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A Shankar IAS Academy Initiative

SCIENCE MONTHLY

JULY 2019

Shankar IAS Academy™

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SPACE

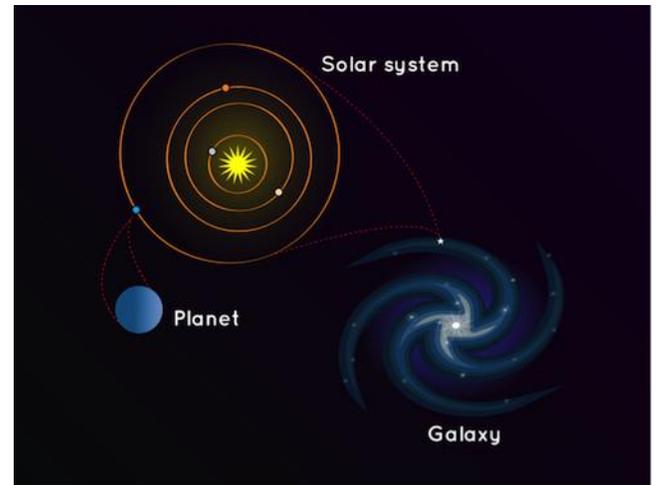
1. MILKY WAY'S VIOLENT BIRTH DECODED

Why in News?

The Milky Way, merged with another smaller galaxy in a colossal cosmic collision roughly 10 billion years ago, scientists said.

What is a galaxy?

- A galaxy is a huge collection of gas, dust, and of stars and their solar systems.
- Stars are collected together into galaxies.
- Galaxies are collected together into groups of galaxies, and these groups are collected into clusters.
- The largest structures in the Universe are galaxy superclusters, which contain millions of galaxies and can measure hundreds of millions of light-years across.
- A galaxy is held together by gravity.
- Our galaxy, the Milky Way, also has a supermassive black hole in the middle.



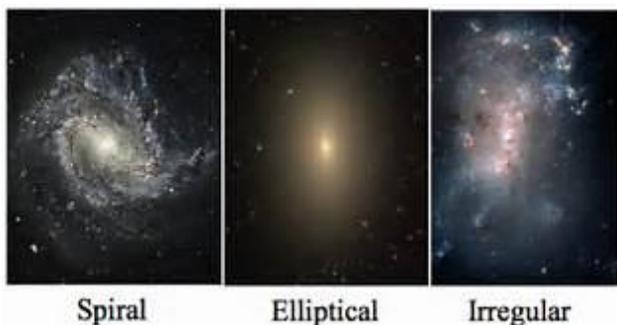
What are the types of galaxies?

- There are three main types of galaxies: Elliptical, Spiral, and Irregular.
- Two of these three types are further divided and classified into a system that is now known the tuning fork diagram.

Spiral galaxies:

- Spiral galaxies are the most common type in the universe.
- Our Milky Way is a spiral, as is the rather close-by Andromeda Galaxy.
- Spirals are large rotating disks of stars and nebulae, surrounded by a shell of dark matter.
- The central bright region at the core of a galaxy is called the “galactic bulge”.

- Many spirals may also contain supermassive black holes in their cores.



2. PUNCH MISSION

Why in News?

Dipankar Banerjee, solar physicist from Indian Institute of Astrophysics is a Co-Investigator of the PUNCH mission.

What is PUNCH mission?

- NASA has selected two new missions to advance our understanding of the Sun and its dynamic effects on space.
- One of the selected missions will study how the Sun drives particles and energy into the solar system and a second will study Earth's response.
- PUNCH stands for "Polarimeter to Unify the Corona and Heliosphere."
- It will focus directly on the Sun's outer atmosphere, the corona, and how it generates the solar wind.
- Composed of four suitcase-sized satellites, PUNCH will image and track the solar wind as it leaves the Sun.
- The spacecraft also will track coronal mass to better understand their evolution and develop new techniques for predicting such eruptions.

Elliptical galaxies:

- Elliptical galaxies are roughly egg-shaped (ellipsoidal or ovoid) found largely in galaxy clusters and smaller compact groups.
- Most ellipticals contain older, low-mass stars, and lack a great deal of star-making gas and dust clouds.
- Therefore there is little new star formation occurring in them.
- Messier 87 is an example of an elliptical galaxy.

Irregular galaxies

- Irregular galaxies are as their name suggests: irregular in shape.
- The best example of an irregular that can be seen from Earth is the Small Magellanic Cloud.



ENVIRONMENT

3. PREDICTING MONSOON

Why in News?

Predicting monsoon seems to be difficult now a days.

What causes a monsoon?

- A monsoon arises due to a difference in temperatures between a land mass and the adjacent ocean.
- The sun warms the land and ocean differently, according to Southwest Climate Change.
- This differential heating causes the winds to eventually switch directions bringing the cooler, moister air from over the ocean.
- The winds reverse again at the end of the monsoon season

What is the difference between hurricane or typhoon and monsoon?

- A monsoon often brings about thoughts of torrential rains, similar to a hurricane or typhoon.
- But there is a difference: a monsoon is not a single storm; rather, it is a seasonal wind shift over a region.
- The shift may cause heavy rains in the summer, but at other times, it may cause a dry spell.

What are some of the important factors affecting Indian monsoon?

- The differential heating of the Indian Ocean and the landmass of Asia.
- The presence and circulation of upper air jet streams in the troposphere.
- The occurrence of snow over the Tibetan Plateau.

4. ZERO BUDGET FARMING

Why in News?

To improve farm income Union Finance Minister Nirmala Sitharaman announced a proposal of zero budget farming

What is zero budget farming?

- This is technically known as Zero Budget Natural Farming (ZBNF), as the Food and Agriculture Organisation of the United Nations calls it
- It is a set of farming methods that involve zero credit for agriculture and no use of chemical fertilisers.
- This evolved as a farming movement in Karnataka as a result of collaboration between agriculturist Subhash Palekar and state farmers association Karnataka Rajya Raitha Sangha (KRRS).
- As it attained considerable success in Karnataka, the model was replicated in

many other states, particularly in South India.

- The zero budget farming aims at pulling the farmers out of the debt trap.
- This is also an attempt to make small scale farming a viable vocation.
- Zero budget farming model promises to cut down farming expenditure drastically and ends dependence on loans.
- It also reduces dependence on purchased inputs as it encourages use of own seeds and locally available natural fertilizers.
- Farming is done in sync with the nature not through chemical fertilisers.

INNOVATION

5. HYDROGEN POWERED FLYING CAR

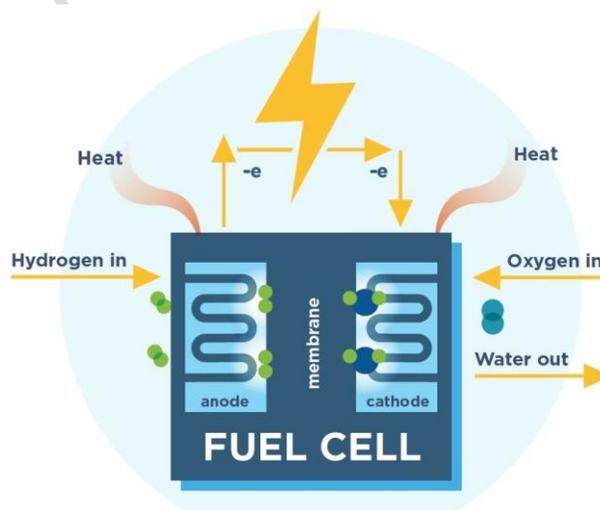
Why in News?

Massachusetts startup Alaka'i has designed a flying car - Skai - "first air mobility vehicle powered by hydrogen fuel cells".

How hydrogen fuel cell works?

- A fuel cell is composed of an anode, a cathode, and an electrolyte membrane.

- A fuel cell works by passing hydrogen through the anode of a fuel cell and oxygen through the cathode.
- At the anode site, the hydrogen molecules are split into electrons and protons.
- The protons pass through the electrolyte membrane, while the electrons are forced through a circuit, generating an electric current and excess heat.
- At the cathode, the protons, electrons, and oxygen combine to produce water molecules.



What are the important methods of producing hydrogen?

Thermochemical Processes

- Some thermal processes use the energy in various resources, such as

natural gas, coal, or biomass, to release hydrogen from their molecular structure.

- Some of the Thermochemical processes are
 1. Natural gas reforming (also called steam methane reforming or SMR)
 2. Coal gasification
 3. Biomass gasification
 4. Biomass-derived liquid reforming
 5. Solar thermochemical hydrogen (STCH).

Electrolytic Processes

- Electrolyzers use electricity to split water into hydrogen and oxygen.
- This technology is well developed and available commercially, and systems that can efficiently use intermittent renewable power are being developed.

Direct Solar Water Splitting Processes

- Direct solar water splitting, or photolytic, processes use light energy to split water into hydrogen and oxygen.
 - Photoelectrochemical (PEC)
 - Photobiological.

Biological Processes

- Microbes such as bacteria and microalgae can produce hydrogen through biological reactions, using sunlight or organic matter.
- Some biological processes are:
 - Microbial biomass conversion
 - Photobiological.

6. OPTOELECTRONICS

Why in News?

IIT Madras develops material with properties suitable for quantum optoelectronics

What is optoelectronics?

- Optoelectronics, in the context of science, deals with light, its detection, creation and manipulation for various purposes.
- This includes X-rays, gamma rays, infrared, ultraviolet and of course visible light.
- These devices are basically transducers, devices that convert one form of energy into another form of energy.
- It can either be electrical-to-optical, which usually means that the machine produces light by expending or using electrical energy.

- Also it can be optical-to-electronic, which means that the device is a detector of light and transforms the detected light signals into equivalent electrical signals for computer processing.

What are the quantum mechanical effects of light on materials in optoelectronics?

- Photovoltaic or photoelectric — This is the direct conversion of light into electricity, which is the effect taken advantage of by solar cells.
- Photoconductivity — This is an electrical phenomenon wherein a material becomes more conductive to electricity through the absorption of electromagnetic radiation such as infrared, ultraviolet and visible light. It is used in charge-coupled device (CCD) imaging sensors.
- Stimulated emission — This is a process where a light photon interacts with an excited molecule which causes it to drop to a lower energy level, resulting in the emission or "liberation" of an identical photon which is transferred to the electromagnetic field. This process is used in laser diodes and quantum cascade lasers.
- Radiative recombination — Electrons are transitioned from the valence to

the conducting band in semiconductors, resulting in a carrier generation and recombination effect which produces light. This process is how LEDs produce light.

BIO-TECHNOLOGY

7. RNA AND COLOUR OF FRUITS, LEAVES

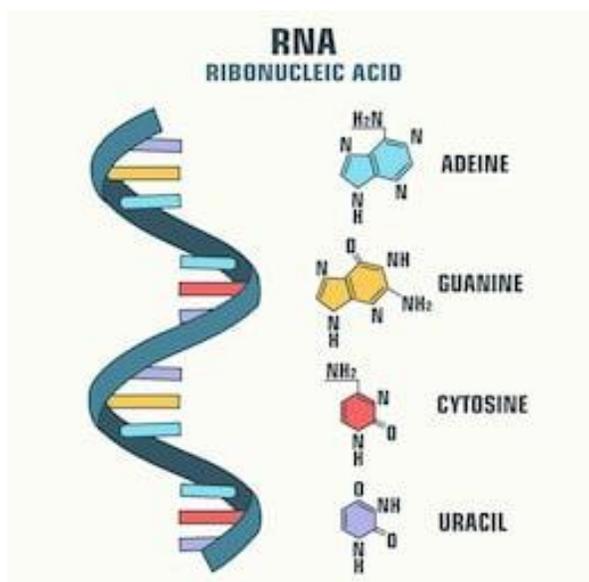
Why in News?

A team from the National Centre for Biological Sciences (NCBS), Bengaluru, has found that the rich colour in fruits and leaves of plants are indirectly controlled by specific micro RNAs — miR828 and miR858.

What is RNA?

- Ribonucleic acid, or RNA is one of the three major biological macromolecules that are essential for all known forms of life (along with DNA and proteins).
- Each RNA nucleotide consists of a nitrogenous base, a ribose sugar, and a phosphate.
- Each RNA molecule typically is a single strand, consisting of a relatively short chain of nucleotides.
- RNA can be shaped like a single helix, a straight molecule, or may be bent or twisted upon itself.
- In RNA, the base adenine binds to uracil.

- There are several types of RNA, including transfer RNA (tRNA), messenger RNA (mRNA), and ribosomal RNA (rRNA).



What are miRNAs?

- miRNAs are a class of endogenous small non-coding RNAs (ncRNAs).
- They are approximately 21 to 24 nucleotides in length found .
- They are found in plants and animals including humans.
- MiRNAs have recently emerged as key regulators in many biological pathways.
- MiRNAs function in the post-transcriptional regulation of gene expression.
- miRNA have been shown to regulate their target messenger RNA (mRNA) by

destabilizing mRNA molecules and translational repression.

What is transgenesis?

Transgenesis is the process of introducing an exogenous gene called a transgene into a living organism so that the organism will exhibit a new property and transmit that property to its offspring.

8. NIPHA VIRUS

Why in News?

Second run of Nipah could be averted through timely detection and control in Kerala.

What is Nipah virus?

- Nipah virus is a zoonotic virus (it is transmitted from animals to humans).
- It can also be transmitted through contaminated food or directly between people.
- In infected people, it causes a range of illnesses from asymptomatic (subclinical) infection to acute respiratory illness and fatal encephalitis.
- The virus can also cause severe disease in animals such as pigs, resulting in significant economic losses for farmers.

What is the treatment for Nipha virus?

- There are currently no drugs or vaccines specific for Nipah virus infection.
- WHO has identified Nipah as a priority disease for the WHO Research and Development Blueprint.

What is zoonotic disease?

- A zoonotic disease is a disease spread between animals and people.
- Zoonotic diseases can be caused by viruses, bacteria, parasites, and fungi. Some of these diseases are very common.

9. QUANTUM DOT AND CANCER DIAGNOSIS

Why in News?

A team of scientists in Assam has developed a chemical process that turns ‘dirty’ coal into a biomedical ‘dot’ to help detect cancer cells.

What is a Quantum Dot?

- Any material at the nanoscale is a nanoparticle.
- A quantum dot is a nanoparticle made of any semiconductor material such as silicon, cadmium selenide, cadmium sulfide, or indium arsenide.

How quantum dot revolutionise medicine?

- Quantum dots enable researchers to study cell processes at the level of a single molecule.
- This may significantly improve the diagnosis and treatment of diseases such as cancers.
- QDs used as active sensor elements in high-resolution cellular imaging, where the fluorescence properties of the quantum dots are changed upon reaction with the analyte.
- Also used in passive label probes where selective receptor molecules such as antibodies have been conjugated to the surface of the dots.

10. RICE BLAST RESISTANCE

Why in News?

By characterising over 150 rice varieties from in the country scientists identified new markers associated with rice blast resistance.

What is Rice blast disease?

- Rice blast is caused by a fungus *Magnaporthe oryzae*.
- It is one of the major diseases of the rice crop.

What are genetic markers?

- Genetic markers are used to identify different features in DNA sequence.
- The features can be used to differentiate between individuals in a population, or to classify individuals between different varieties or cultivars within a species.

What are the uses of genetic markers?

- The different features in the sequence can be used to identify if that particular region was inherited from the female or male parent.
- By using this information we can build up a more complete picture of each individuals genotype at each marker.
- This allows us to track the inheritance of different regions of the genome.

What are types of molecular genetic marker?

There are many, but some of the commonly used ones are:

- RFLP – Restriction Fragment Length Polymorphism
- SSR – Simple Sequence Repeat, or Microsatellite
- AFLP – Amplified Fragment length Polymorphism
- CAPS – Cleaved Amplified Polymorphic Sequence

- dCAPS – derived Cleaved Amplified Polymorphic Sequence
- STS – Sequence Tagged Site
- RAPD – Randomly Amplified Polymorphic DNA
- SNP – Single Nucleotide Polymorphism - technology to screen thousands in one go
- Also Phenotypic markers

11. ROTAVIRUS VACCINE IN UIP

Why in News?

Karnataka to introduce Rotavirus vaccine in Universal Immunisation Programme

What is Rotavirus?

- Rotavirus is caused by a virus.
- Rotaviruses are the most common cause of severe diarrhoeal disease in young children throughout the world.
- It mostly affects babies and young children.
- Rotavirus spreads when a person comes in contact with the poop of someone who has rotavirus.

What are the Symptoms of rotavirus?

- Severe diarrhea
- Throwing up
- Dehydration
- Fever

- Stomach pain
- Changes in behavior

What is Universal immunization programme?

- Immunization Programme in India was introduced in 1978 as 'Expanded Programme of Immunization' (EPI) by the Ministry of Health and Family Welfare, Government of India.
- In 1985, the programme was modified as 'Universal Immunization Programme' (UIP).

What are the vaccines provided under UIP?

BCG

- About-BCG stands for Bacillus Calmette-Guerin vaccine. It is given to infants to protect them from tubercular meningitis and disseminated TB.
- When to give – BCG vaccine is given at birth or as early as possible till 1 year of

OPV

- About-OPV stands for Oral Polio Vaccine. It protects children from poliomyelitis.
- When to give- OPV is given at birth called zero dose and three doses are

given at 6, 10 and 14 weeks. A booster dose is given at 16-24 months of age.

Hepatitis B vaccine

- About – Hepatitis B vaccine protects from Hepatitis B virus infection.
- When to give- Hepatitis B vaccine is given at birth or as early as possible within 24 hours. Subsequently 3 dose are given at 6, 10 and 14 weeks in combination with DPT and Hib in the form of pentavalent vaccine.

Pentavalent Vaccine

- About-Pentavalent vaccine is a combined vaccine to protect children from five diseases Diphtheria, Tetanus, Pertussis, Haemophilis influenza type b infection and Hepatitis B.
- When to give - Three doses are given at 6, 10 and 14 weeks of age (can be given till one year of age).

Rotavirus Vaccine

- About -RVV stands for Rotavirus vaccine. It gives protection to infants and children against rotavirus diarrhoea. It is given in select states.
- When to give - Three doses of vaccine are given at 6, 10, 14 weeks of age.



PCV

- About- PCV stands for Pneumococcal Conjugate Vaccine. It protects infants and young children against disease caused by the bacterium *Streptococcus pneumoniae*. It is given in select states.
- When to give - The vaccine is given as two primary doses at 6 & 14 weeks of age followed by a booster dose at 9 months of age

fIPV

- About- fIPV stands for Fractional Inactivated Poliomyelitis Vaccine. It is used to boost the protection against poliomyelitis.
- When to give- Two fractional doses of IVP are given intradermally at 6 and 14 weeks of age.

Measles/ MR vaccine

- About-Measles vaccine is used to protect children from measles. In few states Measles and Rubella a combined vaccine is given to protect from Measles and Rubella infection.
- When to given- First dose of Measles or MR vaccine is given at 9 completed months to 12 months (vaccine can be given up to 5 years if not given at 9-12

months age) and second dose is given at 16-24 months.

JE vaccine

- **About-** JE stands for Japanese encephalitis vaccine. It gives protection against Japanese Encephalitis disease. JE vaccine is given in select districts endemic for JE.
- When to given- JE vaccine is given in two doses first dose is given at 9 completed months-12 months of age and second dose at 16-24 months of age.

DPT booster

- About-DPT is a combined vaccine; it protects children from Diphtheria, Tetanus and Pertussis.
- When to give -DPT vaccine is given at 16-24 months of age is called as DPT first booster and DPT 2nd booster is given at 5-6 years of age.

TT

- About- Tetanus toxoid vaccine is used to provide protection against tetanus.
- When to give- Tetanus toxoid vaccine is given at 10 years and 15 years of age when previous injections of pentavalent vaccine and DPT vaccine are given at scheduled age.

- Pregnant women-TT-1 is given early in pregnancy; and TT-2 is given 4 weeks after TT-1.TT booster is given when two doses of TT are given in a pregnancy in last three years.

12. WORLD HEPATITIS DAY

Why in News?

The World Health Organisation has listed viral hepatitis as a major public health problem throughout the world and particularly in India.

What is hepatitis?

- Hepatitis is an inflammation of the liver.
 - The condition can be self-limiting or can progress to fibrosis (scarring), cirrhosis or liver cancer.
 - Hepatitis viruses are the most common cause of hepatitis in the world but other infections, toxic substances (e.g. alcohol, certain drugs), and autoimmune diseases can also cause hepatitis.
 - There are 5 main hepatitis viruses, referred to as types A, B, C, D and E.
 - These 5 types are of greatest concern because of the burden of illness and death they cause and the potential for outbreaks and epidemic spread.
- In particular, types B and C lead to chronic disease in hundreds of millions of people and, together, are the most common cause of liver cirrhosis and cancer.
 - Hepatitis A and E are typically caused by ingestion of contaminated food or water.
 - Hepatitis B, C and D usually occur as a result of parenteral contact with infected body fluids.
 - Common modes of transmission for these viruses include receipt of contaminated blood or blood products, invasive medical procedures using contaminated equipment and for hepatitis B transmission from mother to baby at birth, from family member to child, and also by sexual contact.