MARCH 2024

A STEM NEWSLETTER

LabLinks.

ISSUE 1 - COMPUTATIONAL AND MOLECULAR BIOTECHNOLOGY

Feature Articles

Q & A session - “Interviewing professionals in STEM”

STEM Sector on the environment

Success Stories in STEM

Tech trends : Emerging tech

Opportunities corner

About Us

A MESSAGE FROM THE FOUNDERS AND EDITOR IN CHIEF

Respected Readers,

It's with great pleasure that we inaugurate the first edition of LabLinks, dedicated to the synergy between Computational and Molecular Biotechnology. This volume encapsulates a field of innovation, chronicling the confluence of computational ingenuity and molecular intricacies. We will explore the space between algorithmic sophistication and biological complexity, and enfold the shifts indicating unparalleled biotechnological advancements. We hope that as you read through these pages, you will encounter a well-thought-out collection of ideas, where each narrative portrays the transformative impact of biotechnology. We are delighted to begin this magazine with a subject where theoretical constructs enlarge into empirical successes, ushering in a future with boundless possibilities. As hope that we can only take this newsletter further, we cannot wait to take you all on the journey along with us...

Regards, Tara Pratapa, Nitya Kashyap, Anwitha Srivatsa

THIS MONTHS TOPIC
(A BRIEF OVERVIEW)

Molecular and Computational Biology is a upcoming field that encompasses the understanding of relationships between a cell's many processes, as well as how these interactions are regulated.

Within this we touch upon statistics, technology, and experimentation which then further are combined in computational molecular biology to advance scientific research. This sets the path to creating innovative molecular biology analytical instruments.

Upcoming Opportunities in STEM

By Saketh Kollipara - Grade 9

Explore various STEM opportunities such as the Lodha Genius Program, ISRO's Yuvika program, or the EnergyMag Internship for hands-on research, collaborative learning, and a unique experience.

The Lodha Genius Program offered by Ashoka University is great for students from Grades 9-12. Delivered by distinguished faculty from all around the world, it offers students to live in the shoes of a mathematician or scientist, fostering a steady foundation for future endeavors. Students will have 4 weeks of rigorous coursework ranging from International Olympiad problems to collaborative group projects.

YUVIKA (Yuva Vigyani Karyakram) - Young Scientist Program It is one of the most competitive aerospace engineering programs for high school students across India. Its offered by ISRO (Indian Space Research Organization), one of the world's leading space research centers,. Get essential hands-on experience in fields such as science and technology and work alongside appreciated scientists from ISRO; The program serves as a gateway to exposure for high school students with a passion for Science and Aerospace Engineering to learn from the best and gain valuable experience in these fields.

Key takeaways - For high school students (grades 10-12) passionate about sustainability and STEM, prestigious internships like EnergyMag offer valuable real-world experience. These opportunities are often more selective compared to summer programs, yet they provide a chance to excel alongside distinguished professionals. The Lodha Genius Program, YUVIKA, and similar initiatives foster deep engagement within STEM fields, cultivating skills and life-lasting connections.

Neuralink: The merge of AI and Humans?

By Maya Yadlapalli - Grade 9

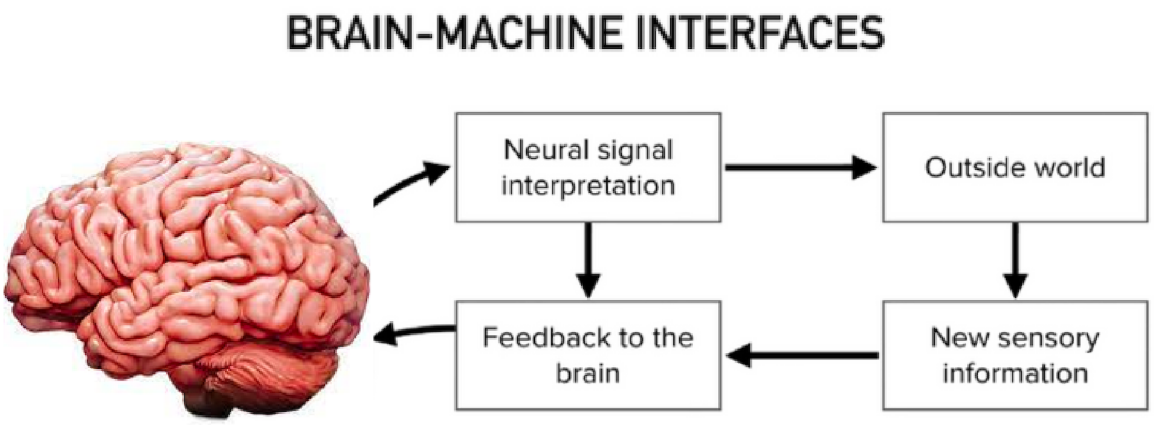
Recent technological advancements have significantly enhanced our lives by addressing disorders and disabilities. In the field of biotechnology, continuous innovation has led to the introduction of new products that provide insights into the human body and its connections through various interfaces. A groundbreaking example of this is Neuralink, which has revolutionized our understanding of the complex network of the human brain.

Founded by Elon Musk in 2016, Neuralink employs neurotechnology, **brain-computer interfaces**, and AI to design **implantable brain-computer** interfaces enabling thought-based communication and device control for individuals with **quadriplegia** (a form of paralysis that affects all four limbs, plus the torso) the "Ability to control their computers and mobile devices with their thoughts.", while simultaneously monitoring and recording brain activity, allowing us to potentially treat neurological disorders, and decode neural signals.

Neuralink, a pioneering technology, enables precise examination of specific brain areas via targeted implants. With this tool, researchers gain profound insights into brain functions related to behavior and illnesses. As a result, Neuralink paves the way for novel treatments like brain-computer interfaces for rehabilitation and personalised medicine based on individual brain activity patterns. Despite ongoing challenges, the scientific community highly regards Neuralink, signifying its potential to transform neuroscience and aid individuals suffering from neurological conditions through non-intrusive data gathering.

Brain-computer interfaces(BCI)

gathers and examines brain signals

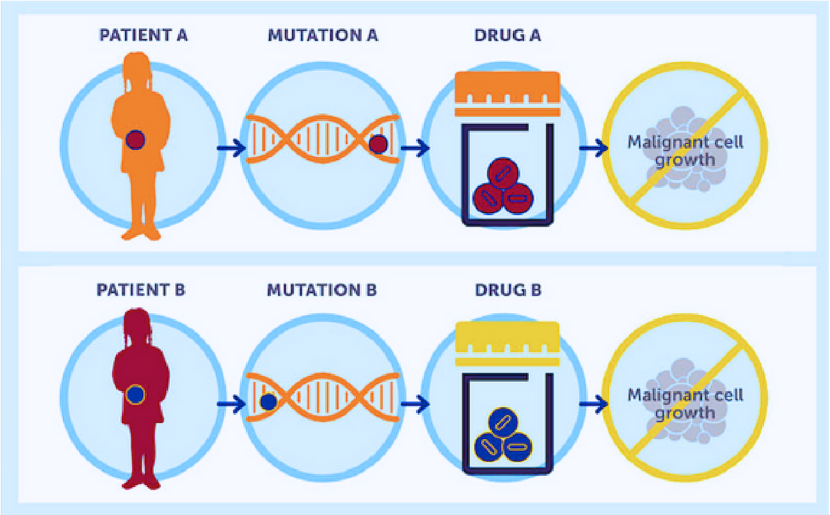


Drugging the Undruggable: Precision Oncology

By Gayatri Papagari - Grade 9

In a rapid and developing world, we are all used to thinking about cancer as this invincible disease, something that there is no cure for and one we have no hope of eradicating. However, this may finally change with the recent emergence of precision oncology. But first, what is precision oncology, and how can this change our modern conception of cancer?

All around the world, publications like Forbes to Oxford Academics agree that precision oncology will be one of the next big things in health care through 2024. Precision medicine refers to '**personalised medicine**', or the tailoring of therapies or treatments to individual patients after taking into account genetic and molecular make-up, lifestyle, and environment. For example, let's look at the first-ever clinical trial for precision oncology, which was the I-SPY 1 trial. In this clinical trial, blood samples of a breast cancer were tested and cancer cells were identified. Then, Herceptin (classified as a targeted therapy) targets the specific protein of breast cancer cells, **inhibiting activity and growth** - was used during the trials, and when the results were favourable, it proved that targeted therapies are effective.



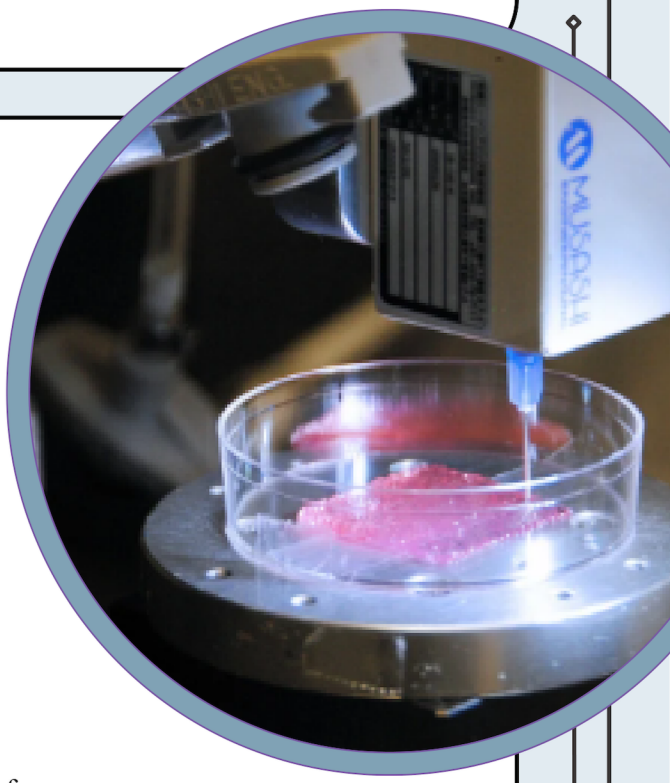
Precision medicine refers to 'personalized medicine', or the tailoring of therapies or treatments to individual patients after taking into account genetic and molecular make-up, lifestyle, and environment.

The successful trial highlighted the effectiveness of precision oncology, Despite challenges in targeting specific tumors due to the complexity of genetic variants, initiatives by organizations like NIH, AstraZeneca, and iLoF aim to advance biomarker utilization and patient-centered drug programs.

To conclude, cancer research and oncology are at a stage where there are infinite possibilities. With the information that precision oncology can give doctors, treatments for cancer will become so much more efficient, opening new doors for cancer treatments and drug development. Who knows, maybe at the end of 2024, cancer will no longer be a demon we have to fight, and instead just an obstacle to defeat.

The Future of Medicine - Tissue Engineering

By Drishika Yeleti - Grade 9



Tissue engineering, once a distant dream of science fiction, is now shaping the medical landscape across the world. Done through the combination of cells, chemical factors and biomaterial in a controlled environment, it is an interdisciplinary field which results in the manufacturing of fully functioning tissues and organs.

One of the purposes of tissue engineering is to develop **biological substitutes** that can restore, maintain, or improve tissue function. This is a revolution in not just the biotechnological industry but the medical one too, offering a fresh breath of air to millions of patients suffering from **degenerative diseases.**

Methods and examples of Tissue Engineering:

Organoids: Organoids are miniature, simplified versions of organs grown in-vitro (outside a living organism or in an artificial environment) from stem cells. They mimic the structure and function of real organs. Organoids have been developed successfully for organs including the brain, liver, kidney etc.

Biomimetic Materials: For creating advanced tissue scaffolds with enhanced functionality, researchers use biomimetic materials which are inspired by nature's design principle. These biomaterials provide an optimal environment for cell growth and tissue regeneration by "mimicking" the biochemical and mechanical properties of native tissues.

3D Bioprinting: 3D bioprinters can create complex tissue structures with exceptional accuracy and precision. This reduces the risk of immunology rejection (where the body rejects the organ due to the impression that it is a foreign object).

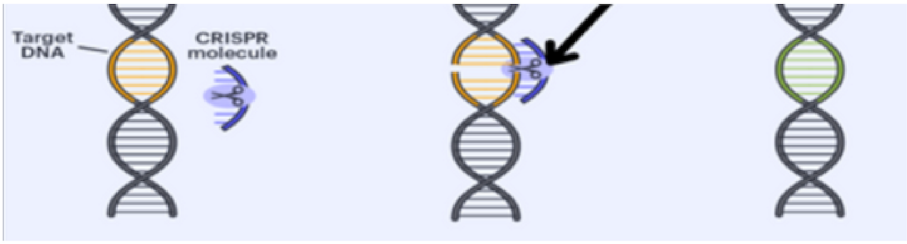
Tissue engineering can truly be considered a crucial change in the way we think about medical care, as it offers solutions to healthcare challenges we once thought were unsolvable. The future of tissue engineering has vast potential in improving patient outcomes, quality of life and extending life expectancy, extending the limits of what we once thought was possible.

"From Science Fiction to Reality: CRISPR-Cas9 and the Future of Genome Engineering"

By Aagam Jain and Nidhi Chandrapu - Grade 9

With the ability to modify genetic code, CRISPR-Cas9 can be considered a ground-breaking discovery in the field of genome engineering. CRISPR-Cas9 (Clustered Regularly Interspaced Short Palindromic Repeats, associated with protein 9) are the names of the components in this system, which has changed the course of science, by providing unimaginable control over DNA. This article will delve into the discovery, and impacts of the infamous CRISPR-CAS 9, thoroughly examining its remarkable journey from the laboratory bench to the forefront of scientific innovation.

DNA and RNA are made up of neucleotides. Consider them the building blocks of all our genetic information



As of today, CRISPR-Cas9 is being used in fixing genetic mutations rather than creating them. This is where blood is extracted from an individual, put under a microscope for the process of the modification and injected back into the body. There are two main strategies associated with the CRISPR-Cas9. The first focuses on using the technology to target and disable specific genes that function within the immune recognition system and the second utilises vectors to improve the visibility of specific surface proteins that helps in evading detection by the immune system.

This machine has been used first by transplanting mouse **iPSCs,** which refers to induced pluripotent stem cells (cells that can give rise to several other cells), into healthy mice and then again by transplanting human iPSCs into humanised mice which are mice that have been given human cells or tissues. The researchers conducting this experiment, Prof. Tobias Deuse and Sonja Schrepfer from the University of California, found that the cells did not evoke any sort of an immune system-related response and totally evaded the radar of the immune system. Essentially the aim of the experiment was to induce stem cells without an immune response, and it was successful.

Though a lot of these machines have numerous side effects, a side effect that may not be all negative is that these therapies and genetic modifications are increasing the abilities of individuals above those that their un-modified DNA does not offer. Scientists are slowly able to improve the quality of people's lives with this machine.

The Remedies of Our Ancestors: Our Past and Future?

By Saanvi Maguluri - Grade 10

Green tea, revered for its health benefits globally, has been consumed for centuries. With its recent gain in popularity due to the promotion and advertising campaigns of brands such as Lipton, many have turned to this option for obtaining health benefits such as improved memory and weight loss. Tea is also renowned for its antibacterial properties, and modern scientific exploration has shed light on its potent polyphenolic components with activity against a wide spectrum of microbes.

Further to this, studies have proven that tea possesses **natural antioxidants** whose activity is stronger than synthetic antioxidants. Tea polyphenols (Polyphenols are micronutrients that naturally occur in plants) are also much less toxic than that of their synthetic counterparts, positioning it as a remarkable ally in seeking wellness. Considering the many benefits of drinking tea and its growing popularity among the general population, what is the **antibacterial activity** of tea and how does it aid in the prevention of **bacterial infections?**

This is the question that is explored in a research paper published by Ms. Vishaka Labar, the current Head of Academics at Indus International School, Hyderabad, alongside co-authors Ms. Rinzi Bhutia and Ms. Y.V.S. Annapurna, which dives deeper into the antibacterial activity of Green and Black tea (Camellia sinensis) extracts, specifically against virulent uropathogens. (pathogen as some strains of E. coli of the urinary tract.)

Their research targeted multi drug resistant bacteria strains E.coli, Klebsiella spp, and Pseudomonas spp. Of the three bacteria, methanol extracts showed the maximum diameter of the zone of inhibition(way to assess the antimicrobial activity of a material or solution in relation to a target microorganism.) In simpler terms, methanol extracts were proven to be most effective in impeding bacterial growth. The same is indicated in the table presented in the research paper, shown below.

Isolates tested	Green tea extracts (Diameter of zone of inhibition in mm)			Black tea extracts (Diameter of zone of inhibition in mm)		
	Ethanol	Methanol	Aqueous	Ethanol	Methanol	Aqueous
E.coli	18	22	18	19	20	19
Klebsiella spp	20	23	17	16	22	14
Pseudomonas spp	15	20	10	14	18	10

In conclusion, the research done by **Ms. Vishaka Labar, Ms. Rinzi Bhutia and Ms. Y.V.S Annapurna** validates the traditional beliefs surrounding green tea and also provides empirical evidence supporting its therapeutic potential against drug-resistant bacteria. Its implications include potential natural treatment, reduced antibiotic resistance, and improved women's health.

The Remedies of Our Ancestors: Our Past and Future?

Q&A with Ms Vishaka Labar by Saanvi Maguluri

In continuation to the Feature Article regarding Ms Vishaka's work and research, Saanvi Maguluri of Grade 10 conducted an interview with her...

What inspired you to research this specific topic?

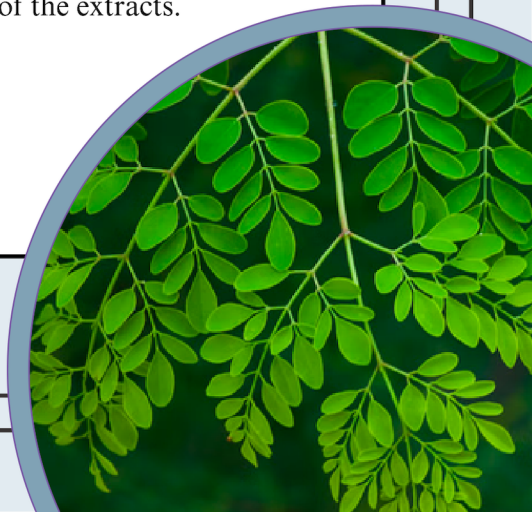
My inspiration for researching this specific topic stems from the significant prevalence of urinary tract infections (UTIs) in women, with approximately 50-60% experiencing at least one UTI in their lifetime. Additionally, I am intrigued by the potential of natural remedies to address health issues. By focusing on widely consumed beverages like tea and abundant green leaves like moringa, I aimed to explore their potential as remedies for UTI issues in women, leveraging nature's healing properties.

How did you narrow down your scope of research to make it relevant to a specific audience?

To narrow down my scope of research and make it relevant to a specific audience, I focused on women's health concerns, particularly related to UTI microbes. As mentioned earlier I aimed to explore natural remedies such as tea and moringa leaves for their antimicrobial activities.

What kinds of technology have you utilized during the experiment?

1. **Microbiological culture techniques:** Standard microbiological methods to culture and identify bacterial strains commonly associated with urinary tract infections (UTIs).
2. **Agar diffusion assays:** To evaluate the antimicrobial properties of tea and Moringa, agar diffusion assays were utilized. This technique involves inoculating agar plates with bacterial cultures and then applying extracts of tea and Moringa onto the agar surface to observe zones of inhibition, indicating the inhibition of bacterial growth.
3. **Spectrophotometry:** Spectrophotometry was used to measure bacterial growth and assess the efficacy of tea and moringa extracts in inhibiting bacterial proliferation. By quantifying the optical density of bacterial cultures at specific wavelengths, we could monitor changes in bacterial growth over time in the presence of the extracts.



What do you think are the implications of this research?

1. ***Potential Natural Treatment:*** Discovering antimicrobial properties in tea and moringa suggests they could serve as effective natural remedies for urinary tract infections (UTIs). This could provide an alternative or complementary approach to conventional antibiotic treatments, particularly for individuals prone to recurrent UTIs or those seeking natural alternatives.
2. ***Reduced Antibiotic Resistance:*** Given the rising concern of antibiotic resistance, identifying natural compounds with antimicrobial activity offers a promising avenue to mitigate this global health threat. Tea and moringa extracts could potentially help reduce reliance on antibiotics for treating UTIs, thereby decreasing the selective pressure driving antibiotic resistance.
3. ***Improved Women's Health:*** UTIs disproportionately affect women, causing discomfort, pain, and potential complications if left untreated. Finding effective natural remedies could improve the management and prevention of UTIs in women, enhancing their quality of life and reducing the burden of recurrent infections.

Could you please share any suggestions that you may have to students who would like to explore similar topics/ areas of research?

1. ***To Define Your Research Question:*** Start by clearly defining your research question or objective. What specific aspects do you want to explore (independent and dependent variables)? This will help guide your research and focus your efforts.
2. ***Conduct a Literature Review:*** Before diving into experiments or data collection, familiarize yourself with existing research in the field. Look for studies on UTIs, natural remedies, and related topics to understand the current state of knowledge and identify gaps or areas for further investigation.
3. ***Choose Your Methodology:*** Determine the most appropriate methodology for your research. Will you be conducting experiments in a laboratory setting, analyzing existing data, or perhaps conducting surveys or interviews? Select the approach that aligns best with your research question and resources available.
4. ***Utilize Available Resources:*** Take advantage of resources available to you, such as laboratory facilities, academic journals, and mentorship from professors or researchers in the field. Don't hesitate to reach out for guidance and support.
5. ***Ethical Considerations:*** Ensure that your research complies with ethical guidelines and standards. This includes obtaining necessary approvals for human or animal subjects research, as well as ensuring the integrity and confidentiality of your data.
6. ***Be Patient and Persistent:*** Research can be challenging and time-consuming, but don't get discouraged. Stay patient and persistent in your efforts, and be prepared to adapt your approach as needed based on your findings and feedback.
7. ***Communicate Your Findings:*** Finally, share your research findings with others in the scientific community through presentations, publications, or conferences. Effective communication of your results is crucial for contributing to the collective knowledge and advancement of the field.

Bioinformatics - Revolutionizing Biology

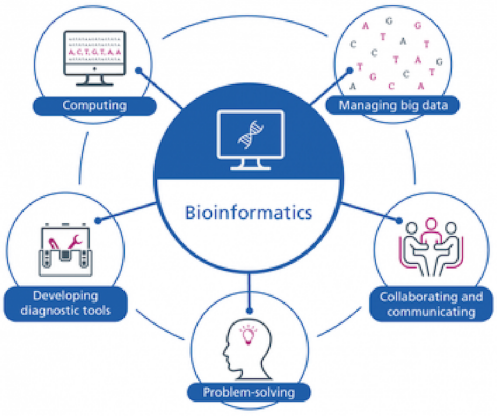
By Saanvi Reddy Parige - Grade 9

This article delves into the role of Computational and Molecular Biology in creating solutions for environmental restoration and will highlight their potential in shaping a more sustainable future. At the intersection of STEM with Computational and Molecular Biology, is the need to utilise numerous computational tools and techniques in order to analyse countless datasets generated through Molecular Biology research, otherwise known as Bioinformatics.

Through this, researchers are able to harness the power of the algorithm to draw conclusions through complex biological information. There are several computational tools which help us come to conclusions regarding the research mentioned previously. A few include:

- **SSAM Workflow:** This tool helps to convert raw count matrices(arranged set of numbers) into normalised expression values (a more comparable number), which can be used to compare gene expression levels across different cells. It also clusters cells based on similarities in reduced dimensions, which can help to identify different cell types or subpopulations.

- **ScType Platform:** This tool uses a scoring mechanism to determine cell-type assignments based on marker gene (if a nucleic acid sequence has been successfully inserted into an organisms DNA) expressions. Essentially, it helps to identify which genes are most strongly associated with different cell types, which can be useful for understanding the function of different cells in a tissue or organism.



- **LineageOT:** This tool leverages mathematical tools from graphical models and optimal transport. It helps to track the development of cells over time, which can be useful for understanding how different cell types arise and how they change over time.

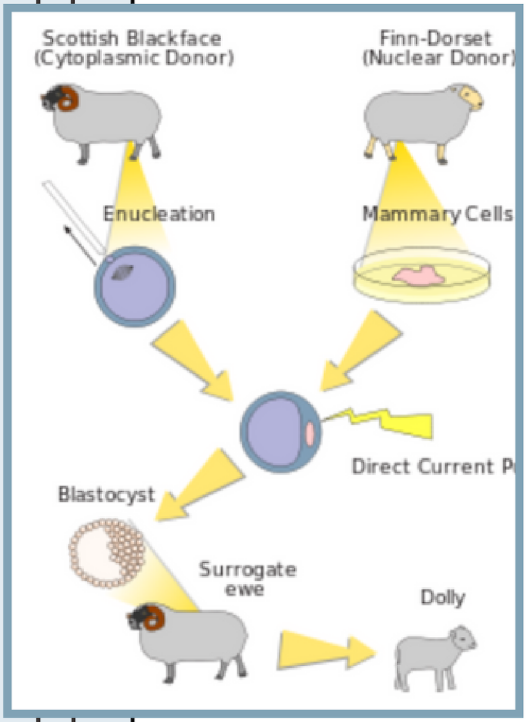
- **SCENIC:** This tool identifies regulatory modules that are associated with cell sub-populations, which can provide insights into cellular states and dynamics. Essentially, it helps to identify which genes are most important for regulating different cellular processes.

Overall, this combination of computational tools and approaches enables researchers, engineers, and policymakers to make informed decisions about renewable energy technology adoption and deployment, ultimately contributing to a cleaner and more sustainable future.

Say Hello to Dolly the Sheep.

By Ishanvi Tupilli - Grade 10

Dolly the sheep is a pioneering success in biotechnology and cloning, proving the effectiveness of somatic cell nuclear transfer (SCNT) techniques. She was born on July 5, 1996, at the Roslin Institute in Scotland. A new era in genetic engineering and developmental biology was ushered in by her birth. An accomplishment spearheaded by Dr. Ian Wilmut and his colleagues.



The cloning of Dolly involved the precise manipulation of cellular reprogramming mechanisms through SCNT. The nuclei of somatic cells (any cell of a living organism other than the reproductive cells are usually regarded as terminally differentiated) were transferred, to reprogram the cells. This procedure challenged the accepted knowledge of **cellular differentiation** by resetting the original sheeps cell's epigenetic landscape, but still enabling them to proceed through normal embryonic development and produce a completely functional organism.

Dolly's birth spurred a great deal of scientific investigation and moral discussion about the potential consequences of cloning technology. Her invention aroused questions about genetic abnormalities, early ageing, and the possibility of being used for human reproductive cloning. Despite these questions, Dolly's legacy resonated with scientists worldwide, paving the way for more investigation into cloning methods and their potential uses. Later developments concentrated on optimising Somatic Cell Nuclear Transfer procedures to increase effectiveness and reduce genetic abnormalities.

Furthermore, Dolly's development highlighted how interdisciplinary biotechnology research is, requiring cooperation between geneticists, molecular biologists, and reproductive experts. This interdisciplinary approach made it easier to come up with creative solutions to solve technological problems and improve cloning processes. Her success story was just the beginning. Opening the door for new directions in disease modelling, cattle breeding, and regenerative medicine.

In conclusion, the birth of Dolly the Sheep was a historical achievement in cloning and biotechnology, highlighting the potential of SCNT techniques in generating genetically identical organisms from adult somatic cells. Her creation catalysed scientific inquiry and ethical discourse, driving further exploration into cellular reprogramming mechanisms and cloning technology's applications in diverse fields of biomedicine and agriculture.

Dolly was the first mammal to be cloned from an adult somatic cell.

STAY UPDATED FOR NEXT MONTHS ISSUE!

Website + Instagram soon to follow

Any enquiries or questions you can reach out to us at

tara.pratapa@indusschoolhyd.com
nitya.kashyap@indusschoolhyd.com


LabLinks