CURRENT AFFAIRS PROGRAM
PRE-CUM-MAINS 2024
OCT 2023: BOOKLET-1
NOBEL PRIZES, 2023

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1) NOBEL AWARDS, 2023

- Nobel prizes are regarded as most prestigious awards given for intellectual achievement in the world. These are a set of **six international awards.**

  - » The will of **Swedish Scientist Alfred Nobel** established **these prizes in 1895** and the first Nobel prize in Physics, Chemistry, Medicine, Literature and Peace were awarded in **1901**.

  - » In 1968, **Sweden's Central Bank Sveriges Riksbank** established the **Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel**, which although **not being a Nobel Prize**, has become commonly known as the **Nobel Prize in Economics**.

- **About Alfred Nobel**:
  - » He is a 19th century **businessman and chemist** from Sweden. He held more than **300 patents**. His most popular invention was **dynamite** which he created by mixing **nitroglycerine** with a compound that made the explosive more stable. The dynamite soon started getting used in construction as well as defence industry which made Nobel very rich.

  - » It perhaps also made him **think about his legacy**, because towards the end of his life he decided to **use his vast fortune to fund annual prize** "to those who, during the preceding year, have **conferred the greatest benefit to humankind**".

  - » For reasons that are not entirely clear, Nobel decided that **peace prize should be awarded in Norway** and other prizes in Sweden. Nobel historians suspect that Sweden's history of militarism may have been a factor.

- **Who awards these prizes?**
  - » The **Royal Swedish Academy of Sciences** awards the Nobel Prize in **Physics**, the Nobel Prize in **Chemistry**, and the **Sveriges Riksbank Prize in Economic Sciences** in Memory of Alfred Nobel.
  - » The **Nobel Assembly,** consisting of 50 professors at **the Karolinska Institute, Stockholm, Sweden** awards the Nobel Prize in **Physiology or Medicine**.

  - » The **Swedish Academy** grants the Nobel Prize in Literature.

  - » The **Norwegian Nobel Committee** awards the Nobel Peace Prize.

- **Nobel Prizes in 2023**:
  - » In **Physiology or Medicine**, the prize has gone to scientists **Katalin Kariko** and **Drew Weissman**, whose work enabled the development of **mRNA vaccine against COVID-19**.

  - » In **Physics,** the Nobel Prize has been awarded to **Anne L'Huillier, Pierre Agostini,** and **Ferenc Krausz** in the field of attophysics for developing flashes of light short enough to take snapshots of electrons.

» In **Chemistry**, the Nobel Prize has gone to **Moungi G. Bawendi**, **Louis E. Brus,** and **Alexei I. Ekimov** for the discovery and synthesis of **Quantum Dots**.

» **The** Nobel prize in **Literature** has been awarded to **Job Fosse**, "for his innovative plays and prose which give voice to the unsayable".

» The Nobel Prize in **Economic Sciences** has been awarded to **Claudia Goldin** for research on the **workplace gender gap**.

» The **Nobel Peace Prize for 2023** has been awarded to Iranian activist **Narges Mohammadi** for here relentless fight against the oppression of women in Iran and her unwavering commitment to promoting human rights and freedom.

– **Prizes:**
  » $1 million; 18-carat gold medal; and diploma

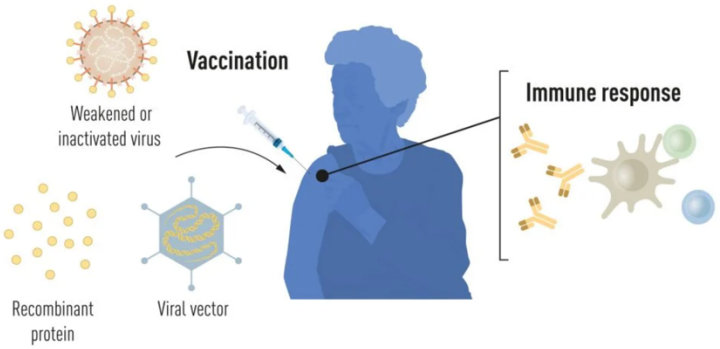
2) S&T: UNDERSTANDING VARIOUS TYPES OF VACCINES

– **Live Attenuated virus vaccines** such as the combined rubella-mumps-measles vaccines and the yellow fever virus vaccine, induce **robust and long-lived antibody and T-cell mediated immunity**.
  » **Note**: For the development of yellow fever vaccine, Max Theiler was awarded the Nobel Prize in Physiology or Medicine in 1951.

  » These vaccines **induce effective but transient immune responses**, requiring repeated boosting.

  » COVID-19 vaccine developed using this mechanism - Covaxin developed by Bharat biotech.

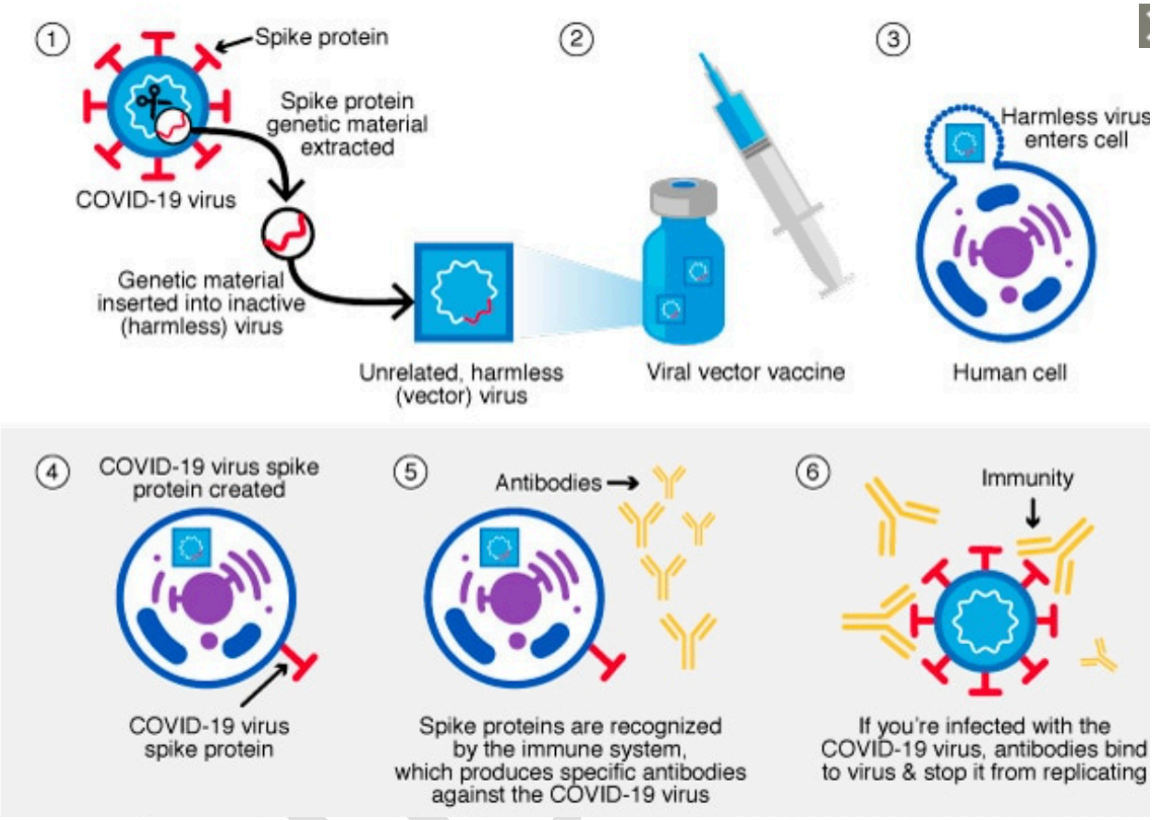
– **Viral Vector Vaccines**: It uses a safe virus (not harmful) which serves as a platform to produce target proteins to generate immune response.
  » Such viral vector efficiently enters cells where the encoded antigen are produced by the bodies protein synthesis machinery.
    • The first example of a licensed viral vector vaccine was the Vesicular stomatitis virus - based vaccine against **Ebola**, approved in 2019, which was soon followed by an adenovirus-based Ebola vaccine.



  – **During COVID-19** various vaccines
    » **Oxford-AstraZeneca** (ChAdOx1 nCoV-19) used adenovirus route.

- **Covishield** used in India is a version of this.

» **Sputnik V Vaccine** also has gone adenovirus route.



- **Both the above methods** (live attenuated virus or viral vector vaccine) used cell culture-based manufacturing facilities which is **resource intensive**. Further they **may also introduce diseases** and is safer and stable than vaccine containing whole pathogens.

- Therefore, researchers have focused upon sub-unit vaccines that circumvent the need of large-scale cell cultures by delivering nucleic acid (DNA or mRNA) directly to vaccine recipients, exploiting the body's own capacity to produce proteins.

– **Subunit Vaccines**: (Protein subunit vaccines)

» Protein subunit vaccines **include only the parts of virus that best stimulate immune system**. These vaccines contain single protein components of the respective virus and are referred as subunit vaccine.

- It includes Hepatitis B Vaccine (HBV) and Human papillomavirus (HPV) vaccine.

» **advantages:**

- No risk of introducing the disease and is safer and stable than vaccine containing whole pathogens.
- Suitable for immunocompromised individuals.
- Well established tech

» **Disadvantage**
- Relatively complex to manufacture (compared to other vaccines like RNA vaccines)
- May require multiple doses.

» **COVID-19 vaccine** developed using this method:
- **Corbevax** is a protein subunit COVID-19 vaccine developed by Texas Children hospital. It delivers spike protein to the body directly.
  - **How was protein manufactured?**
    - Add gene of spike protein into yeast to produce large number of proteins. After isolating the virus spike protein from the yeast and adding an adjuvant, which helps trigger an immune response, the vaccine was ready.

– **DNA and RNA subunit vaccines**:
» **Advantages** of subunit vaccines (DNA or mRNA vaccines)
- **Less Resource intensive** and thus easy to manufacture.
- **More flexibility** - Since the sequence can be easily changed to encode different antigens.
- This also makes iterative testing of new candidate vaccines and generation of updated vaccines rapid and efficient.

» **Initially DNA vaccine was thought to be more promising** but didn't translate into success. A likely reason for it was that injected DNA must cross two barriers, the plasma membrane and the nuclear membrane, to reach the cellular compartment where transcription takes place (DNA conversion to mRNA). In contrast, mRNA-based vaccines only need to gain access to the cell cytoplasm where translation takes place (mRNA conversion to protein)

» **Another advantage of mRNA vaccine**: Delivered nucleic acid can't integrate into the host genome. This is an additional safety aspect of this method.
- **E.g of DNA vaccine** (developed for COVID-19):
- **E.g for mRNA vaccine** (developed for COVID-19): Moderna COVID-19 (mRNA-1273) vaccine.

3) S&T: BIOLOGY/PHYSIOLOGY NOBEL PRIZE, 2023

– The 2023 Nobel Prize in Physiology or Medicine has been awarded to **Katalin Kariko (**Hungary) and **Drew Weissman** (USA) for their **discoveries concerning nucleoside base modifications that enabled the development of effective mRNA vaccine against COVID-1**9. Through their groundbreaking findings, which have fundamentally changed our understanding of how mRNA interacts with our immune system, the laureates contributed to the unprecedented rate of vaccine development during the COVID-19 crisis.

– **Background:**
» **Other methods of vaccine development** - Whole Virus -, protein-, and vector- based vaccines requires **large scale cell culture**. It is a **resource intensive** process and **limits the possibilities for**

rapid vaccine production in response to outbreaks and pandemics. **mRNA based vaccines** solved these problems.

- **During the 1980s**, efficient methods of producing mRNA without cell culture were introduced, called **in-vitro transcription**. Ideas of using mRNA technologies for vaccine and therapeutic purposes also took off, but **roadblocks lay ahead**.
  - » *In vitro* transcribed mRNA was **considered unstable and challenging to deliver**. It required development of **sophisticated carrier lipid systems** to encapsulate the mRNA.
  - » This mRNA also gave rise to **inflammatory reactions**.
  - » These problems limited the enthusiasm for developing the mRNA technology for clinical purposes.
- **Contributions**:
  - » **In 1990s**, Kariko was an assistant professor at the University of Pennsylvania and met immunologist **Drew Weissman there**.
  - » They worked together to prevent the immune system from launching an inflammatory reaction against lab-made mRNA, previously seen as a major hurdle against therapeutic use of mRNA.
    - They found that **inflammatory response** was almost abolished when base modification was included in the mRNA. Therefore, in 2015 they published that adjustments (modifications) to nucleosides, can keep the mRNA under the immune system's radar.
    - Later, they also showed that the delivery of mRNA generated with base modification markedly **increased protein production compared to unmodified mRNA**. This effect was due to the reduced activation of an enzyme that regulates protein production.

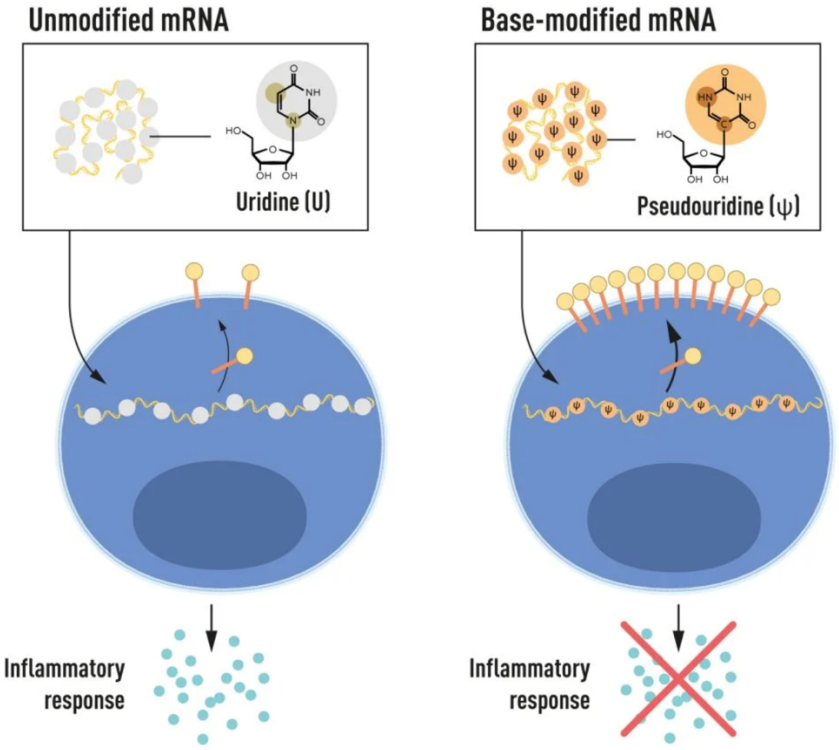


Figure 2. mRNA contains four different bases, abbreviated A, U, G, and C. The Nobel Laureates discovered that base-modified mRNA can be used to block activation of inflammatory reactions (secretion of signaling molecules) and increase protein production when mRNA is delivered to cells.

- **Development of Vaccines**:
  - After the above discoveries, interest in mRNA technology picked up. Vaccines for Zika and MERS-CoV were pursued.

  - **After the outbreak of COVID-19 pandemic**, two base-modified mRNA vaccines encoding the SARS-CoV-2 surface protein were developed at record speed. Protective effects of around 95% were reported, and both vaccines were approved as early as Dec 2020.

  - The impressive flexibility and speed with which mRNA vaccines can be developed pave the way for using the new platform also for vaccine against other infectious diseases.
  - In the future, the technology may also be used to deliver therapeutic proteins and treat some cancer types.

  - **How mRNA vaccine protects you against COVID-19**:

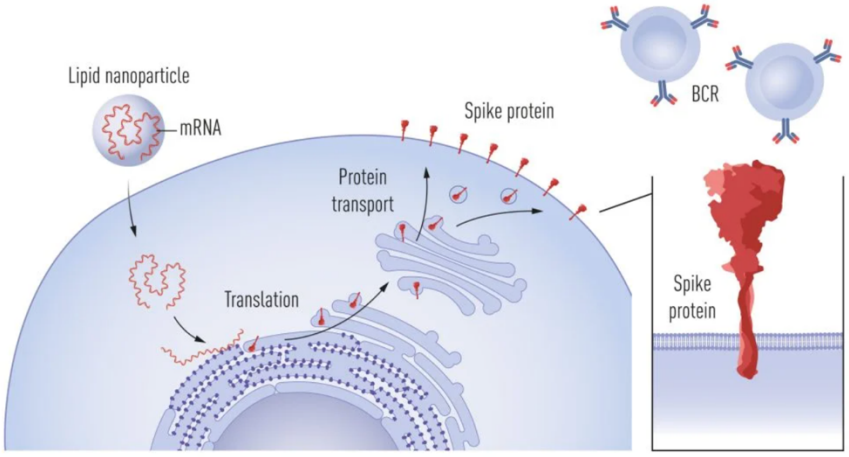


Figure 4. Spike production following mRNA vaccination and recognition of spike by B cells.
Following uptake of mRNA into cells, facilitated by lipid nanoparticles, the mRNA acts as a template for spike protein production. Spike is then transiently expressed on the cell surface, where it is recognized by B cells via their B cell receptors (BCRs), stimulating the secretion of spike-specific antibodies.

  - Through their fundamental discoveries of the importance of base modification in mRNA, this year's Nobel Laureates critically contributed to this transformative development during one of the biggest health crises of our time.

4) S&T: PHYSICS NOBEL PRIZE 2023

- **Quick Summary:**
  - » **Anne L'Huillier**, **Pierre Agostini** and **Ferenc Krausz** have been awarded Nobel Prize in Physics, 2023.
  - » **What did they do?**
    - Through their experiments, they have created **flashes of light that are short enough to take snapshots of electrons**' extremely rapid movements.
    - **Anne L'Huillier** discovered a new effect from laser light's interaction with atoms in a gas.
    - **Pierre Agostini** and **Ferenc Krausz** demonstrated that this effect can be used to create shorter pulses of light than were previously possible.

- **Background: Understanding the Problem**:

» Human eyes cannot clearly see hummingbird's beating its wings which can be around 80 times per second. We are only able to perceive this as a whirring sound and blurred movement. It is because extremely short events are impossible to observe by human eyes.

- **High Speed photography** can capture detailed images of fleeting (short) phenomena. **A highly focused photograph of a hummingbird in flight requires an exposure time that is much shorter than a single wingbeat**.

- **The faster the event, the faster the picture needs to be taken if it is to capture the instant**.

- **Atom's** natural timescale is that of femtoseconds (10^{-15} sec). These movements can be studied with the very shortest pulses that can be produced with a laser.
  - A **femtosecond** was, in the 1980s, regarded as the limit for the flashes of light it was possible to produce.

- But, electrons natural timescale is further lower in **attoseconds (10^{-18} sec)** i.e. in the world of electrons, positions and energies change at speeds of between one and a few hundred attoseconds. Therefore, flashes of light produced at femtosecond was not enough to see processes occurring on the timescale of electrons.

- **Development of Attosecond Pulses**:
  - » The mathematics that describes waves demonstrate that any wave form can be built if enough waves of the right sizes, wavelengths, and amplitudes (distance between peaks and troughs) are used. The **trick to attosecond pulses** is that it is possible to make shorter pulses by combining more and shorter wavelengths.
  - » **In 1987**, **Anne L' Huillier and her colleague**s at a French laboratory passed an infrared laser beam through a noble gas. The beam's interaction with atoms in the gas produced **overtones** (overtones are waves of light whose wavelength was an integer fraction of the beam. For e.g, if the beam had a wavelength of 100, the overtones would have wavelength of 10, 25, 50 etc.)
    - By finetuning the setup used to produce the overtones, scientists realized that it should be possible to create intense pulses of light each a few attosecond long.
  - » **In 2001**, **Pierre Agostini** and his research group in France successfully produced and investigated a series of 250-attosecond light pulses, or a pulse train.
  - » **At the same time**, **Ferenc Krausz** and his team in Australia developed a technique to separate an **individual 650 second pulse from a pulse train**.
    - Using this researcher were able to measure the energy of some electrons released by some krypton atoms.

- **Applications of attosecond physics**:
  - » It allows scientists to capture images of activities that happen in incredible short spans. This can be used for exploring short-lived atomic and molecular processes implicated in fields like material, science, electronics, and catalysis.
  - » In **medical diagnostics,** attosecond pulses can be used to check for the presence of certain molecules based on their fleeting signatures.
  - » These pulses could also be used to develop faster electronic devices, and better telecommunication, imaging and spectroscopy.

5) S&T: CHEMISTRY NOBEL PRIZE: QUANTUM DOTS

- **Quick Summary**:

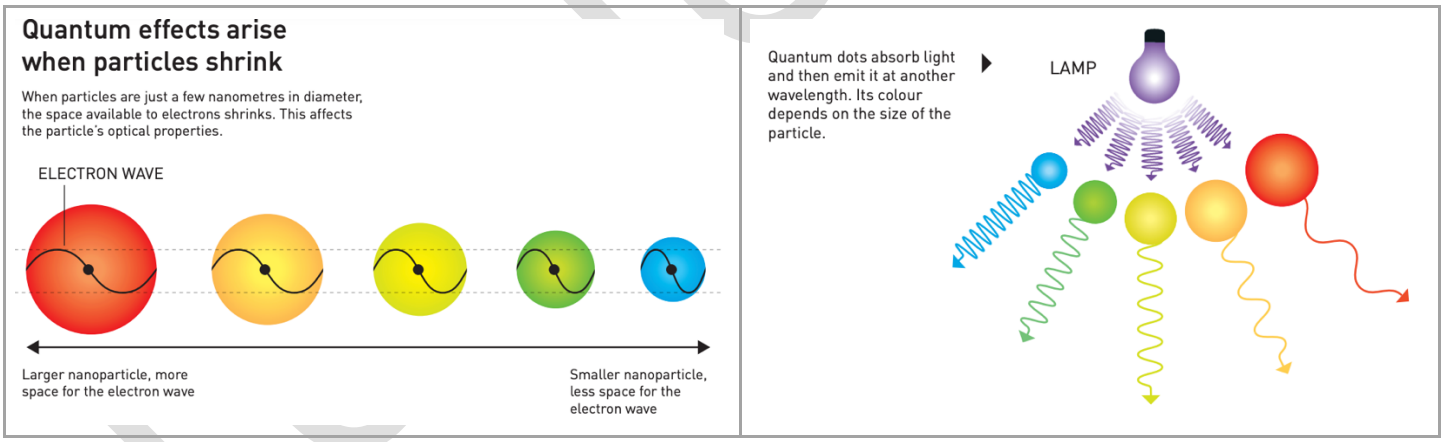
» The **Royal Swedish Academy of Sciences** has decided to award the Nobel Prize in Chemistry, 2023 to:
  a. **Moungi G. Bawendi** (MIT, USA)
  b. **Louis E. Brus** (Columbia University, USA)
  c. **Alexei I. Ekimov** (Nanocrystals Technology Inc., New York, NY, USA)

"For the discovery and synthesis of "Quantum Dots".

– **Details**:
  » **Quantum Dots** are nanoparticles so tiny that their size determines their properties.
    ○ **Understanding Size of Quantum Dots**:

A quantum dot is a crystal that often consists of just a few thousand atoms. In terms of size, it has the same relationship to a football as a football has to the size of the Earth.

  » **Understanding Properties:** They have many fascinating and unusual properties. Importantly, they have different colors depending on their size.



– **For decades**, Quantum phenomena in the nanoworld were just a prediction.

– **Contributions:**
  » **In the early 1980s,** Alexie Ekimov and Louis Brus succeeded in creating - independently of each other - quantum dots, which are nanoparticles so tiny that quantum effects determine their characteristics.
    ○ **Alexie Ekimov**, in early 1980s, succeeded in creating size-dependent quantum effects in colored glasses.

        - The color came from nanoparticles of copper chloride and Ekimov demonstrated that the particle size affected the color of the glass via quantum effects.
        - This was the first time someone had succeeded in deliberately producing quantum dots - nanoparticles that cause size-dependent quantum effects.
    - **Louis Brus**, a few years later, was the first scientist in the world to prove **size-dependent quantum effects** in particles floating freely in a fluid.

» **Moungi Bawendi**, in 1993, revolutionized the chemical production of quantum dots, resulting in almost perfect particles. This high quality was necessary for them to be utilized in applications.

- **Applications:**
  - » Researchers have primarily utilized quantum dots to create colored light.
    - The luminous property of quantum dots is utilized in **computer and television screens** based on QLED technology, where the Q stands for quantum dot.
    - In these screens blue light is produced using the energy-efficient diodes that were recognized with the Nobel Prize in Physics 2014. Quantum dots are used to change the color of some of the blue light, transforming it into red or green. This makes it possible to produce three primary colors of light needed in a television screen.
  - » **LED Lamps**: Quantum dots are used in LED lamps to adjust the cold light of the diodes. The light can then become as energizing as daylight or as calming as the warm glow from a dimmed bulb.
  - » **Biochemistry and Biomedicine**: Biochemists attach quantum dots to biomolecules to map cell and organs. Doctors are also investigating the potential use of quantum dots to track tumour tissue in the body. Chemists instead use the catalytic properties of quantum dots to drive chemical reactions.
    - **Surgeries**: These can guide surgeons when they remove tumour tissues, among many other things.
  - » **Future Applications**: Researchers believe that in the future they could contribute to flexible electronics, tiny sensors, thinner solar cells, and quantum cryptography.

- **Conclusion**:
  - » Quantum Dots are bringing great benefits to humankind, and we have just begun to explore their potential.

6) ECONOMY NOBEL: WORKPLACE GENDER GAP

- **Why in news?**
  - » 2023 Nobel Prize in Economic Sciences awarded to U.S. economist Claudia Goldin for research on the workplace Gender Gap (Oct 2023)

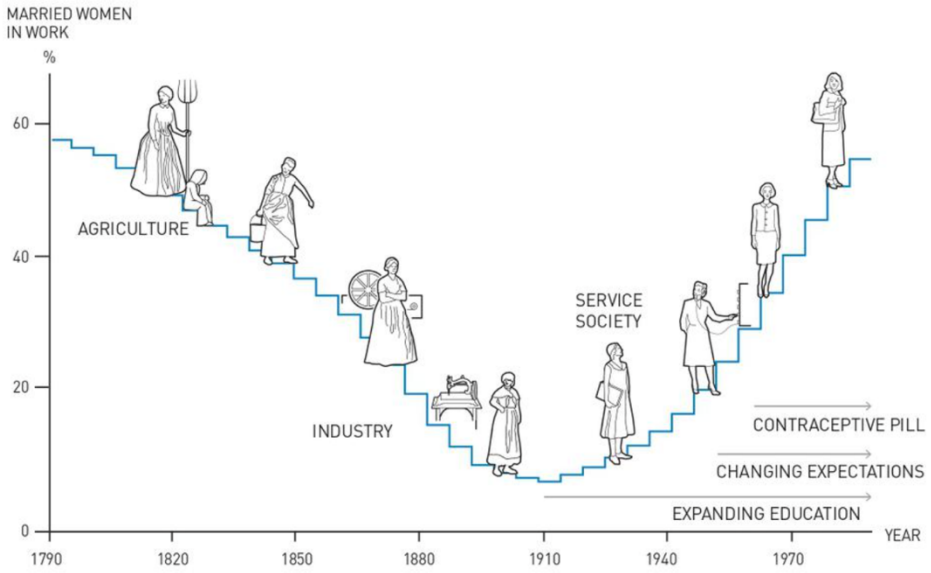
- **Details:**
  - » **Claudia Goldin**, a professor at Harvard is only the third woman to ever be awarded the economic prize.
    - Earlier, Elinor Ostrom was awarded this in 2009 and Esther Duflo was awarded in 2019.

- **Key Contribution**:

» She has **studied 200 years of women participation in workplace in USA**. Her work is the "first comprehensive account of women's earning and labour market participation through the centuries".

» As per her, the most important in the unequal paradigm "**is that both lose**". Men are able to have the family and step up because women step back in terms of their jobs, but both are deprived. Men forgo family time and women often forego their career.

» The **most significant of her observation** was that **female participation in the labor market didn't exhibit an upward trend over the entire period**, but rather a **U-Shaped curve**. In other words, economic growth ensuing in varied periods didn't translate to reducing gender differences in the labour market.

- 

– **How did female participation move between the agrarian and industrial era?**

» The **participation of married women decreased with the transition from an agrarian to an industrial society** in the early nineteenth century.

○ **The female participation in labor force was incorrectly assessed** and stated in census and public data.

• For e.g, a standard practice entailed categorizing women's occupation as "wife" in records. This was wrong because this identification didn't account for activities other than domestic labor such as working alongside husband in farms or family businesses, in cottage industry etc.

• Thus, **proportion of females in labor force** was considerably greater at the end of the 1790s than was shown in the official stats.

○ **Prior to advent of industrialization** in the 19th century, women were more likely to participate in the labor force. This was because industrialization had made it harder for married women to work from home since they wouldn't be able to balance the demand of their family.

- **The beginning of the 20th century marked the upward trajectory for female participation in the labor force**:
    - **Technological progress**, **the growth of the service sector** and **increased levels of education** brought an increasing demand for more labor.
        - **However**, **Social Stigma**, **legislation** and other institutional barriers limited their influence.
        - **Marriage Bars** and **Prevalent Expectations** were two factors of importance there.
            - **Marriage Bars** refer to the practice of firing and not hiring women once married. This peaked during the 1930s Great Depression and the ensuing years - preventing women from continuing as teachers or officer workers.
            - **Prevalent Expectations** about their future careers. Women at varied points were subject to different circumstances when deciding on their life choices. Their decisions could be based on an assessment of expectations that might not come to fruition.
                - In the early 20th century for example, women were expected to exit the labor force upon marriage. When things turned marginally in the second half of the century, married women would return to the labor force once their children were older. However, this meant a reliance on educational choices that were made previously, as the author notes, **at a time when they were not expected to have a caree**r. The "underestimation" was overcome in the 1970s when young women **invested more in education**.

        - **Introduction of birth control pills** played a crucial role in creating conditions for women to plan their careers better. Though this influenced educational and career choices positively, it didn't translate into **disappearance of the earning gap** between men and women, though it became significantly smaller since the 1970s.
        - **Pay Discrimination** (i.e., employees being paid differently because of factors such as color, religion, or sex, among others) increased significantly with the growth of the services sector in the 20th century.

- **Source of Gap**:
    - » **Needing to combine paid work and family care needs**.
    - » **Decisions** (and expectations) related to pursuing education and raising children.
    - » **Technical Innovations**
    - » **Laws and norms**
    - » **Structural transformation in an economy**.

- **Nobel laureate Claudia Goldin's hope** for the future is that women have a career as well as a spouse who wants what they want.