5.Fluorescent Proteins- Science & Technology

How proteins are being tweaked to be quantum sensors inside the body

Scientists have discovered that genetically modified fluorescent proteins (like MagLOV) can act as quantum sensors inside living cells, detecting magnetic fields and radio waves even at room temperature. This breakthrough paves the way for a new class of hybrid quantum-biological technologies capable of tracking microscopic cellular processes with unprecedented precision.

1. Context

Scientific Breakthrough- Two major studies published in *Nature* (February 2026) have revealed that fluorescent proteins can detect magnetic fields and radio waves from inside living cells.

Mechanism- These proteins act as quantum sensors, leveraging quantum behaviors even in the noisy environment of a living cell.

Significance- The results pave the way for genetically encoded quantum sensors and a new class of hybrid quantum-biological technologies.

2. Key Proteins Involved

A. Enhanced Yellow Fluorescent Protein (EYFP)

Description- A genetically engineered variant of the Green Fluorescent Protein (GFP).

Function- It emits yellow light and is widely used to visualize and track cellular processes within living cells.

New Capability- Researchers successfully modified EYFP to exhibit quantum sensing properties.

B. MagLOV

Description- A newly developed, genetically engineered magneto-sensitive fluorescent protein.

Mechanism- It detects magnetic fields inside living cells by linking changes in electron spin to measurable changes in fluorescence.

3. Key Findings of the Study

Room Temperature Viability- Engineered proteins (like MagLOV) functioned as sensors in *Escherichia coli* bacteria even at room temperature, proving that fragile quantum states can survive biological "noise."

Potential Applications-

1. Tracking protein shape changes.
2. Monitoring biochemical reactions in real-time.
3. Revealing drug-target binding with unprecedented precision.

4. About Fluorescent Proteins

Definition- Light-emitting proteins that absorb light at a specific wavelength and emit it at a longer wavelength.

Discovery- The Green Fluorescent Protein (GFP), originally discovered in jellyfish, is the most famous example.

Nobel Recognition- The development and application of GFP were awarded the Nobel Prize in Chemistry (2008).

Working Mechanism

1. Chromophore- Contains a special light-sensitive part called a chromophore.
2. Absorption- When hit by light (usually blue or UV), the protein absorbs the energy.
3. Excitation- This energy excites an electron inside the chromophore.
4. Emission- The excited electron quickly returns to its normal state, releasing energy as visible light (green, yellow, red, etc.). This emitted light is called fluorescence.

5. About Quantum Sensors

Definition- Devices that utilize quantum properties of particles (like electron spin or superposition) to measure extremely tiny physical changes.

Detection Capabilities- capable of detecting weak-

1. Magnetic fields.
2. Electric fields.
3. Temperature changes.
4. Gravitational variations.

General Applications of Quantum Sensors

Medical imaging (high-precision scans).
Navigation systems (GPS-free navigation).
Geological exploration (mapping underground resources).
Quantum computing research.

6. Applications of Fluorescent Proteins in Science

Field	Application
Cell Biology	• Tracking protein movement inside cells. • Studying cell division processes. • Visualising cancer progression in living tissues.
Neuroscience	• Mapping neural circuits. • Studying synaptic connections within the brain.
Medical Research	• Drug discovery. • Developing disease models to understand progression and treatment.
Plant Sciences	• Studying stress responses. • Analysing pathogen interactions and photosynthetic processes.
Synthetic Biology	• Designing and monitoring engineered gene circuits.

7. Limitations of Traditional Fluorescent Proteins

Photostability Issues- Prone to photobleaching, which causes a gradual loss of fluorescence during prolonged illumination.
Biological Interference- Fusing fluorescent proteins to target proteins may interfere with proper folding, localisation, or biological function.
Environmental Dependence- Fluorescence intensity and stability can fluctuate based on intracellular conditions like pH, temperature, and ionic concentration.
Limited Quantum Efficiency- Traditional proteins are not inherently optimized for quantum sensing; engineered variants like MagLOV are specifically designed to overcome these constraints.
Source- https-//www.thehindu.com/sci-tech/science/engineered-proteins-maglov-qubits-quantum-sensors-inside-cells/article70662833.ece