

A person is lying on a table, and a cold atmospheric plasma device is being used on their chest. The device is emitting a bright purple glow. The background is dark, and there are some white cables or tubes visible.

Cold Atmospheric Plasma in Oncology

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Concept & Motivation

- Novel cancer treatment modality
- Based on **reactive species generation**
- Key idea:
 - Deliver **chemically active species** to cancer cells
- Goal:
 - Maximize tumor damage
 - Minimize healthy tissue effects

Low Temperature Plasma (LTP)

- Non-equilibrium system: Electron temperature \gg gas temperature
- Gas temperature $< 40^{\circ}\text{C}$ \rightarrow biologically safe
- Operates at atmospheric pressure
- **Efficient reactive species generator**

Plasma Medicine Journey

Plasma generation

Gas

Liquid

Cell

Outcome

Plasma Generation Mechanism

Applying an electric field to gas

Helium, Neon, Argon

Electron acceleration

gas molecule dissociation
excitation
ionization
photon emission

Plasma generation

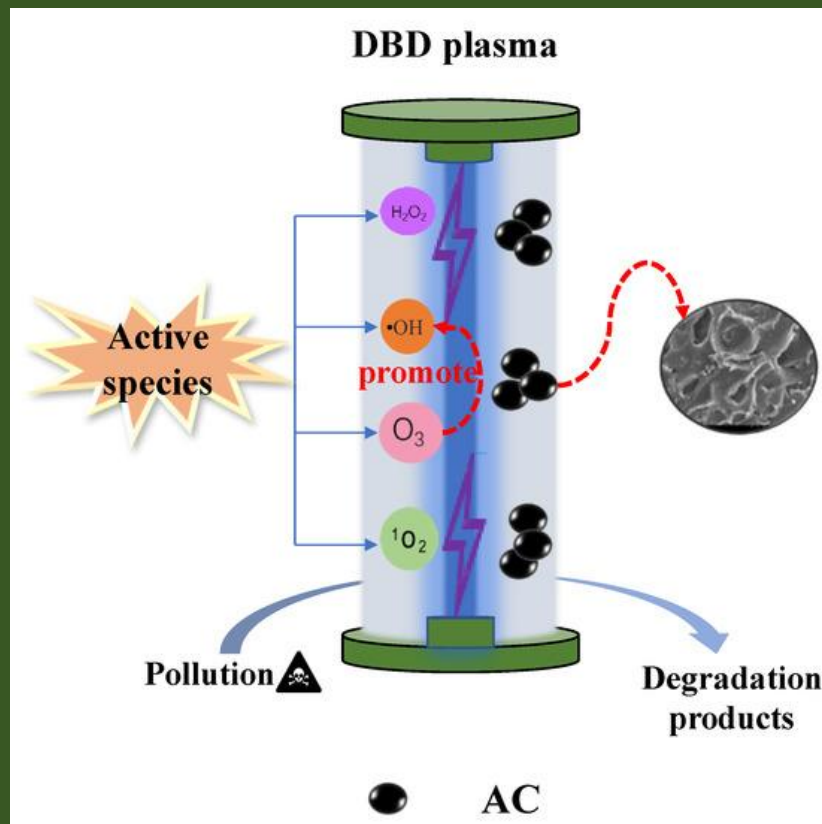
Electron avalanche → gas breakdown

Plasma interacts with air components.

Plasma outcome

Gas Chemistry

- Chemical:
 - ROS (OH, H₂O₂, O₂⁻)
 - RNS (NO, NO₂⁻, ONOO⁻)
- Physical:
 - UV/VUV radiation
 - Electromagnetic fields
 - Minor heating, shock effects
- Controlled by **power, gas, pressure**



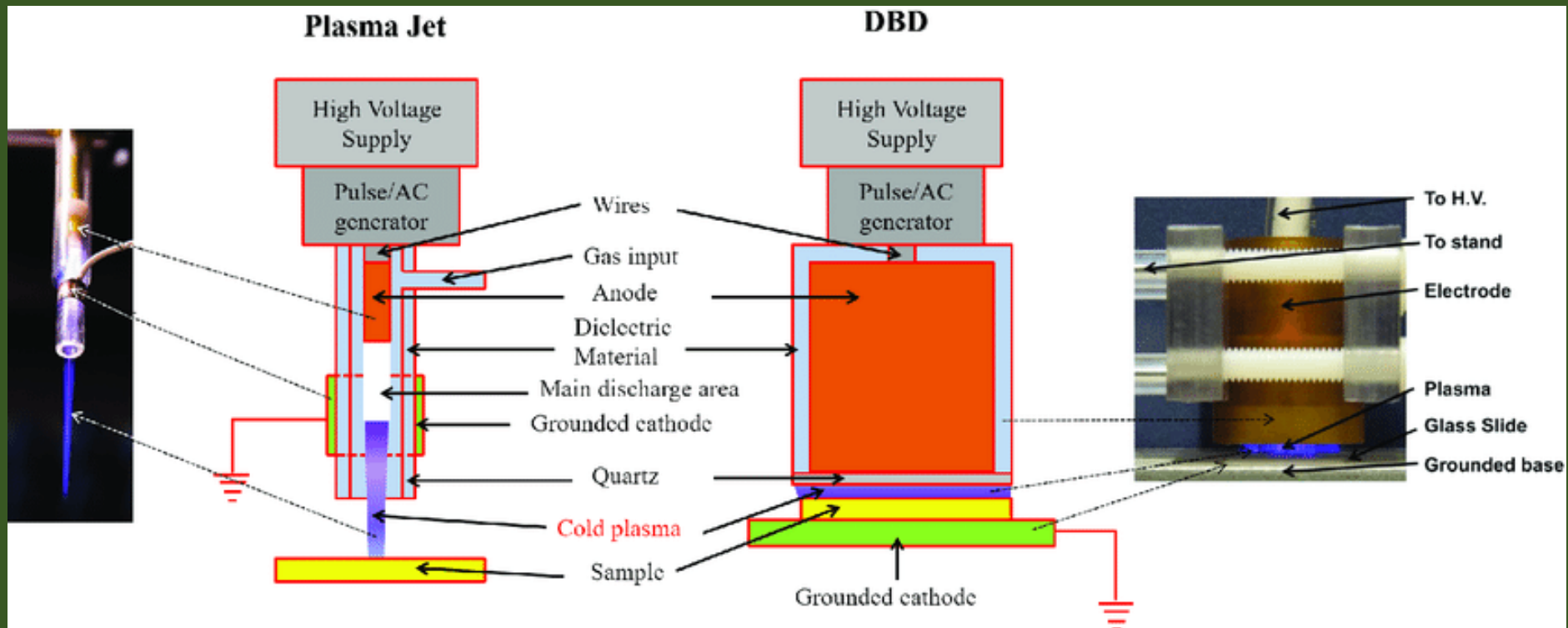
Plasma Sources

1. Atmospheric Pressure Plasma Jet (APPJ)

offer focused, precise treatment with better temperature control via gas flow

2. Dielectric Barrier Discharge (DBD)

cover larger areas but need cooling for extended use.



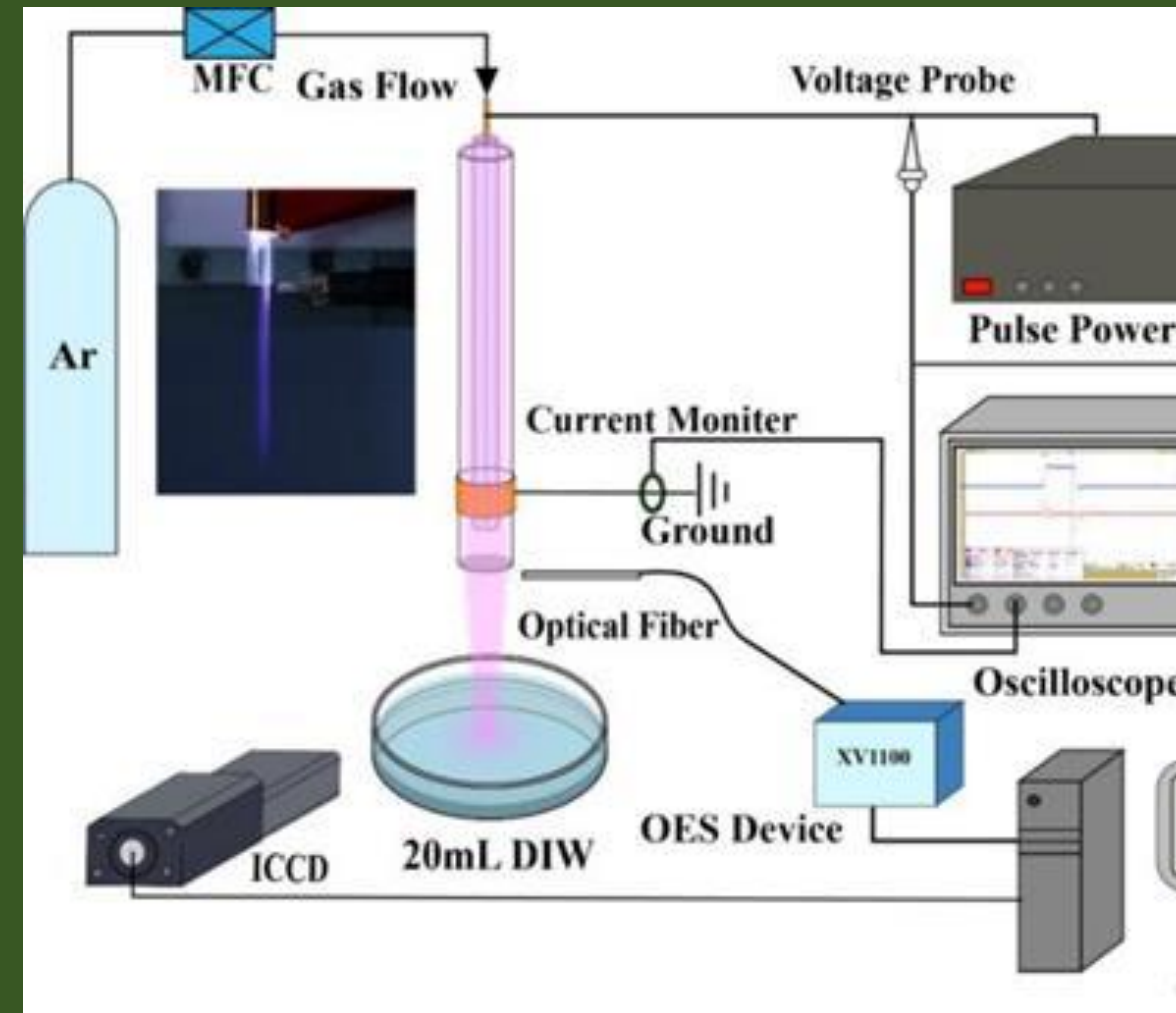
Plasma Activated Medium (PAM)

Description: **liquid exposed to plasma before being injected into the biological system.**

Liquid media such as cell culture and Ringer's lactate solutions, saline, and water are the most commonly used media for generating reactive species.

The benefits of PAM

- It is **stored under proper conditions**; it will not degrade and lose its chemical properties and then can be **applied later for treatment.**



Plasma Activated Medium (PAM)

Direct plasma source

- Direct treatment is defined as a method in which **plasma is in direct contact with the biological target.**
- All plasma species and their synergistic interactions can take an active role in biological effects.
- **only delivered ROS/RNS during** the plasma jet ignition

Indirect plasma source

- It is influenced by **chemical species rather than the physical aspects** of the source.
- Only plasma species that still remain **after removing ionizing radiation** are delivered to the biological target.
- **continued to deliver ROS/RNS into a nearby medium** long after the plasma was quenched.

Various plasma-generated ROS/RNS are involved in DNA damage

low levels of ROS/RNS

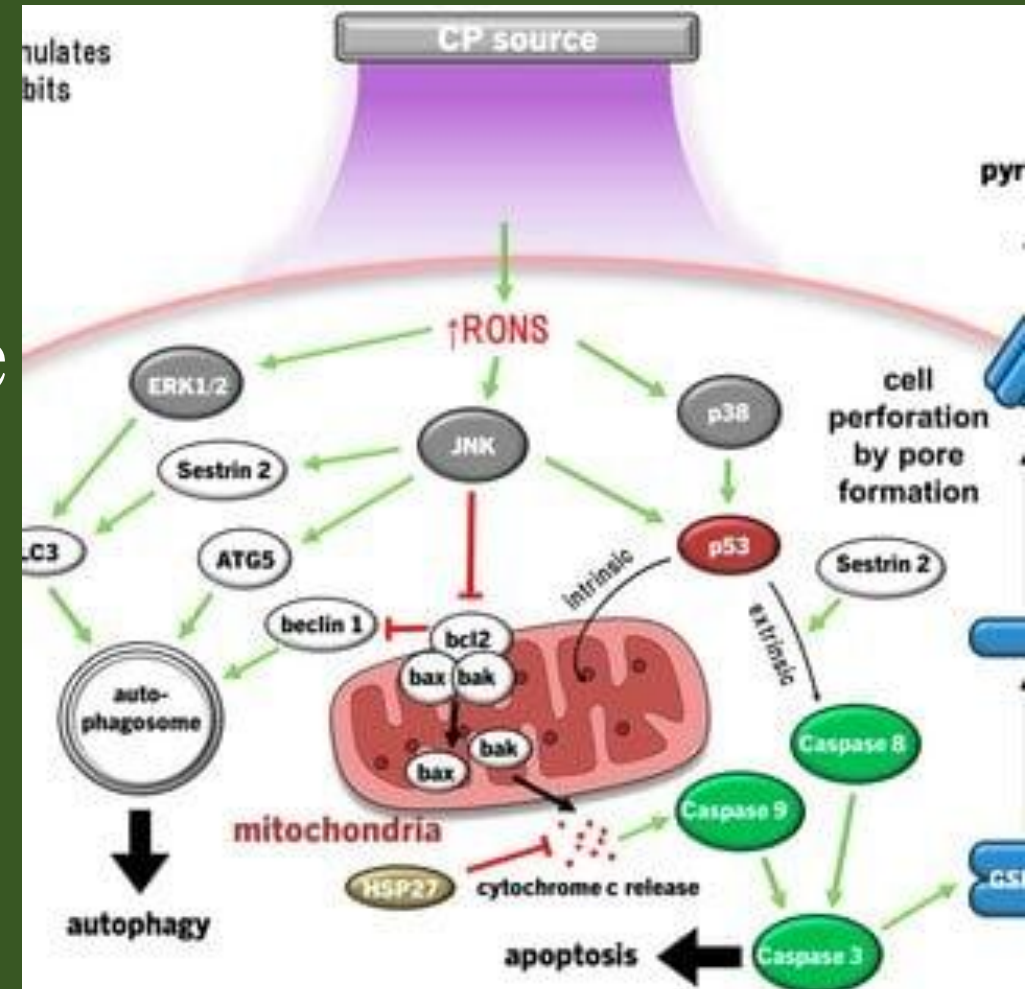
- promote cell survival, proliferation, and migration

Excessive ROS levels

- accumulating the **oxidative stress**, and finally, the initiation and execution of **apoptosis**

Selectivity Toward Cancer Cells

- Cancer cells:
 - Elevated baseline ROS
 - Reduced antioxidant defenses
- CAP increases ROS beyond the tolerance threshold
- Preferential cancer cell death



Thank You
Any questions?