create immunity to the parts of the germ that cause a disease instead of the germ itself.** That means the immune response is targeted to the toxin instead of the whole germ.
    - Toxoid vaccines are used to protect against: **Diphtheria, Tetanus.**
- **Viral Vector Vaccines:**
    - Viral vector vaccines use **a modified version of a different virus as a vector** to deliver protection.
    - Several different viruses have been used as vectors, including influenza, v**esicular stomatitis virus (VSV), measles virus, and adenovirus, which causes the common cold.**
        - Adenovirus is **one of the viral vectors used in some Covid-19 vaccines** being studied in clinical trials.
    - The vaccines are used to protect against: **Covid-19**

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims

Q1. With reference to recent developments regarding 'Recombinant Vector Vaccines', consider the following statements:

1. Genetic engineering is applied in the development of these vaccines.
2. Bacteria and viruses are used as vectors.

Which of the statements given above is/are correct?

(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Ans: (c)

Q2. In the context of vaccines manufactured to prevent COVID-19 pandemic, consider the following statements: (2022)

1. The Serum Institute of India produced COVID-19 vaccine named Covishield using mRNA platform.
2. Sputnik V vaccine is manufactured using vector based platform.
3. COVAXIN is an inactivated pathogen based vaccine.

Which of the statements given above are correct?

(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

Ans: (b)

Exp:

- COVISHIELD vaccine is based on the platform which uses a recombinant, replication-deficient chimpanzee adenovirus vector encoding the SARS-CoV-2 Spike (S) glycoprotein. Following administration, the genetic material of part of coronavirus is expressed which stimulates an immune response. **Hence, statement 1 is not correct.**
- Sputnik V is the world's first registered vaccine based on a well-studied human adenovirus vector platform. It has been approved for use in 71 countries with a total population of 4 billion people. The vaccine is named after the first Soviet space satellite. The vaccine's efficacy is 97.6%, based on the analysis of data on the incidence of coronavirus among Russians vaccinated with both vaccine components between December 5, 2020 and March 31, 2021. **Hence, statement 2 is correct.**
- Covaxin is an inactivated viral vaccine. This vaccine is developed with Whole-Virion Inactivated Vero Cell-derived technology. They contain inactivated viruses, which cannot infect a person but still can teach the immune system to prepare a defence mechanism against the active virus. **Hence, statement 3 is correct.**
- **Hence, option (b) is correct.**

Mains

Q. What is the basic principle behind vaccine development? How do vaccines work? What approaches were adopted by the Indian vaccine manufacturers to produce COVID-19 vaccines? **(2022)**

Source: TH