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### From The Chief Editor's Desk



Dr. Basudeb Bakshi

Dear Readers,

It gives us great pleasure and pride to present the 9<sup>th</sup> volume of biannual E-magazine "Spectrum: The Measure of Progress". In this era of technology, E-magazine is the fastest approachable platform to showcase research work, achievements and new developments in science and technology. The goal is to unlock young minds' potential and provide a platform to express and exchange their ideas, knowledge, and information about current trends in innovation, science and technology.

This magazine should be viewed as a launch pad for those who have the potential to thrive ahead. We, in "Spectrum: The Measure of Progress", believe that sky is not the limit for the knowledge and innovative ideas. The institute focuses on advancing knowledge and enlightening students in science and technology. All of us in the editorial board enjoyed compiling this magazine immensely. On behalf of our editorial team, I would like to offer a word of thanks to all our readers, contributors, authors, and editors who have volunteered to contribute for the success of the E-magazine. I hope, our readers will find this E-magazine informative and inspiring. With all best wishes for fulfilment of each dream.

### Genome editing technology-A potential tool for human welfare.



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#### Introduction

Genome editing is a group of technologies that give scientists the ability to change an organism's DNA. Genome editing, or genome engineering, or gene editing, is a type of genetic engineering in which DNA is inserted, deleted, modified, or replaced in the genome of a living organism. Unlike early genetic engineering techniques that randomly insert genetic material into a host genome, genome editing targets the insertions to site-specific locations. Genome editing technology is a technique for targeted genetic modifications, enabling the knockout and addition of specific DNA fragments. This technology has been widely used in various types of biomedical research, clinics, and agriculture.

#### Techniques of genome editing

There are four genome editing techniques -

1. Restriction Enzymes or Mega

endonuclease- It is a first site-specific endonuclease enzyme discovered and purified from bacteria and is frequently used to cut and modify DNA and genome of any organism. Targeted nucleases have provided researchers with the ability to manipulate virtually any genomic sequence, enabling the facile creation of isogenic cell lines and animal models for the study of human disease, and promoting exciting new possibilities for human gene therapy.

2. Zinc Finger Nucleases (ZFNs): It increases recognition potential for editing specific gene sequences. ZFNs are class of DNA binding proteins. Facilitate target editing of genome. ZFNs, are the fusions between a custom-designed Cys2-His2 zinc-finger protein and the cleavage domain of the FokI restriction.

3. Transcription activator like effector-based nuclease (TALENs) commonly called TALE Nucleases based on fusion of DNA binding domain and DNA cleavage domain. TALENs can engineered to bind any desired sequences to cut at specific location of DNA. TALENs are typically assembled to recognize between 12- to 20-bps of DNA, with more bases typically leading to higher genome-editing specificity.

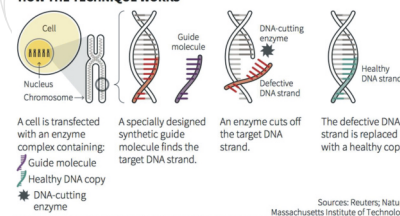
Compared to ZFNs, TALENs show

improved specificity, reduced toxicity and increased affinity for target DNA

4. Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)-Cas9 gene editing. The most important and advance method of gene and genome editing discovered recently.

Among above all four technology, CRISPR-Cas9 and TALENs can be configured to recognize new genomic sequences has driven a revolution in genome editing that has accelerated scientific breakthroughs and discoveries in disciplines as diverse as synthetic biology, human gene therapy, disease modelling, drug discovery, neuroscience, and the agricultural sciences.

#### HOW THE TECHNIQUE WORKS



#### What Is CRISPR Gene Editing?

CRISPR is a type of gene-editing technology that lets scientists more rapidly and accurately 'cut' and 'paste' genes into DNA. It is based on a targeted DNA-destroying defence system originally found in certain prokaryotes.



The most widely used approach to genome editing nowadays is based on Clustered Regularly Interspaced Short Palindromic Repeats and associated protein 9 (CRISPR-Cas9). In prokaryotes, CRISPR-Cas9 is an adaptive immune system that naturally protects cells from DNA virus infections. CRISPR-Cas9 has been modified to create a versatile genome editing technology that has a wide diversity of applications in medicine, agriculture, and basic studies of gene functions.

The Nobel prize in chemistry 2020 was awarded jointly to Emmanuelle Charpentier and Jennifer A. Doudna for the development of CRISPR/Cas9 method for genome editing. Using these, researchers can change the DNA of animals, plants and microorganisms with extremely high precision. This technology has had a revolutionary impact on the life sciences, is contributing to new cancer therapies and may make the dream of curing inherited diseases come true.

### Important applications of CRISPR

#### Technology for human welfare

- Inserting viral genome can be removed by altering immune cells. Can be used for treatment of viral infection like HIV, HSV, Covid 19 and other virus infection whose vaccine and treatment are not available.
- Could cure mutation derived cancer - Blood disorders, Blindness.
- Can be used for curing genetic and hereditary diseases by adding or removing DNA sequences that causing the diseases like Cystic fibrosis, Muscular dystrophy, Huntington's disease etc
- Organ transplantation- gene editing of mismatch human or even non-human mammals as a potential organ donor. Editing will reduce the risk of immune response and rejection when using mismatch organs/tissues/cell for transplantation.
- CRISPR-Cas9 has also allowed generation of animals suitable for human disease modelling. The team of Yuyu Niu from Yunnan Key Laboratory of Primate Biomedical Research

applied CRISPR-Cas9 via co-injection of Cas9 mRNA and sgRNAs into one-cell-stage embryos. The team generated CRISPR-edited cynomolgus monkeys for brain disorders that cannot be fully studied in mice.

- US scientists are also studying the use of CRISPR for treating the Human Immunodeficiency Virus (HIV). They used CRISPR to edit the HIV genome out of immune cells, called T cells, from an HIV patient. Scientists found that CRISPR can prompt the HIV virus to mutate. However, more studies are still needed before CRISPR can be used to treat HIV.
- Gene editing to produce cattle that are less susceptible to Foot and mouth diseases, tuberculosis, Brucellosis, Infectious bovine rhinotracheitis (IBR).
- CRISPR-Cas9 has great potential for transforming agriculture by making plants tolerant to biotic and abiotic stresses and improving their nutritional value and yield.

### Indian currency goes virtual



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The term crypto currency has lately gone synonymous with popular tenders like "Bitcoin, Ethereum and Dogecoin". However these have remained seemingly an unpopular

choice with the central banking authorities of various nations around the world. Hence, the central banking authority of India (RBI) is no exception to it and is rightly wary of the risks associated with crypto. However the current method involving hard cash based dealings is slowly losing the momentum and popularity likewise, also to mention costs involved and logistics demanded. Hence, catching up with the global trends, the central banking authority of India, RBI (Reserve Bank of India) has announced the launching of its indigenously developed digital currency termed as "Central Bank Digital Currency". But before we jump to the analysis of the development, it's essential to equip ourselves with some rudimentary facts. The first has to be the clarity on the difference between Crypto and Digital currency. So, keeping it easy, the digital currency differs from crypto currency on criteria of operation, platforms, regulating bodies, transaction methods etc.

### WHAT MOTIVATES INDIA TO DIGITALIZE THE RUPEE?

There are many grounds that are specific to the requirements of various nations and their economies that promote the introduction of digital currency. The island country of Bahamas had introduced the digital currency to tackle the issues relating to the distribution of hard cash owing to challenging geographical terrain. Similarly, countries such as Sweden are pondering upon this

method to minimize the use of paper in issuance of currency tender. Also the usage of private virtual currencies could lead to unwanted risky and dangerous consequences which can be potentially curbed by popularizing the regulated digital currency.

#### The factors that are motivating India's introduction of CBDC are as follows:

- The payment systems are available 24X7, 365 days a year to both retail and wholesale customers, they are largely real time, the cost of transaction is perhaps the lowest in the world, users have a wide array of options for doing transactions and digital payments have grown at an impressive CAGR of 55% over the last five years.

- Reduction in cost associated with physical cash management.

The total expenditure incurred on security printing during April 1, 2021 to March 31, 2022 was ₹4,984.80 crore as against ₹4,012.10 crore in the previous year (July 1, 2020 to March 31, 2021).

This cost, is predominantly borne by four stakeholders –general public, businesses, banks, and the Central Bank banknotes, and costs associated with delay in reconciliation and settlement.

- Further, given the geographical spread and pockets where making physical cash available is a challenge, CBDC is expected to facilitate seamless transactions.
- To further the cause of digitization to achieve a less cash economy.
- Supporting competition, efficiency and innovation in payments.
- Given the fact that India is the highest recipient of the remittances, the possibility of exploring a seamless cross border digital currency transaction mechanism could be hugely beneficial for India.
- Safeguard the trust of the common man in the national currency vis-à-vis proliferation of crypto assets
- The proliferation of CBDC will further

enhance the financial inclusion. The realization of the CBDCs is however equally necessary to see the benefits reaping. Hence, an effective and elaborate system needs to be developed in order to further simplify management, usage, tracking and security concerning the CBDCs.

#### THE CBDC TYPES.

The CBDC is supposed to be launched with two versions, namely CBDC-W and CBDC-R. The CBDC-W will serve the wholesale area whereas the CBDC-R will serve the retail region. Both the versions will be developed based on the requirements and the necessary functionalities.

The wholesale CBDCs are intended for the settlement of interbank transfers and related wholesale transactions. They serve the same purpose as reserves held at the central bank but with additional functionality

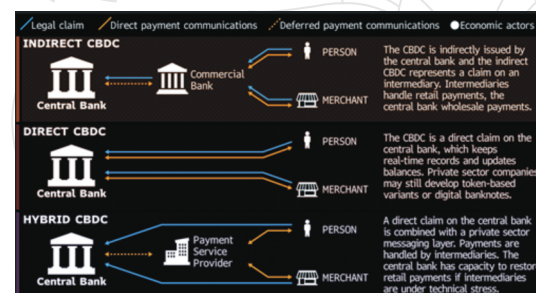
CBDC-R is an electronic version of cash primarily meant for retail consumption. India is already having a sound payment system with a different array of payment products ranging from RTGS, NEFT to UPI etc. coupled with an exponential increase in digital transactions. The introduction of CBDC-R will provide a safe, central bank instrument with direct access to the Central bank money for payment and settlement.

#### THE CBDC MODELS.

The CBDC is being planned to be developed on the proposed two models.

(The graphic below contains concise information about the proposed CBDC models)

- Single Tier Model
- Two-Tier Model





## FINAL TAKE

With the system and infrastructure competent enough to handle massive scale transactions, the CBDC will also come with cutting edge platforms

ensuring customer confidentiality and highest standards of authentication. The CBDC coming with top notch security standards is bound to attract flurry of customers in no time. Therefore,

there's no stopping CBDC from becoming India's yet another homemade digital marvel priority.

### Medicinal plants with their classification: A review



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The term of medicinal plants includes various types of plants used in herbalism and some of these plants have medicinal activities. These medicinal plants are considered as rich resources of ingredients that can be used in drug development and synthesis. Medicinal plants have been utilized as a wellspring of medicine. Affirmation of the safety, quality, and adequacy of therapeutic plants and natural products has currently become a key issue in industrial and developing nations. Active compounds created throughout secondary metabolism are typically responsible for the biological properties of plant species used throughout the globe for numerous functions, as well as the treatment of infectious diseases. Plants, which have one or more of their parts having substances that can be used for the treatment of diseases, are called medicinal plants.

As per World Health Organization ancient medication is that the whole of the information, skills, and practices supported the theories, beliefs, and experiences endemic to fully totally different cultures, whether or not comprehensible or not, used in the upkeep of health in addition as within the prevention, diagnosis, improvement or treatment of physical and mental disease. The term medicative plants embrace varied styles of plants employed in herbalism and a few of those plants have some meditative activities. medicative plants are the "backbone" of ancient drugs, which suggests quite 3.3 billion folks at intervals in the less developed countries consume medicative plants day to day. Herbal medicines may include whole parts of the plant or are mostly prepared from leaves, roots, bark, seed, and flowers of plants. They are administered orally,

inhaled, or directly applied to the skin. The utilization of typical medication and meditative plants in most developing nations, as a basis for the support of excellent eudaemonia, has been usually seen by United Nations Educational Scientific and Cultural Organization. Besides, an expanding dependence on the utilization of therapeutic plants in industrialized societies has been followed to the extraction and development of many medications and chemotherapeutics from these plants and in addition from conventionally utilized rural herbal medications.

**Classification of herbal medicines:** Recently the United Nations agency classified herbal medicines into four completely different categories consistent with their origin, evolution, and styles of current usage. Indigenous herbal medicines: Indigenous herbal medicines are those which are historically used in a local community or region and are very well known through long usage by the local population in terms of their composition, treatment, and dosage. It may be used freely by the area people or within the native region. However, if the medicines during this category enter the market or transcend the area people or region within the country, they need to satisfy the wants of safety and effectuality ordered down within the national regulations for herbal medicines. Herbal medicines in systems: herbal medicines in systems are used for an extended time and are documented with their special theories and ideas, and accepted by the countries. For example, Ayurveda, Unani, and Siddha. Modified herbal medicines: Modified herbal medicines are changed in form, or kind together with dose, dose type, mode of administration, herbal medicative ingredients, ways of preparation, and medical indications. They have to fulfil the national restrictive necessities of the security and effectiveness of herbal medicines. Imported product with a herbal medicine base: This category covers all foreign flavourer medicines furthermore as raw materials and products foreign herbal medicines should be registered and marketed within the countries of origin. The protection and efficaciousness

information ought to be submitted to the national authority of the commercialism country that wants to fulfill the wants of safety and efficaciousness of regulation of herbal medicines in the recipient country. The classification of Herbal medicines into; Ayurvedic Herbalism, Chinese Herbalism, African Herbalism, Western Herbalism. Greece and Rome were their originating countries which were then spread to Europe, and North and South Plants-based medicine play an important role in world health. Plant primary metabolites: Organic compounds created at intervals in the plant kingdom have metabolic functions essential for plant growth and development created in each plant, embody carbohydrates, amino acids, nucleotides, fatty acids, steroids, and lipids. Plant secondary metabolites: Organic compounds produced in Plantae don't have apparent functions involved in plant growth and development. Produced in several plant families, in specific groups of plant families or specific tissues, cells, or developmental stages throughout plant development. It includes terpenoids, special nitrogen metabolites (including, protein amino acids, amines, cyanogenic glycosides, glycosylates, and alkaloids), and phenotype prospects of Medicinal Plants: Medicinal plants have a promising future as a result of their area unit regarding half a million plants way and wide, and an outsized portion of them and their therapeutic activities haven't to explore nonetheless, and their meditative activities may well be conclusive in the treatment of present or future studies. The basic uses of plants in medication can containing the future, as a supply of therapeutic agents, and because of the material base for the extraction of semi-synthetic chemical compounds like cosmetics, perfumes, and food industries. The popularity of health care plant-derived products has been derived from their increasing acceptance and use within the cosmetic business additionally to increase public prices within the daily maintenance of personal health and well-being.

### Nanotoxicology



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Nanotoxicology is the study of the toxicity of nanomaterials. We all are known to the fact that how widely nanotechnology is spreading nowadays but we don't know about its toxic effects. Because of the quantum size effects and large surface area to volume ratio, nanomaterials have unique properties compared with their larger counterparts that affect their toxicity. Of all the possible hazards, inhalation exposure appears to present the most concern, with animal studies showing pulmonary effects such as inflammation, fibrosis, carcinogenicity for some nanomaterials. Skin contact and ingestion exposure are also concern.

Nanomaterials have at least one primary

dimension of less than 100 nanometers, and often have properties different from those of their bulk components that are technologically useful. Because nanotechnology is a recent development, the health and safety exposure to nanomaterials, and what levels of exposure may be acceptable, is not yet fully understood. Nanoparticles can be divided into combustion-derived nanoparticles like diesel soot, manufactured nanoparticles like carbon nanotubes are naturally occurring particles from volcanic eruptions, atmospheric chemistry and many more. Typical nanoparticles that have been studied are titanium dioxide, alumina zinc oxide, carbon black, carbon nanotubes and buckminsterfullerene.

Size is the key factor in determining the potential toxicity of a particle. However it is not fully important factor. Other properties of nanomaterials that influence toxicity include: chemical composition, shape, surface structure,

surface charge, aggregation and solubility, and the presence or absence of functional groups of other chemicals. The large number of variables influencing toxicity means it is difficult to generalize about health risks associated with exposure to nanomaterials. The extremely small size of nanomaterials also means they much more readily gain entry in human body than larger sized particles. How these nanoparticles behave inside the body is still a big question that needs to be resolved.

There are some preventions also which can prevent nanoparticles from harming human beings. Even insoluble particles which reach the finely branched alveoli in the lungs can be removed by macrophage cells engulfing them and carrying them out to the mucus. Nanoparticles in the blood can also be filtered out by the kidneys and excreted in urine. In this way we can get saved from the harmful effects of nanoparticles.



## The story of real Smurf family

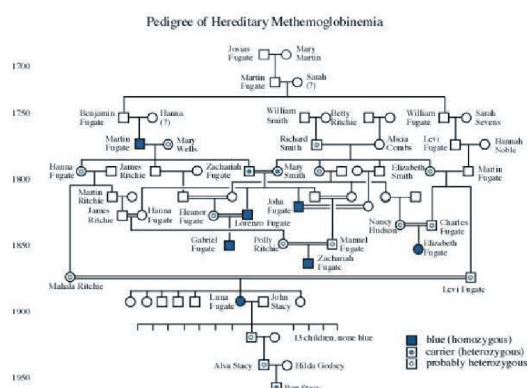


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**Martin Fugate: The First Blue Man in Kentucky.** The story starts in 1820, when a French orphan Martin Fugate and his wife Elizabeth Smith moved onto the banks of Troublesome Creek, a beautiful area in Appalachian Kentucky. There is no official record documenting that Martin was actually blue, but he and his wife both carried a recessive gene that gave their son Zachariah Fugate a startling blue color. Martin and Elizabeth had seven children—four of them were blue. Since the gene causing their blue coloration is recessive, the family had a 25% chance of having a blue child with each pregnancy if Martin and Elizabeth were carriers.

If Martin was blue, the odds would have increased to 50% for each child as Martin would have carried two copies of the recessive gene.



Inbreeding was a common occurrence in the rural and isolated Appalachian region. Fugate descendants married other Fugate descendants, concentrating the “blue gene” over generations. The gene found in the Fugate family is from a line



of French Huguenots, whose descendants settled in Kentucky, Ireland, and Finland. The Fugates looked like anybody else, except they had the blue color.

Luna Fugate, the great-grandmother of Benjamin Stacy, the last blue fugates, was one of the bluest fugates known to the Appalachian region. Luna was described as being blue all over, with lips the color of a dark bruise. Despite her alien-like color, she was entirely healthy and had 13 children in her 84-year span of life.

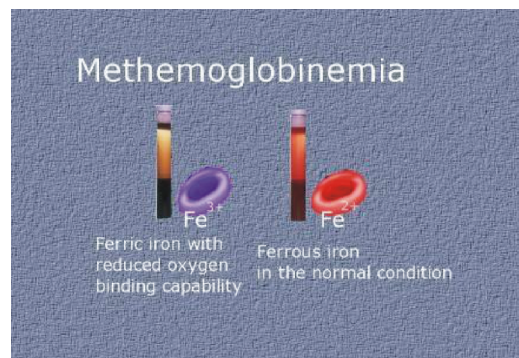
### Reason of Blue Skin Colour

This is because of a condition called methemoglobinemia, which causes methemoglobin levels in the red blood cells to rise above 1 percent. It turns the skin blue, the lips purple, and the blood a chocolate brown. Methemoglobinemia can be triggered by exposure to particular chemicals (benzocaine and xylocaine, for example), but in this case, it was inherited and the product of a faulty gene that most probably caused a deficiency in an enzyme called cytochrome-b5 methemoglobin reductase.

### Cure of the problem:

By the early 1960s, some members of the blue Fugates had begun to resent their cobalt-tinted skin. Not only did their skin mark them as different, but by that time, people had already begun to associate their skin color with the family's history of inbreeding.

It was then that two Fugates approached Madison



Cawein, a hematologist at the University of Kentucky's medical clinic at the time, in search of a cure.

Using research collected from studies of isolated Alaskan Eskimo populations, Cawein was able to conclude that the Fugates carried a rare hereditary blood disorder that causes excessive levels of methemoglobin in their blood.

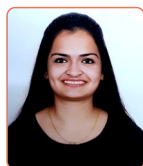
Cawein devised a cure for this disorder. Counterintuitively, the best chemical for activating the body's process of turning methemoglobin to hemoglobin is methylene blue dye. The Fugates he treated ingested this dye and within a few minutes, the blue coloration of their skin disappeared, and their skin turned pink.

As long as they kept ingesting pills of the substance regularly, these blue people of Kentucky could live their lives normally.

Even one of the last Fugates Benjamin Stacy's skin began to change to the average color for a baby within a couple of months. By the age of seven, he had lost nearly all of this blue coloring, indicating that he likely only received a copy of the gene from one parent.

Though today Benjy and most of the Fugate family descendants have lost their blue coloring, the tint still comes out in their skin when they are cold or flush with anger. In those moments, the legacy of the blue Fugates of Kentucky lives on—a legacy of hardship, isolation, and perseverance.

## Synthesis, characterization, and applications of transition metal dichalcogenide materials



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Nowadays, due to high energy demand, the consumption of natural energy resources has increased. One of the natural resources, fossil fuel is thus heading to depletion. The use of fossil fuels increases greenhouse gas leading to global warming and pollution. Thus, mankind is putting effort to overcome the foreseen energy crises and calamities by an alternate process. In the search for an alternate process, the deriving of energy from the sun whose energy is copious on earth is increasing. One of the techniques for converting solar energy into electricity is photovoltaic solar cells. In the photovoltaic solar cell, the metal chalcogenides have found an important place as a base material. Transition metal dichalcogenides (TMDCs) are materials that belong to groups III to XII in a periodic table. The basic formula of TMDCs is  $MX_2$  where, M represents the Transition Metal and X belongs to chalcogen

material (S, Se, Te) which is arranged in three sandwich layers of X-M-X with covalent bonding with weakly vander waals forces. TMDCs are an emerging 2D analogy of Graphene with their captivating physiochemical properties to find application in various fields such as optoelectronic devices, memory storage, solar cells, etc. Among the TMDCs, niobium diselenide ( $NbSe_2$ ) is a promising one that possesses superconducting behaviour and is known as the polytype to study the charge density wave. The materials are expected to be employed as contact materials for 2D semi-conductor, which are also used as solid lubricant material, photodetectors, biosensors, etc. There are lots of techniques which are available in the literature for the synthesis of TMDCs in form of nanomaterials such as vacuum evaporation, electro-deposition, electrodeless deposition, sputtering, chemical vapour deposition (CVD), plasma-enhanced CVD, spray pyrolysis, pulsed laser irradiation, brush plated technique, etc. To date, there is no single article found for the synthesis of  $NbSe_2$  through the wet chemical method. In terms of the Wet Chemical method the chemical bath deposition is low-cost, inexpensive, and easy to apply on large area scale, also there is no need for any sophisticated heavy expensive instruments for synthesis. The method works on the basic principle that a liquid precursor

reacting solution undergoes a chemical change at a solid surface leaving a solid layer in the form of a thin film on the substrate or in a form of nanoparticles. The different techniques used for characterizing the material such as EDAX for elemental analysis, XRD for structural analysis, scanning electron microscope (SEM), and transmission electron microscope (TEM) for surface analysis. For finding different electronic, optical, and magnetic properties, techniques such as UV-VIS NIR, vibrating sample magnetometry (VSM), etc are used efficiently.

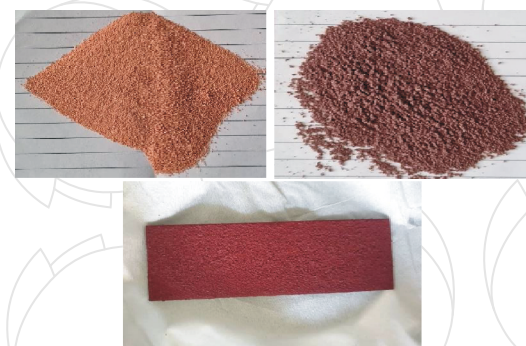


Fig. (1) and (2) show the  $NbSe_2$  nanoparticles synthesized at different temperatures, Fig. (3) shows the Deposited  $NbSe_2$  thin film