Engineering Bharat's Bio-vision

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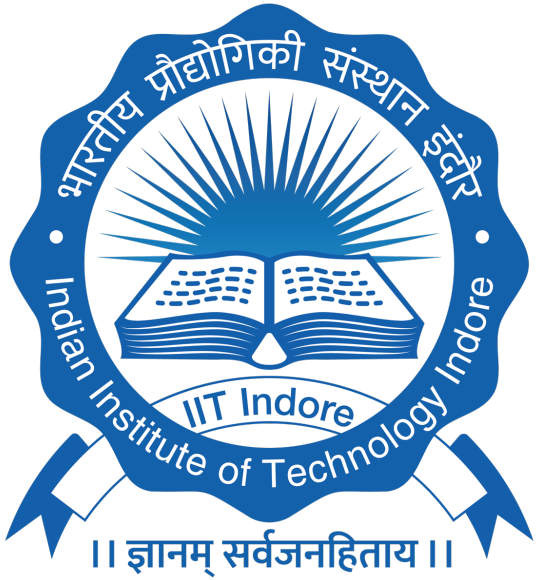
February 17, 2025



Indian Institute of Technology, Indore

WELL DONE & Heartiest CONGRATULATIONS!!!

TO EACH ONE OF YOU

Indore's Famous 'Bhel puri'

@YouTube

A Great Mix

Can Have

An Amazing Outcome!

"Mixing engineering and biology" will help to develop new technologies and solutions for the future

The Engineering Of Living Organisms Could Soon Start Changing Everything

Medicine on Demand-Reimagining Drug Development Through Oligo Innovation

Ethics Elixirs and Enterprises: **The Triad of Longevity's Future**

Expand Your Design Space Ask Bigger Questions with **Complex DNA Synthesis Service**

Partnering Intelligent Algorithms and **Enzymatic DNA Assembly** to Accelerate the Future of Synthetic Biology

Unlocking Possibility: **Leveraging AI to Accelerate Novel Protein Solutions** that Scale

Heads Up Scale Up The Hidden Costs of Outsourcing Bioprocess Development

Scaling Highly Engineered Strains to Produce Complex Pharmaceuticals

Direct Air capture Enzymatically Accelerated Rock Weathering

E-Skin That Heals In Seconds: The Future of Health Monitoring

Rapid Protein Production Achieved Through Biologically Engineered Reaction Crucibles

Genetically Modified Fish Could Erase Mercury Pollution

Eyes Wide Open: How **Stem cell Shots** Could Reboot Ocular Health

The Microbe That Speaks a New Genetic Language

Engineering Tomorrow: Push into the **Frontier of Synthetic Biology**

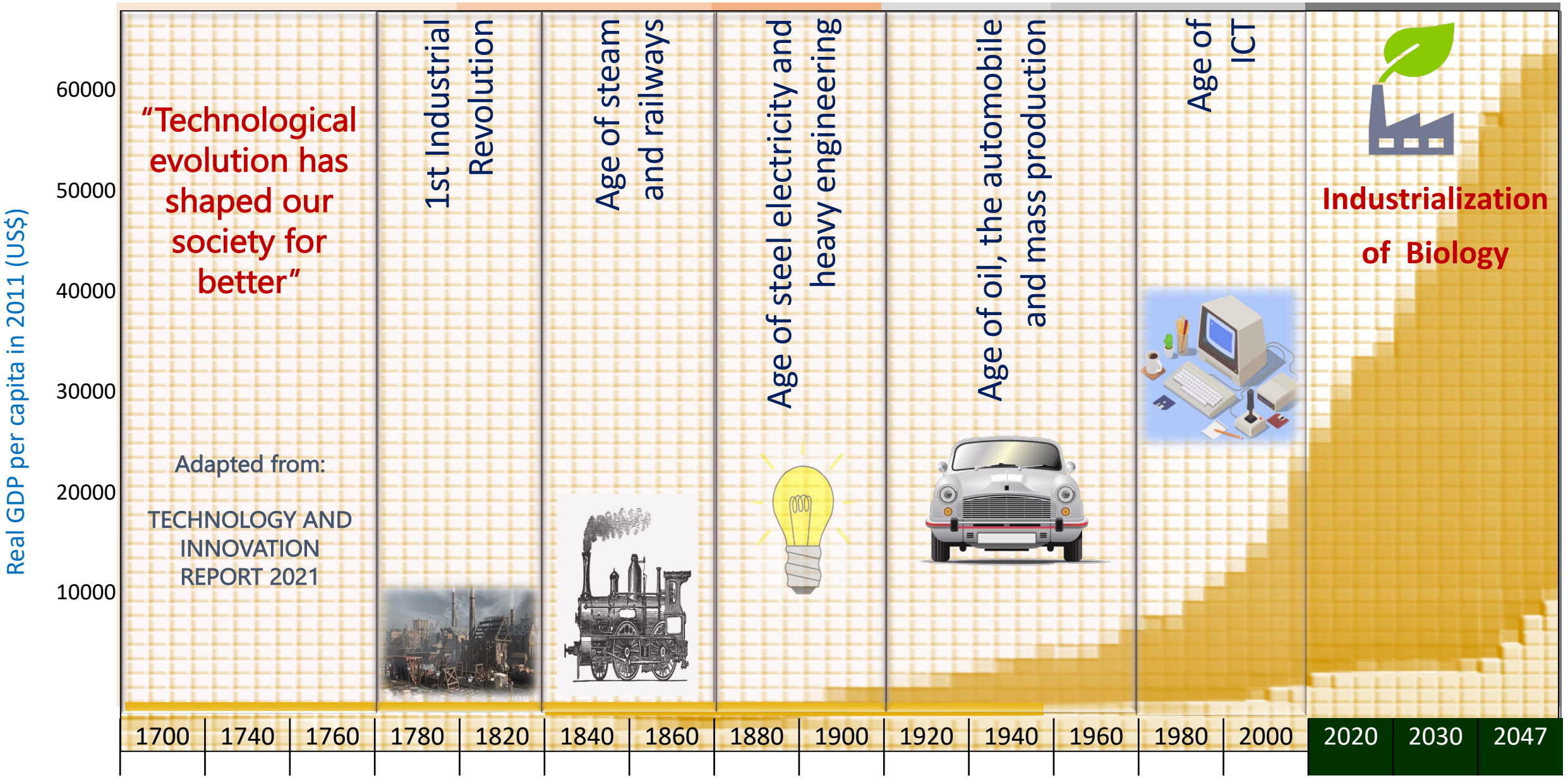
Engineering Roots for **Climate-Resilient Crops**

The **Brain-Machine Interface** Just Got a Major Upgrade

The Power Of Synthetic Biology In Shaping A Sustainable Future

Health Bio	***Cutting-edge advancements in cellular reprogramming, gene therapies, and neurotech*** *reshaping health innovations through* ***AI-driven discovery and engineered cell therapies***
Hyperscale Bio	***Fusion of AI, biology, and engineering, driving breakthroughs in automated science****, foundational models, and computational drug discovery;* ***transforming protein and antibody engineering***
Earth Bio	***Uncovering biology's role in addressing climate challenges*** *with innovations in green chemistry, cultivated foods, and renewable fuels;* ***engineering sustainable solutions at planetary scales***

Industrial revolutions are rare, but when they come, they change everything



BIO-REVOLUTION IS COMING!

A Timeless Message

A scene from a 1943 US TV show

Focus on *Twin Tech Transitions*

for Sustainable Development

DRIVE INNOVATIONS ⟷

- **DIGITAL TECH**
- **GREEN TECH**

⟷ CREATE NEW OPPORTUNITIES

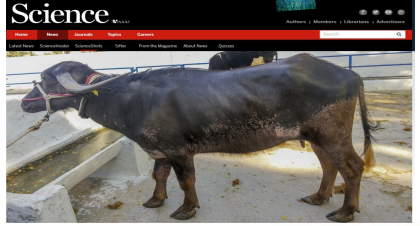
Strategically Integrate Finance with Technology Development

Bharat Needs Its Own Growth Model

Not going by the 'Silicon Valley Playbook' OR 'MassBio recipe'

Let's start solving for Bharat, instead of **cutting and pasting** our models and assumptions **from the rest of the world to apply to India**

We need to start **asking questions** that are more **in line with our own** demographic, economic, and geographical **realities**



Let's break Stereotypes!

भैंस की व्यथा

बच्चा जब थोड़ा बड़ा होता
है , दूध *मेरा* पीता है,
वो भी बोर्नविटा डाल डाल कर ।
और
निबन्ध लिखने के लिये *गाय**हाथी* या
कुत्ते ..... क्यों ?
अगर बच्चा लिख नहीं पाता
तो बोलते हैं ....
*काला अक्षर भैंस बराबर
तो क्या दूसरे जानवर
पोस्ट ग्रेजुएट हैं ??

भैंस की जबान से

यदि काइ गल्ती कर ता लाग
कहते हैं कि *गई भैंस पानी में*
बाकी के जानवर क्या
कोका कोला में जाते हैं ?
कोई न सुने तो कहते हैं
भैंस के आगे बीन बजाना
बाकी के आगे क्या

लता मंगेशकर का गाना
बजाते हैं ?

क्या बिगाड़ा है हमने

Global Challenges Require Concerted Sustainable Interventions

- Climate Change
- Unsustainable Material Consumption
- Waste Generation

END-OF-LIFE CYCLE Assessment

What a Mess!

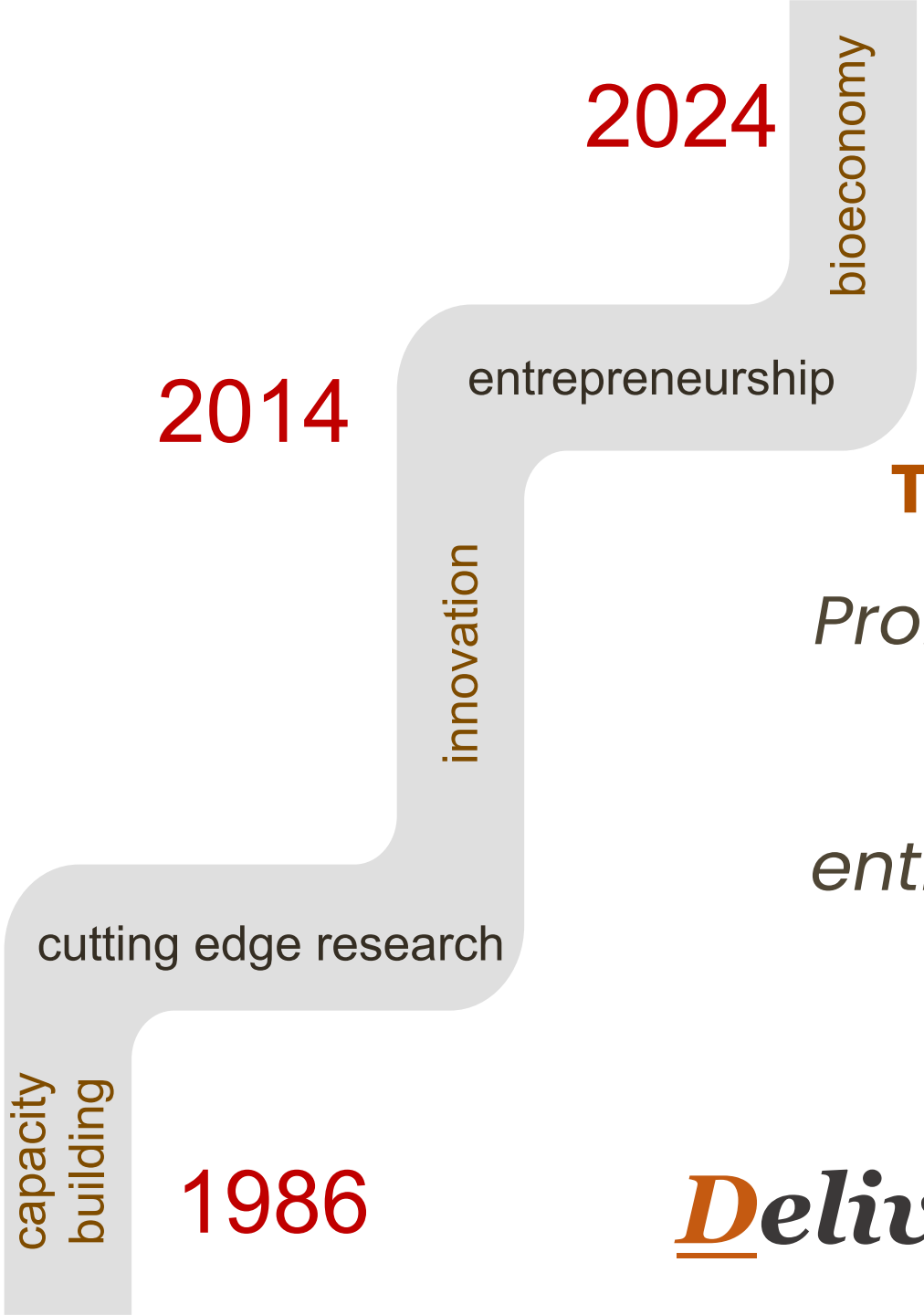
The Sari Mess:

As Char Dham pilgrims discard garments in rivers,

~7 quintal fished out in >2 months

A Pressing Problem

- Pilgrims have been discarding clothes on the banks of the *Bhagirathi and Yamuna*
- 4 quintal clothes from Bhagirathi
- Government *appeals make no difference*
- Not any ritual but laziness
- Pilgrims leave behind heavy wet clothes that were used to take a dip in the river



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The Department of Biotechnology

Promoting excellence and innovation - driven discovery research and entrepreneurship in biotechnology and modern biology

Delivering a Better Tomorrow

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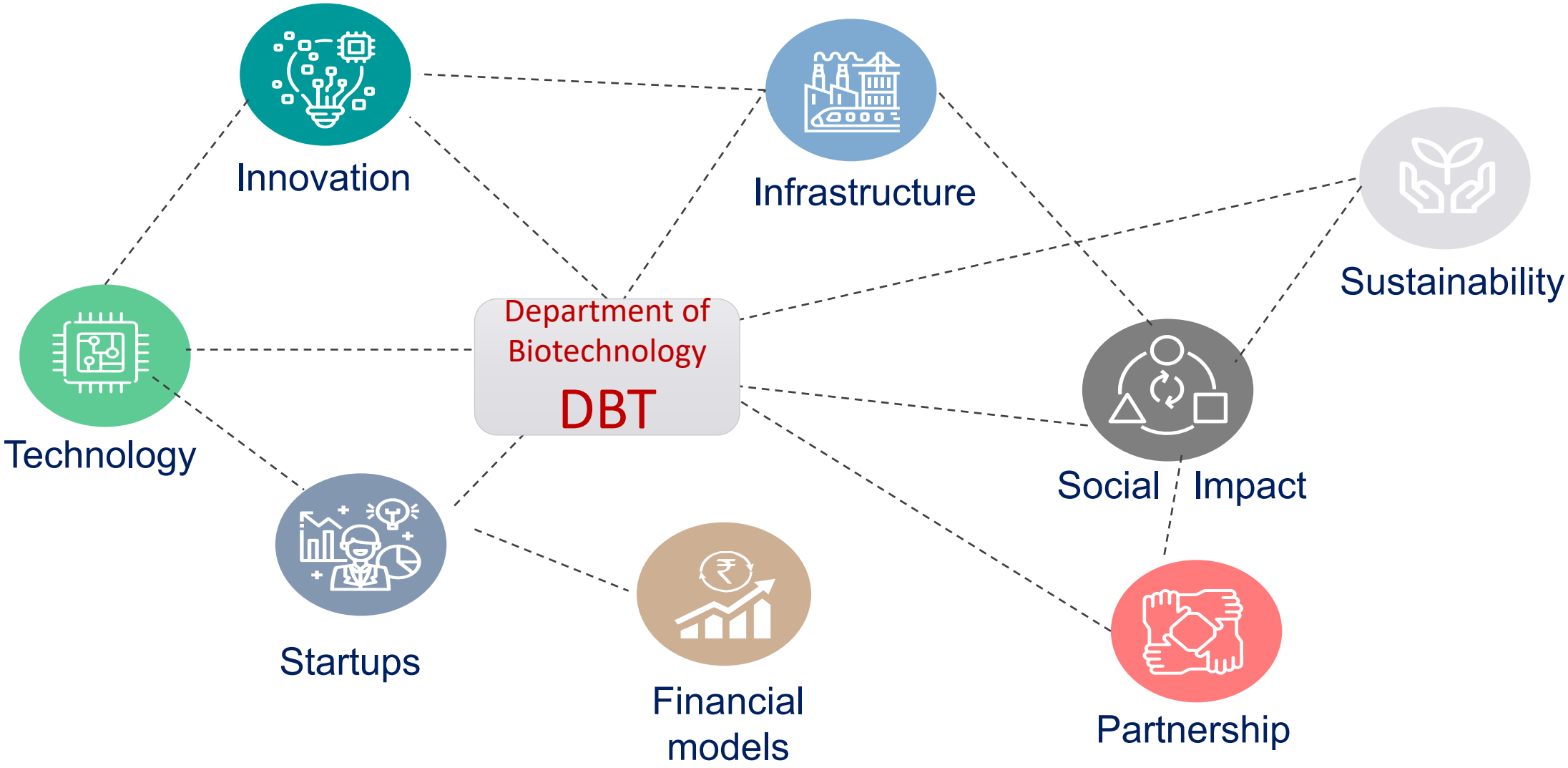
Collective Intelligence & Networking

Not just a funding agency



The Union Cabinet, chaired by the Prime Minister Shri Narendra Modi Approved BioE3 Policy on August 24, 2024

- A framework that give directions for future Scientific, Industrial & Societal advancements
- A commitment to foster and advance future that is more **S**ustainable, Innovative, and **R**esponsive to global challenges
- Bharat to be amongst the global leaders in the next industrial revolution
- Potential to create new jobs and intensify entrepreneurial momentum

The Strategic Roadmap

1. Bio-based Chemicals & Enzymes
Catalyzing Greener Reactions

2. Functional Foods & Smart Proteins
Taste without Cruelty

3. Precision Biotherapeutics
Remedies that understand YOU

4. Climate Resilient Agriculture
Krishi that makes earth happy

5. Carbon Capture & Utilization
Recover to Prosper

6. Futuristic Marine & Space Research
Diving into Infinity

Catalyzing Accelerating Transformation with Bio-Enablers (मूलांकुर)

Public Private Partnerships

Bio Artificial Intelligence Hubs

Biomanufacturing Hubs

Skilling and human resources

Regulatory enablement & inter-ministerial coordination

International Collaboration

BIOLOGY WILL BUILD THE NEXT TECHNOLOGY REVOLUTION!!

Just the way IT Industry revolutionized life in 1990s!

Everything will be impacted by new biology

Food Water Energy
Environment Plants Animals Humans

The rapid advancements in artificial intelligence, biotechnology, and other exponential technologies are reshaping the world faster than ever before!!

Biomanufacturing will empower us to reimagine the future

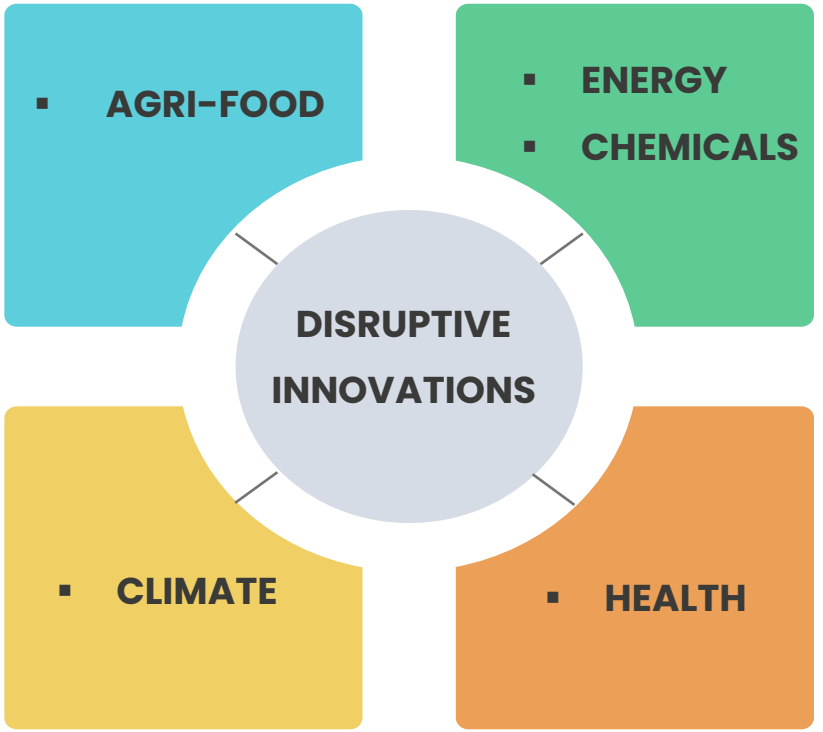
Synthetic Bioengineering

Leveraging Living Systems by genome engineering for efficient production of target compounds/ chemicals/ materials/Proteins

+

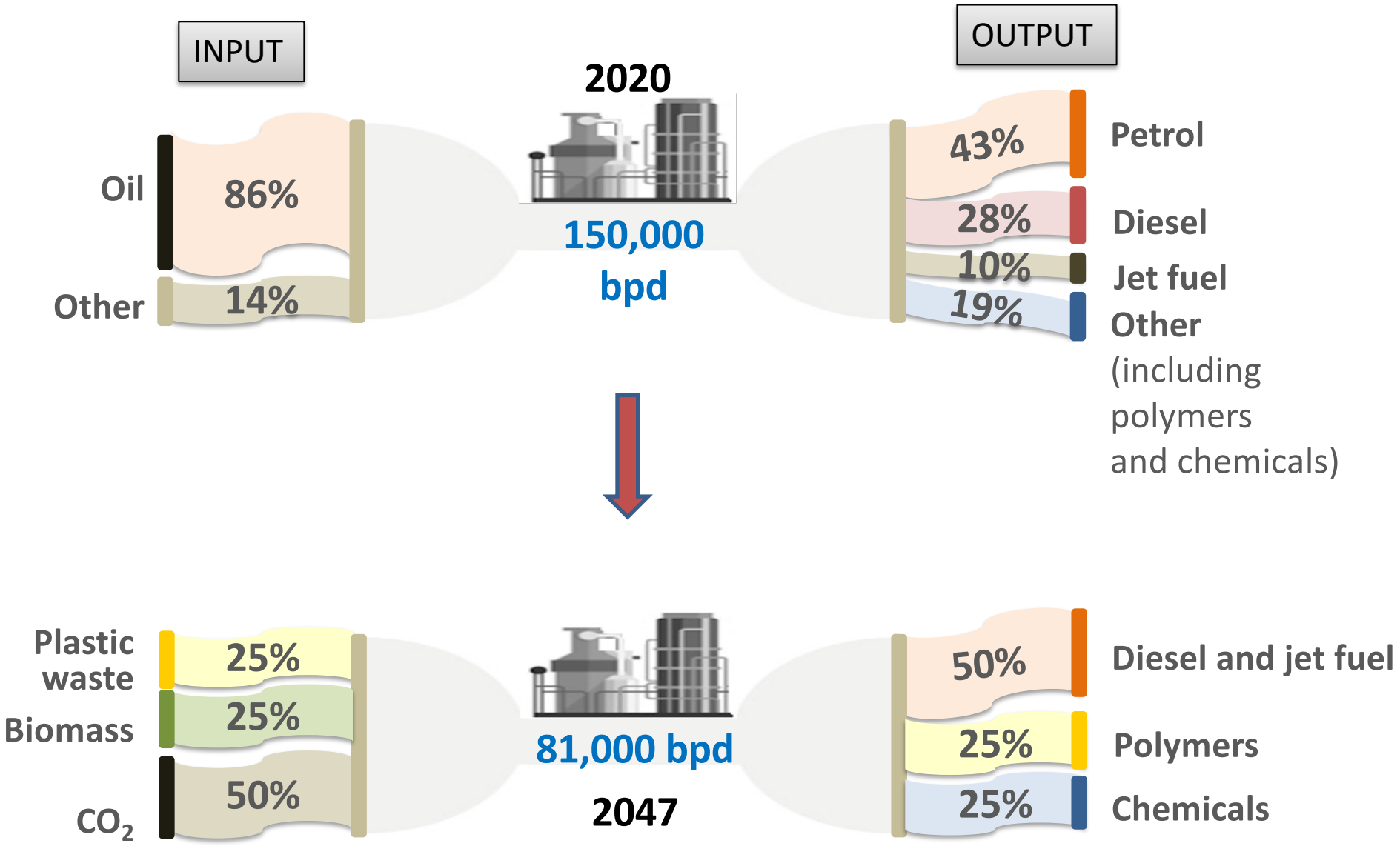
Precision BIOmentation

Using customized productive organisms and intelligent bioprocesses



Tech Solutions for Future Security (in the non-strategic sector)

Plotting a Transition Towards Fossil-free Oil Refinery of 2047



(Nature 2024, Vol 629, 295)

Paradoxical Carbon Economy Cycle

- India imports ~350 million tons of carbon in the form of fossil energy.
- This results in 2.6 GT CO2 emission from this.
- ~450 million tons of carbonaceous resources is wasted (Agro/MSW)

Numaligarh 2G ethanol Plant – Enzyme requirement

- **Numaligarh plant has capacity to process 3,00,000 ton bamboo per year**
- **Numaligarh plant uses formicobio™ technology to process biomass**
- **The plant can produce 60,000 kilo liter ethanol per year along with 19,000 tons of furfural, 11,000 tons of acetic acid, and 144 gigawatt hours of green energy**
- **Average biomass composition for bamboo plant – Cellulose (45%), hemicellulose (25%), lignin (25%)**
- **Pretreated bamboo biomass produced per year – 1,27,750 ton**
- **Enzyme requirement per year (@9% pretreated biomass) – 11,500 ton**
- **Cellulase Enzyme cost per year (@Rs 350 per kg) – Rs. 419 crore**

Our Chemical Life – About 60,000-70,000 molecules

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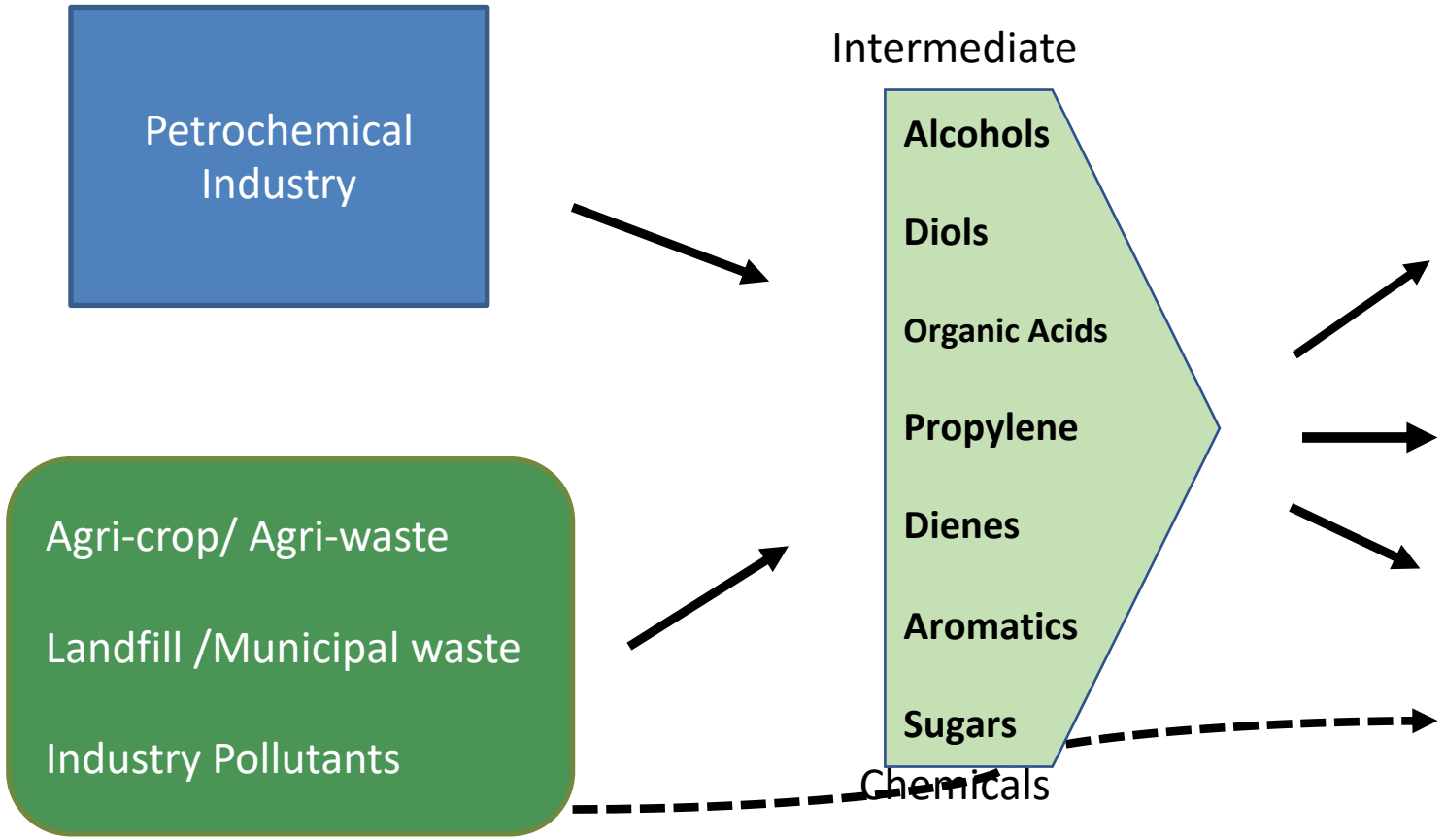
Speciality Chemical Industry Market US$60 Billion by 2026 (KPMG report)



OUR CHEMICAL INDUSTRY

- Agro- & Poultry- chemicals
- Dyes and pigments
- Food and Feed additives
- Pharmaceuticals
- Construction chemicals
- Water treatment chemicals
- Homecare Ingredients
- Polymers and bioplastic
- Perfumery/ flavors
- Fertilizers
- Industrial chemicals
- Paints, coatings & Adhesives

TRANSITION from Nonrenewable petrochemical feedstock to biomass-derived feedstock – CIRCULAR ECONOMY

Manufacturers identifying sustainable chemistry practices in India.

Castor Oil

Castor is grown over an area of about 1M ha in India with a production of around 1.7-2M tonnes.

India accounts for 65% of worldwide castor oil production and over 87% of global exports.

India exports castor oil to over 134 countries, with exports in 2020/21 valued at US$622.64M.

China is the largest market for Indian castor oil, importing US$279.14M worth of product in 2020/21. This was followed by the Netherlands (US$71.34M), France (US$57.6M), USA (US$55.87M) and South Korea (US$23.37M)

India has to import castor oil-formulated products and derivatives at a much higher price than the oil due to a lack of manufacturing facilities for value-added products.

Reimagining Milk, Dairy, MEAT, EGGS

***Scarcity* of land & water, *antibiotic* resistance in cattle, cost of *feed* and *GHG* impact**

THE CATTLE COUNT

- As per 20th Livestock Census in the country
- 303.76 million bovines (cattle, buffalo, mithun and yak)
- 74.26 million sheeps
- 148.88 million goats
- 9.06 million pigs
- 851.81 million poultry

THE MILK DATA

- Milk Data for Year: 2022-23 (25% total world)
- Milk Production: 230.6 Million tonnes
- Human Population: 1376 Million
- Per Capita Availability: 459 Gram /day

Source: Perfect Day

PRECISION FERMENTATION OF FOOD, DRINK, MEAT, PROTEIN IS THE NEW EXCITING & CRITICAL SOLUTION

Building Next-Gen Biologics: Disrupting Therapeutics with Innovation

The next wave of biologics is set to revolutionize medicine by integrating **synthetic biology, AI-driven design, and precision delivery systems.**

- AI-Driven Biologics Discovery & Optimization
- Engineered Antibodies & Alternative Scaffolds
- mRNA and Gene-Editing Therapeutics
- Cell-Based Biologics
- Microbial & Synthetic Biology-Based Therapeutics
- Smart Drug Delivery Systems
- Next-Gen Biologics for Emerging & Rare Diseases

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Bio-Vision for VIKASIT Bharat

- Bio-Pharma
- Bio-Agri
- Bio-Industrial
- Bio-Energy
- Bio-Services
- Bio-Medtech
- Bio-AI

From today's consumptive manufacturing paradigm to the one based on regenerative principles

– a parable from Your Sacred Self by Dr. Wayne Dyre

In a mother's womb were two babies. One asked the other: "Do you believe in life after delivery?" The other replied, "Why, of course. There has to be something after delivery. Maybe we are here to prepare ourselves for what we will be later." "Nonsense" said the first. "There is no life after delivery. What kind of life would that be?"

The second said, "I don't know, but there will be more light than here. Maybe we will walk with our legs and eat from our mouths. Maybe we will have other senses that we can't understand now."

The first replied, "That is absurd. Walking is impossible. And eating with our mouths? Ridiculous! The umbilical cord supplies nutrition and everything we need. But the umbilical cord is so short. Life after delivery is to be logically excluded."

The second insisted, "Well I think there is something and maybe it's different than it is here. Maybe we won't need this physical cord anymore."

The first replied, "Nonsense. And moreover if there is life, then why has no one has ever come back from there? Delivery is the end of life, and in the after-delivery there is nothing but darkness and silence and oblivion. It takes us nowhere."

"Well, I don't know," said the second, "but certainly we will meet Mother and she will take care of us."

The first replied "Mother? You actually believe in Mother? That's laughable. If Mother exists then where is She now?"

The second said, "She is all around us. We are surrounded by her. We are of Her. It is in Her that we live. Without Her this world would not and could not exist."

Said the first: "Well I don't see Her, so it is only logical that She doesn't exist."

To which the second replied, "Sometimes, when you're in silence and you focus and you really listen, you can perceive Her presence, and you can hear Her loving voice, calling down

Practise to Perceive Unseen Prospects

BiOE3

Biotechnology for Economy, Environment & Employment

Thank you

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