# Swami Shraddhanand College

**University of Delhi**

## ZOOLOGY DEPARTMENT

**Educational Trip to**

## "Geology Museum, Department of Geology"

Date: **27th March, 2023**

Day: **Monday**

Time: **10:00 AM - 02:00 PM**

Course: **B.Sc (Prog.) Life Sciences**

Paper Name: **Genetics and Evolutionary Biology**

Paper Code: **42234406**

No. of Students: **55**

**Teacher Convenors: Ms. Akanksha, Dr. Manmohan Singh**

The Department of Zoology, Swami Shraddhanand College organized an educational visit to Geology Museum, University of Delhi, for B.Sc (Prog.) Life Sciences IV semester students on 27th March 2023, under supervision of Ms. Akanksha and Dr. Manmohan Singh. The tour was organized to fulfill the academic requirement of the practical syllabus of Genetics and Evolutionary Biology Core Paper.

The visit started with the interaction to Mr. Manjeet Rinni, one of the faculty members of the Geology Department. He explained in detail about the geological time scales, fossils and minerals. Later the students were taken to the museum that had fossils, specimens of rocks, minerals etc. The museum also had mind maps for types of fossils, different eras and periods.

Students showed so much enthusiasm and interest observing real fossils, they were curious to know about all of them.

The **objective** of this visit was to fulfill academic requirements of the practical syllabus of Genetics and Evolutionary Biology Core Paper.

It provided an interactive session with the museum curator and to understand how earth originated and what change it underwent with time.

To let the students learn about the major events in the history of life and the contribution of fossil studies in evolution.

To understand evolution, it is important to look into the evidence of evolution and fossils are the only direct evidence of biological events of the history of Earth and hence are important in understanding the construction and evolutionary history of different kinds of plants and animals.

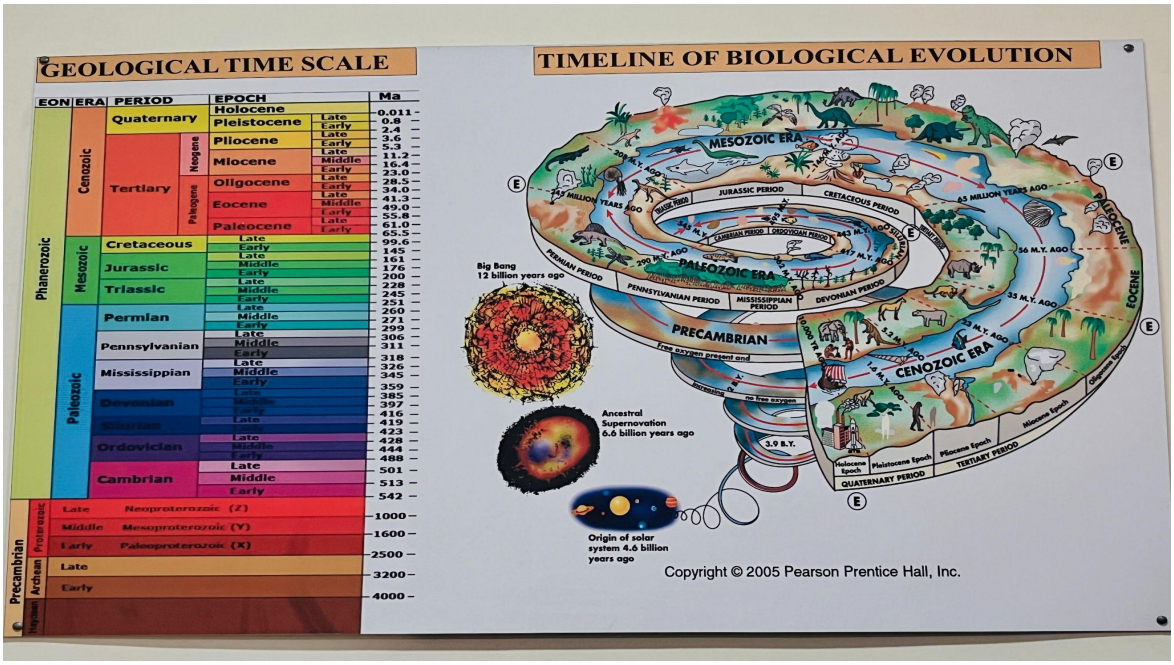
The **outcome** of this visit was to learn about major events in the history of life and the contribution of fossil studies in evolution. Students were so excited when they observed real fossils and they took various pictures of the fossils to identify different mold, cast, amber etc. while doing so, students were more curious and wanted to learn more about it. By studying the fossils they can learn a lot about how animals and plants lived and behaved million years ago.

This was a great opportunity for undergraduate students to visit such museums and experience real objects to understand their subject well. The visit has provided a real exposure of the fossils to identify different types of fossils and how they formed. This event indeed inspired students to give their hundred percent in science and to develop a scientific approach to understand it.

The Students had a wonderful experience through this educational trip. They acquired much more knowledge about each and everything after having a live look at the fossils. Before this, they only knew the names of such minerals, types of fossils but now after visualizing them, they had a great

idea about its structure and its formation. This trip has made students more enthusiastic about learning more of the world we live in.

**Following are Pictures taken during the visit..**




Timeline of Biological Evolution

Mr. Manjeet Rinni explaining the Geological Time Scale

# Different types of Fossils





*Neuropteris* in Ironstone Nodule
Dudley
Coal Measures Formation


85
85 Woodocrinus expansus
Age: Carboniferous
Location: England

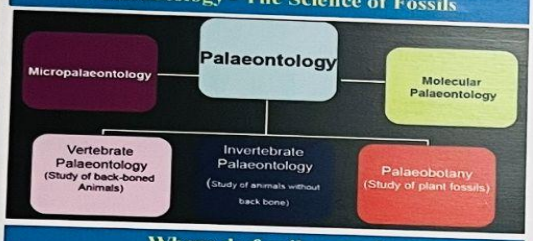

Scales and impressions of scales in rock. A trunk of fish with numerous ganoid scales.
Lower Jurassic Kota Formation, Pranhita-Godavari Valley


Impression of a teleost fish trunk from the Deccan intertrappean beds of Bamanbor, Rajkot district, Gujarat.

## What is a fossil?

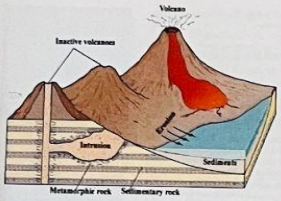
The term fossil was first applied in Geology in the 16th Century; at that time, and until the late 18th century, a fossil could also refer to any mineral object, archaeological artifact or curiosity dug from the ground. But now the definition is restricted to evidence of former life.
By modern definition fossils are evidences of the former existence of life, not only direct evidence such as hard parts(bones, teeth and shells), but traces of activity such as footprints, tracks, trails, burrows and borings, teeth marks, coprolites, gastroliths, attachment structures and so forth.

## Palaeontology - The Science of Fossils



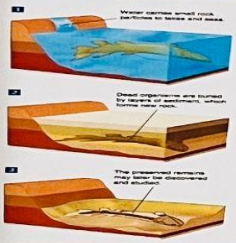

## Where do fossils occur?

There are three groups of rocks in nature- Igneous, Metamorphic, and sedimentary. Among these fossils are preserved only in sedimentary rocks.




Likely candidates among sedimentary rocks for preservation of fossils:
- Breccia, sandstone, conglomerate- rarely preserve fossils
- Sediments deposited under water are more likely candidates but fast flowing water rarely allows rapid burial
- Fossils of terrestrial or freshwater origin are patchy reflecting the isolation of their habitats
- Deposits under stagnant water, such as bog iron ore, often bear fossils. Shales deposited by rivers from the mud is another good source of fossils
- Sediments from the bottom of the sea are even better candidates
- Chance encounter- sediments deposited from catastrophic movements of turbidity currents may rarely contain fossils-e.g. Burgess Shale

## How do fossils form?




- Most fossils form when living things die and are buried by sediments
- Dead organisms sink to the bottom and get buried by sand, silt, and clay that is carried by rivers and streams to the oceans and seas
- The weight of layers of sediment compresses the lower layers
- The sediments slowly harden into rock and preserve the shape of the organisms.
- Chemical activity turns the sediment to rock, preserving the fossils.
- Hard parts of the organisms are preserved when they are saturated with and replaced with mineral compounds
- Sometimes organisms are buried quickly in clay, volcanic ash, or ice before they decay, and so are preserved whole

## Modes of fossil preservation

One of the keys to preservation is resistance. Either the conditions are mild enough (calm water little oxygen) not to destroy much of the organism or those parts that do not get preserved are the most resistant to chemical and physical damage. Good examples of these are the shells of clams and the teeth of mammals. The nature of preservation is dependent upon the interaction of several factors. The composition of the organism and its structure play vital roles in how the body will react to the physical and chemical activities that normally break down or damage dead organisms. Intimately related to this is the sedimentary environment in which the organisms lived. It will determine the type and intensity of the physical and chemical processes. Finally, numerical abundance will affect the nature of preservation by increasing or decreasing the chances of something being preserved, simply because of the sheer numbers or lack of certain organisms.

## Types of fossils

There are many ways in which record of an organisms can be preserved. Body fossils can occur in many ways, including: unaltered preservation, recrystallization, replacement, permineralization, carbonization, impressions, casts and internal molds.

## 1.Body fossils

### 1A. Unaltered remains

This category includes those fossils which have undergone little or not change in structure and composition.
**Original Skeletal Material:** Organisms which have hard parts are preserved as the original material. This includes many invertebrate shells composed of calcium carbonate, silica, chitin, or vertebrate bones of calcium phosphate.

### Most Common Body Fossils

- Vertebrate Fossils - Teeth, bones
- Invertebrates – Shells of aquatic organisms which are durable and suitable for preservation
- Typical plant fossils – wood, bark leaves, tough outer coatings of seeds, spores, pollen


Ammonites


Fish


Leaf


Wood


Ammonite ornament


Pollen & Spores


Shark Tooth

## Encrustation

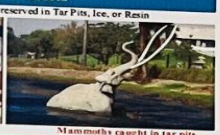
In many caves, groundwater seeps and drips constantly; the high concentration of dissolved minerals in such water is left behind when the water drips, and forms a thin crust on the interior surface of the cave and whatever lies in it. This will coat and preserve any organism which dies here.


Fish Skeletons in Limestone Nodules from150 m.y old rocks of Pranhita-Godavari valley

## Trapped Fossils

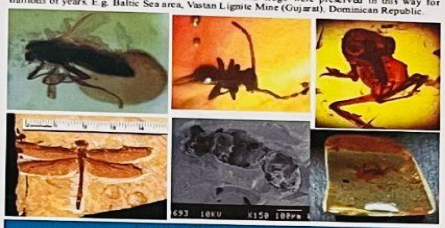
Most perfect & complete fossils are preserved in Tar Pits, Ice, or Resin


Mammoths preserved under ice sheets


Mammoths caught in tar pits

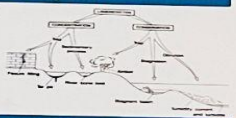
## Fossils in Amber

Amber often contains plant and animal remains trapped in the sticky resins dripped down trunks and stems. Insects, spiders, small lizards and frogs were preserved in this way for millions of years. E.g. Baltic Sea area, Vastan Lignite Mine (Gujarat), Dominican Republic.



## Lagerstätte Deposits

A Lagerstatte is a sedimentary deposit that exhibits extraordinary fossils with exceptional preservation sometimes including preserved soft tissues. These formations may have resulted from carcass burial in an anoxic environment with minimal bacteria, thus delaying decomposition.

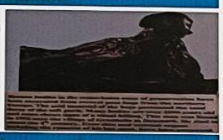


## Refrigeration

During the Pleistocene glaciations, when ice sheets cover much of the Northern Hemisphere, some animals (mammoths, for example) fell into crevasses in frozen terrain or became trapped in permanently frozen soil. Some of these animals have been discovered perfectly preserved.

## Mummification

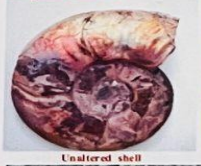
In very dry regions, animals may dry out quickly and be preserved, soft parts and all



## Exceptional Preservations


350 m.y. old fossil *lycopod* tree stumps in life position, Scotland


Fossil Crustacean from India


Unaltered shell


*Archaeopteryx*, Germany


Skin of the Upper Cretaceous duck-billed dinosaur replaced by minerals


Exceptional preservation gill filament in the Cretaceous Limestones of Santana Formation, Brazil. A. Recent. B. fossil.

## 1B. Altered remains

As sediments become compressed by the weight of overlying sediments, they slowly undergo the process of Lithification. Common cementing materials in the ground water are carbonates, silica and iron oxides. Often the groundwater and their minerals may affect the fossilization process.

**Internal Mold**- If the shell is filled in the sediment internally, the impression of the inside of the shell is called internal mold.

**Mold**- The sediment itself can preserve the form of a fossil even after it has long been dissolved away. Dissolution of a shell from the rock matrix will leave behind an impression called an external mold.

**A Cast** is a replica of a fossil created by filling a mold with mineral or some other material.


*Calamites*


*Stigmaria*

## Permineralization

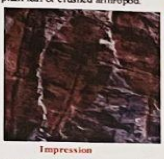
**Permineralization & Recrystallization**: This is the filling of pore spaces in porous material such as wood or bone by the precipitation of minerals from water.
Example: petrified wood, or dinosaur bone
When minerals replace the cell-wall and internal structures, it is known as petrifaction

**Replacement** refers to the removal of the original remains of an organism and the substitution of that matter with mineral deposits.


*Megalosaurus* lower jaw

## Carbonization

Carbonization occurs when all organic volatiles are distilled away because of the effects of heat and/or pressure, leaving a carbon film/ remnant of the organism. This usually occurs with organisms rich in carbon that possess thin or no skeletal material. Carbonization is often indicated by the shiny black texture of what appears to be an impression of an organism, often a plant leaf or crushed arthropod.


Impression

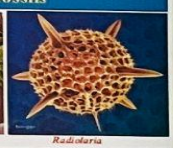

Compression

- Two dimensional imprints of plants or their parts without organic material
- Leaves – most common impressions
- Record information of external shape and morphology of plant organs

**Carbon Films** an extremely thin coating of carbon on rock that forms when materials that make up an organism become gases and escape leaving only carbon behind.
Organic substance such as cuticle is often preserved.

## Microfossils


*Coccoliths*


*Radiolaria*


*Ostracods*

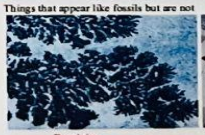

*Diatoms*


*Dinoflagellates*


*Foraminifers*

## Pseudo Fossils

Things that appear like fossils but are not


Dendrite

# How do fossils get preserved

## Trace Fossils

Trace fossils are the remains of an organism's activity or behavior.


Dinosaur Tracks


Dinosaur eggs


Dinosaur Eggshells


Trilobite

Trilobite Tracks


Burrows

## Gastroliths

These are smooth, polished stones that are often found in the abdominal cavities of the skeletons of dinosaurs. They are thought to have helped those huge animals grind up vegetable matter in their stomach.

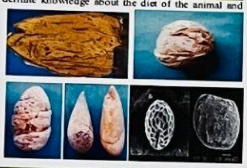

Gastroliths

*Psittacosaurus* fossils with gastroliths in its stomach region, American Museum of Natural History

## Coprolites

Fossils excrement can sometimes give definite knowledge about the diet of the animal and vegetation of the area.

- Analysis of fossil dung of many herbivorous animals showed a variety of plant and animal remains – Provide clues on the diet of the animals
- Dinosaur coprolites from 65 m.y. rocks of central India revealed presence of phytoliths of grasses
- Late Triassic Coprolites from peninsular India yielded about 50 taxa of plants



## Living Fossils

**"Living fossils"** are those animals and plants which are rare nowadays, especially those like the coelacanth and slit shells, which were known as fossils before they were discovered to be still living.

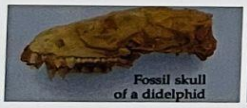
**False Crabs**

These are not true crabs but are related to spiders and scorpions. The modern horseshoe crab Limulus lives close to the shoreline in the Far East and in the Atlantic Ocean off North America. It is very similar to the fossil *Mesolimulus*, an animal that lived in the sea about 150 million years ago. Other fossil horse shoe crabs include species which lived in freshwater swamps 300 million years ago.


150 m.y

Living and fossil Horse shoe crab

Didelphids are a family of marsupial mammals which include the opossums. They are first recorded in the Late Cretaceous of North America. Modern opossums have many features typical of the related primitive didelphids of Cretaceous age, although they do have some significant differences.


Fossil skull of a didelphid


Virginia opossum

**Lone ranger**

Ginkgos first appeared in the Triassic and were much more widespread in the geological past than they are today. Only a single species, *Ginkgo biloba*, lives today. The characteristic fan-shaped leaves are easily recognizable when fossilized, as in this Jurassic example.


Recent and fossil Gingko biloba Jurassic age

**Coelacanth**

The first modern coelacanth was identified in 1938 by Professor Smith, an ichthyologist in South Africa. Undoubtedly, the most famous of all living fossils is the coelacanth. Coelacanth have a distinctive three-lobed tail and fins with arm-like bases. They range back to the Devonian.

Living & Fossil coelacanth fish

## Other Fossils

**DNA from fossils:** In recent years biochemical analyses have been developed which can reliably separate and analyze extremely small samples (<1 μm), and this has meant that original organic molecules of the once living organism can be studied. Although free amino acids are the most commonly encountered fossil molecules, in many cases exhibiting remarkable preservation, it is the potential for fossil DNA that has captured the popular imagination.

## What do fossils tell us ?

Fossils are one of the most important sources of information from the geological record.

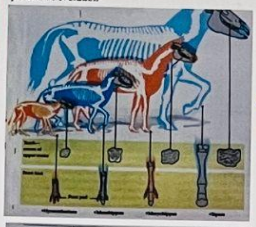
- Dating of rocks: chronological sequence of events in earth's history
- Provides clues to past environments & ecosystems, past biodiversity changes, climatic changes
- Best evidence for evolution of life
- Past distribution of land and sea

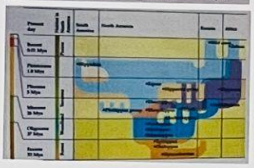
The following broad categories of scientific information can be retrieved from fossils:

**Taxonomic:** Fossils contain morphological information which allows them to be recognized and named, and their relationship to other taxa recognized and living taxa.

### Evolutionary

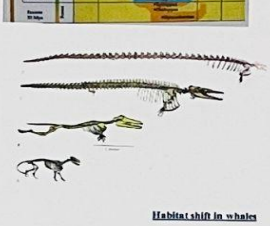
**Evolutionary:** Fossils provide direct evidence on the evolutionary progression of life-who descended from whom. Evolution of horse is one of the triumphant proof of the process of evolution





Each stage shows slight changes that took place as one species is replaced by another

Evolution of horse is one best example

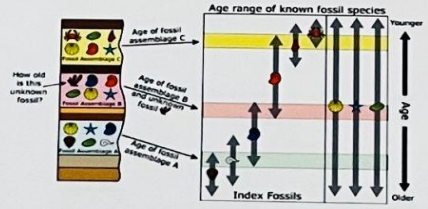


Habitat shift in whales

### Age relationship of rocks

Fossils are the most important guides in subdividing the rock sequence into units denoted by time boundaries. They provide information on chronological sequence of events in earth's history. They are particular useful in the search of hydrocarbons and correlation of oil wells within a basin or on a regional scale.

**Relative Time - Law of Superposition**

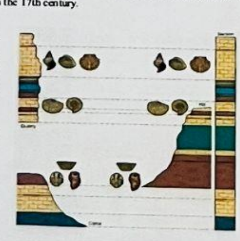

Since sedimentary rocks form by things falling down under gravity, a sequence of sediments must get younger upward. This is known as the Law of Superposition, proposed by Neils Stensen (Steno) in the 17th century.

**Relative Time & Correlation**

No single sequence of sedimentary rocks provides a complete record of Earth history. We need to deduce Earth's history by weaving pieces of history into a longer story.

How do we do this?

- Principle is that rocks containing the same fossil assemblage were deposited at the same time.
- This procedure, called correlation, was discovered by William Smith in the early 19th century. (pre-dating formal theory of evolution!)
- Only good back to 540Ma

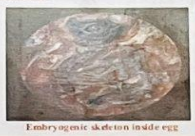


### Behaviour & Physiology

Fossils provide information on the mode of life of once living, and now extinct, organisms. Trace fossils are particularly useful in this respect.

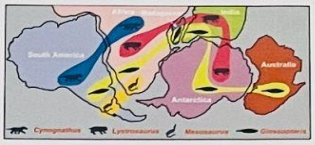

Parental care in dinosaurs


Brooding of eggs by a parent oviraptor


Embryogenic skeleton inside egg

### Past distribution of land and sea

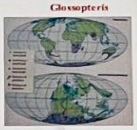
Fossils can help us in understanding the past distribution of land and sea (coming together and moving apart of continents in the geological past). Alfred Wegner's continental drift hypothesis was based on Glossopteris Flora and the reptiles *Mesosaurus* and *Lystrosaurus*.




Fossil evidence for contiguity of Southern continents in the geological past


*Mesosaurus*, an aquatic reptile of Lower Permian age

Glossopteris

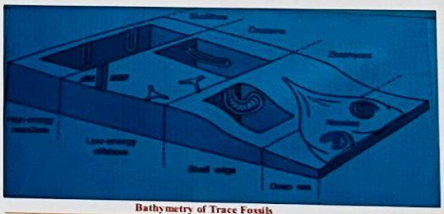

Continental Drift

### Past Ecosystems

Fossils and fossil assemblages provide insight into the nature and development of ecosystems and of the interaction of plants and animals with each other and their ancient environment

### Palaeobathymetry

It is now commonly accepted that trace fossil assemblages in marine sedimentary rocks are related to the relative depth of the depositional environment. Similarly, foraminifers and ostracods among microfossils are often used in the reconstruction of depth of the depositional basin.


Bathymetry of Trace Fossils

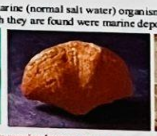
### Past Environment

Living organisms are limited in distribution and diversity by environmental factors. The nature of ancient environments, and the specifics of depth, temperature, salinity and oxygen levels, may be determined through the comparison of living and fossil assemblages.

Many organisms are very particular about where they live – their ecological niche.

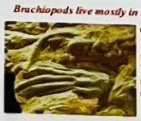
Certain plants and animals are indicators of to the environment in which they are living. Some are obvious like fish.

We know that corals are marine (normal salt water) organisms. If we find fossil corals we know that the rock in which they are found were marine deposits.




*Brachiopods live mostly in marine bottom waters*

*Trilobites* were marine organisms that are now extinct. Finding a trilobite in a rock tells a paleontologist that the rock is at least 225 million to 575 million years old and was deposited under marine waters



Crinoids were also called "sea lilies" lived in warm, shallow marine waters. They are actually animals related to starfish and sea urchins.


Enthusiastic students exploring the Geology Museum

The visit ended with an informal discussion among the students and teachers about the center and its galleries, followed by clicking a group photograph. The visit thus turned out to be successful by fulfilling its aim of imparting scientific knowledge in an interesting way to the students which will remain fresh in their memories for long. All students had prepared a detailed report along with pictures of this visit.

| Educational trip to Geology Museum (27th March, 2023)<br>(STUDENTS ATTENDANCE) | | | |
|---|---|---|---|
| Sr. No. | Student Name | College Roll No. | Course |
| 1. | Nidhi | 3602 | B.Sc (P) Life Science |
| 2. | Sakshi | 3603 | B.Sc (P) Life Science |
| 3. | Kajal Kumari | 3605 | B.Sc (P) Life Science |
| 4. | Annu Kumari | 3609 | B.Sc (P) Life Science |
| 5. | Vanshika Sharma | 3614 | B.Sc (P) Life Science |
| 6. | Vishal Singh | 3617 | B.Sc (P) Life Science |
| 7. | Khushi Malik | 3618 | B.Sc (P) Life Science |
| 8. | Priya | 3619 | B.Sc (P) Life Science |
| 9. | Darpan Vats | 3620 | B.Sc (P) Life Science |
| 10. | Megha Bisht | 3621 | B.Sc (P) Life Science |
| 11. | Madhav Dawar | 3622 | B.Sc (P) Life Science |
| 12. | Lakshita Chhabra | 3630 | B.Sc (P) Life Science |
| 13. | Harshita Sharma | 3634 | B.Sc (P) Life Science |
| 14. | Aakriti Singh | 3638 | B.Sc (P) Life Science |
| 15. | Anushka Sumrani | 3641 | B.Sc (P) Life Science |
| 16. | Arun Yadav | 3644 | B.Sc (P) Life Science |
| 17. | Tannu Sharma | 3649 | B.Sc (P) Life Science |
| 18. | Himanshi | 3650 | B.Sc (P) Life Science |
| 19. | Aakanksha Yadav | 3652 | B.Sc (P) Life Science |
| 20. | Aryan Prakash | 3653 | B.Sc (P) Life Science |

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| 21. | Ojasvi Singh | 3655 | B.Sc (P) Life Science |
| 22. | Geetanjali Israni | 3656 | B.Sc (P) Life Science |
| 23. | Aksh Kumar | 3658 | B.Sc (P) Life Science |
| 24. | Surbhi Singh | 3659 | B.Sc (P) Life Science |
| 25. | Yuvraj Singh Gill | 3660 | B.Sc (P) Life Science |
| 26. | Ruchi Gaur | 3801 | B.Sc (P) Life Science |
| 27. | Mansi | 3802 | B.Sc (P) Life Science |
| 28. | Nabila | 3803 | B.Sc (P) Life Science |
| 29. | Mahvish Fatma | 3807 | B.Sc (P) Life Science |
| 30. | Anushka Kotnala | 3811 | B.Sc (P) Life Science |
| 31. | Anurag Gupta | 3812 | B.Sc (P) Life Science |
| 32. | Parmila | 3816 | B.Sc (P) Life Science |
| 33. | Akanksha Pandey | 3818 | B.Sc (P) Life Science |
| 34. | Sarita | 3819 | B.Sc (P) Life Science |
| 35. | Jayantika Aggarwal | 3821 | B.Sc (P) Life Science |
| 36. | Preeti Yadav | 3823 | B.Sc (P) Life Science |
| 37. | Swati Kheto | 3824 | B.Sc (P) Life Science |
| 38. | Garima | 3826 | B.Sc (P) Life Science |
| 39. | Mamta | 3828 | B.Sc (P) Life Science |
| 40. | Shivani | 3829 | B.Sc (P) Life Science |
| 41. | Cherena Thokchom | 3831 | B.Sc (P) Life Science |
| 42. | Parul Dhiman | 3832 | B.Sc (P) Life Science |
| 43. | Amit Singh | 3835 | B.Sc (P) Life Science |
| 44. | Prerana | 3836 | B.Sc (P) Life Science |
| 45. | Vipasha Rathi | 3837 | B.Sc (P) Life Science |

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| 46. | Abhishek | 3838 | B.Sc (P) Life Science |
| 47. | Sahil | 3842 | B.Sc (P) Life Science |
| 48. | Khushi Choudhary | 3845 | B.Sc (P) Life Science |
| 49. | Bharti | 3848 | B.Sc (P) Life Science |
| 50. | Sapna Kumari | 3849 | B.Sc (P) Life Science |
| 51. | Shabahat Fatima | 3850 | B.Sc (P) Life Science |
| 52. | Himanshu Singh | 3851 | B.Sc (P) Life Science |
| 53. | Abhishek Kumar | 3852 | B.Sc (P) Life Science |
| 54. | Himanshu Datta | 3853 | B.Sc (P) Life Science |
| 55. | Sajal | 3873 | B.Sc (P) Life Science |