Organoid Intelligence and Bio-Computers

For Prelims: Organoid intelligence, Potential uses of Bio-computers.

For Mains: Threats and opportunities of Organoid-culture.

Why in News?

Recently, Scientists have outlined a plan for a **potentially revolutionary new area of research called "organoid intelligence",** which aims to create "biocomputers", where **3D brain cultures grown in the lab are coupled to real-world sensors** and input/output devices.

- Technology is **expected to harness the processing power of the brain** and understand the biological basis of human cognition, learning, and various neurological disorders.

What is this Technology?

- These **"mini-brains"** (with a size of up to 4 mm) are **built using human stem cells and capture many structural and functional features of a developing human brain**. It is used to study human brain development and test drugs to see how they respond.
    - However, Brain organoids developed in the lab are **not advanced enough** as they **lack the required sensory inputs and blood circulation** that are necessary for the development of a complex organ like the human brain.

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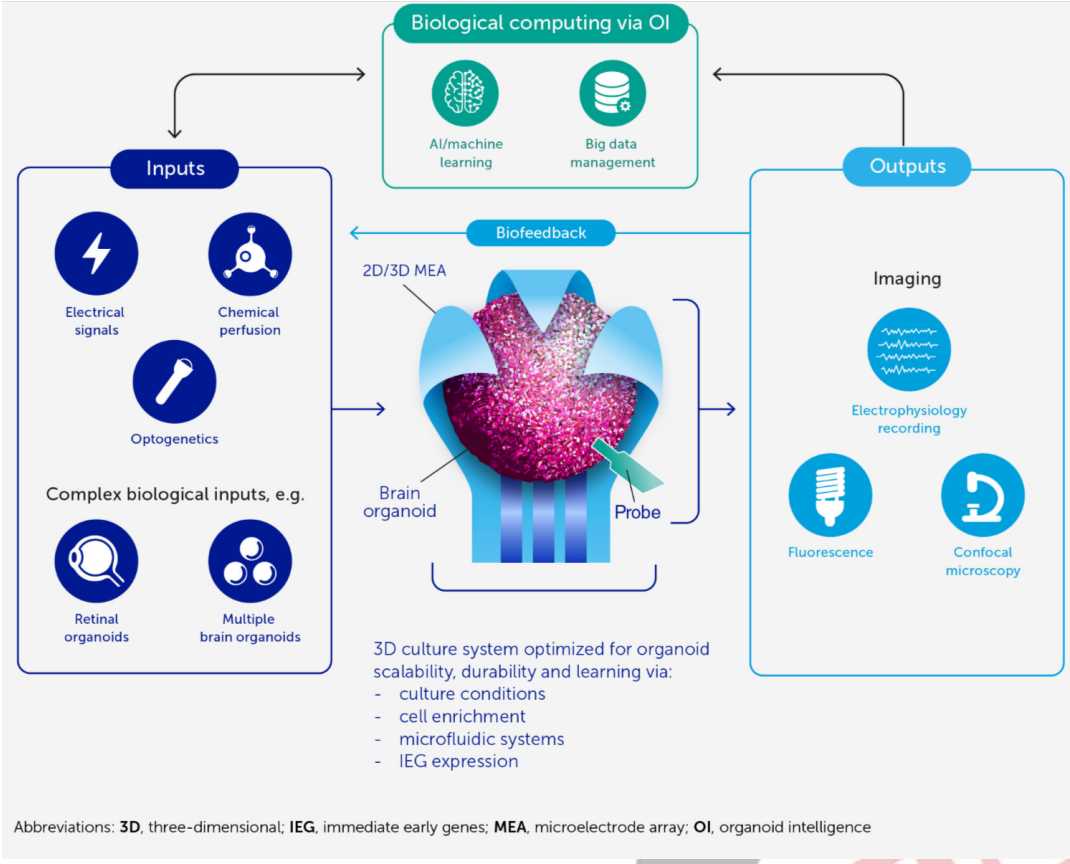

- Moreover, Scientists **transplanted human brain organoid cultures into rat brains** and observed that they formed connections with the rat brain and **showed functional activity.**
    - This system could provide a **way to study brain diseases** in a human context.
    - However, the organoids are still in the rat-brain microenvironment, which **may not be representative of the human brain.**

What is the New 'Bio-computer'?

- Researchers plan to **combine brain organoids with modern computing methods using machine learning** to create "bio-computers".
- They will **grow organoids inside structures with multiple electrodes** that can record the firing patterns of neurons and mimic sensory stimuli.
- Machine-learning techniques will then be used **to analyse the effect of neuron response patterns on human behavior** or biology.
- Scientists have already grown human neurons on a microelectrode array and trained them to generate electrical activity similar to what electrons would generate while playing table tennis.

What are the Opportunities for 'Bio-Computers'?

- **Brain organoids developed using stem cells from individuals** with diseases like Parkinson's disease and microcephaly can aid drug development for these conditions.
- These organoids **can provide insights into the biological basis of human cognition,** learning, and memory by comparing the data on brain structure, connections, and signaling between healthy and patient-derived organoids.
- While **human brains** are slower than computers at simple arithmetic, they **outshine machines at processing complex information.**

Way Forward

- Currently, brain organoids have a diameter of less than 1 mm, roughly **three-millionth the size of an actual human brain.** So, scaling up the brain organoid is key to improving its computing

capacity.

- Neural recordings from each neuron and connection will be needed to store and analyse using '**Big Data**' infrastructure.
- Researchers will also **have to develop microfluidic systems to transport oxygen and nutrients, and remove waste products.**
- There is also a need to **identify, discuss, and analyse ethical issues** as they arise in the course of this work.

Source:TH