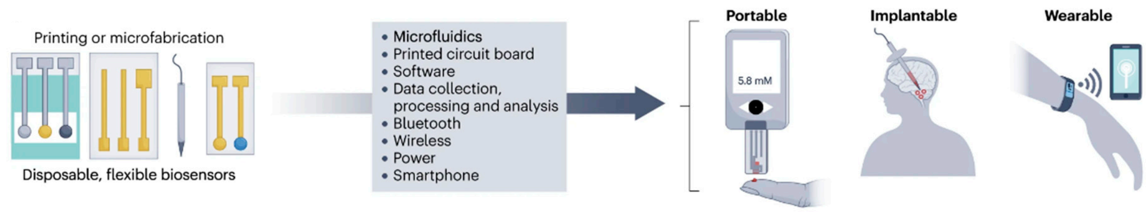
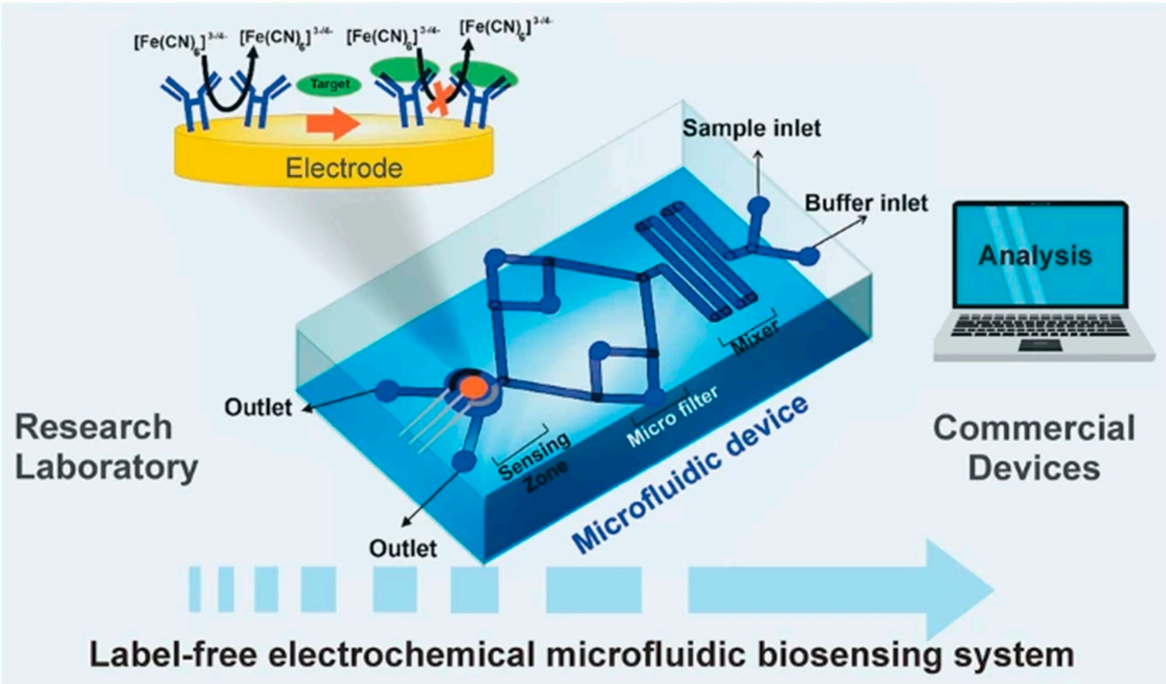
Figure 2B: Biosensor Types and Fabrication



Explanation:

- **Disposable, Flexible Biosensors (Left Section)**
- These sensors are created through processes such as printing or microfabrication.
- The sensors are flexible and can be disposed of after use. They consist of a simple design with electrodes that detect biological signals.
- These biosensors collect data and provide inputs to more complex systems, as shown by the arrow.
- **Data Processing (Middle Section)**
- Various technologies come into play for handling the data collected by the biosensors, including:
    - **Microfluidics:** Controls the flow of small amounts of fluid, often used in lab-on-a-chip technologies.
    - **Printed circuit board (PCB):** Used to connect the sensors and the processing unit.
    - **Software:** For analyzing the data collected from the biosensors.
    - **Data Collection, Processing, and Analysis:** Handles raw data and transforms it into meaningful information.
    - **Wireless Technologies (Bluetooth, Wireless, Power):** Used for communication with other devices, including smartphones.
    - **Smartphone:** Indicates mobile connectivity, likely for remote monitoring and data management.
- **Advanced Medical Devices (Right Section)**

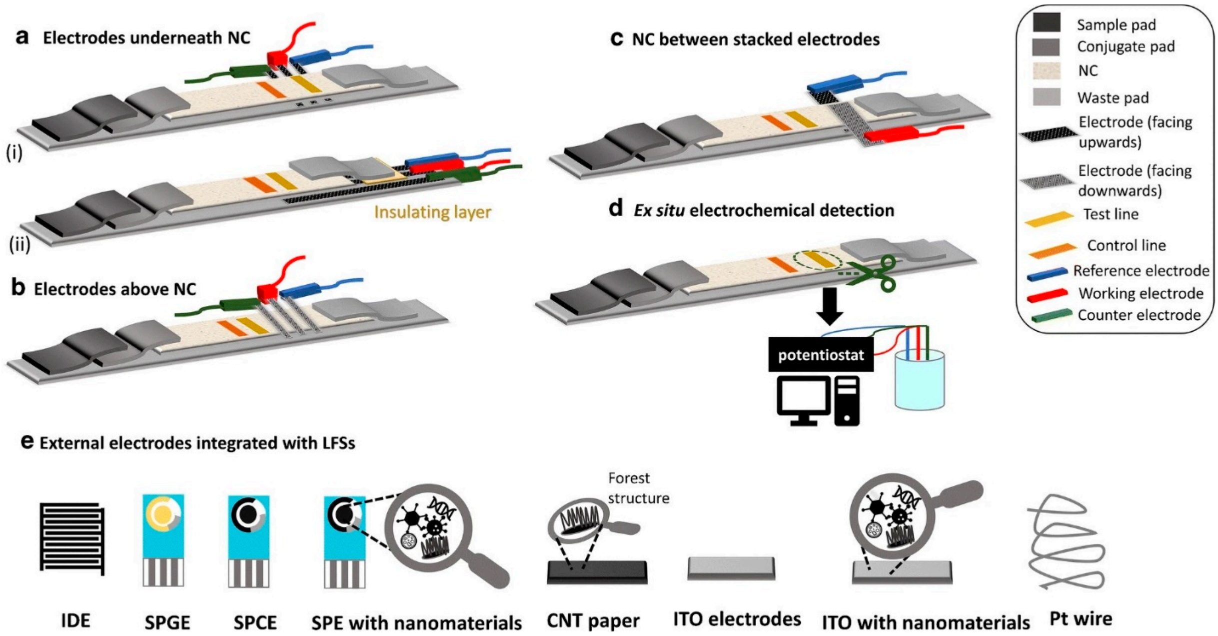
- **Portable Devices:** Small, handheld devices that process biosensor data, such as blood glucose meters. The screen shows a readout (5.8 mM), likely indicating a medical measurement.
- **Implantable Devices:** These are placed inside the body for continuous monitoring (e.g., brain implants for neurological monitoring or treatment).
- **Wearable Devices:** Smart devices, such as watches or bands, that monitor biosensor data wirelessly and transmit it to smartphones or other systems.



Explanation:

1. **Electrode and Target Interaction (Top-Left)**
   - The top section shows a biochemical interaction between the electrode and a target molecule, facilitated by electrochemical redox reactions.
   - The target molecule is recognized by specific agents (possibly antibodies or DNA strands) immobilized on the electrode surface. The flow of electrons during the redox reaction, represented by the $[Fe(CN)_6]^{3-}/[Fe(CN)_6]^{4-}$ redox pair, generates a measurable signal without requiring labels (hence "label-free").
   - The presence or absence of the target molecule can be detected by measuring changes in the electrochemical signal.

2. **Microfluidic Device (Center)**
   - The main part of the image illustrates a microfluidic device, which channels fluids through tiny pathways to a **sensing zone**.
   - **Sample Inlet:** Where the biological sample is introduced into the device.
   - **Buffer Inlet:** Where buffer solutions enter the system to help with fluid control and maintain the right chemical environment.
   - **Micro Filter:** Used to filter the sample, ensuring that only particles or molecules of interest are directed to the sensor.
   - **Sensing Zone:** The core area where the target molecules interact with the electrode. Electrochemical detection occurs here, as seen in the earlier section (electrode and target interaction).
   - **Outlet:** The processed sample and any waste leave the system through the outlet, ensuring continuous flow.
3. **Analysis (Top-Right)**
   - The signal generated by the interaction of the target molecule with the electrode is sent to a **computer or commercial device** for analysis.
   - This analysis can provide quantitative or qualitative information about the sample, such as the concentration of a specific biomarker.
4. **Research Laboratory to Commercial Devices (Flow at the Bottom)**
   - The image highlights the movement from research laboratory systems (where the device might be developed and tested) to commercial biosensing devices for practical use, such as in diagnostics or healthcare settings.
   - The arrows at the bottom signify the potential pathway of this technology from research to real-world applications, with the goal of developing **commercial devices** that utilize this advanced biosensing system.



Explanation: **(a) Electrodes Underneath NC (Nitrocellulose Membrane)**

- **i)** Shows electrodes placed underneath the nitrocellulose membrane (NC). The electrodes detect signals as fluids from the sample pad (on the left) pass over the sensing area.
- **ii)** A variation where an **insulating layer** separates the electrodes from the NC. This helps protect the electrodes while still allowing signal transmission from the reaction on the NC surface.

(b) Electrodes Above NC

- This configuration has the electrodes placed **above** the NC membrane, as opposed to underneath. This orientation allows for direct interaction between the electrodes and the sample or fluid on the NC membrane.

(c) NC Between Stacked Electrodes

- In this configuration, the NC membrane is **sandwiched between stacked electrodes**. One set of electrodes faces upwards, and the other set faces downwards. This creates a direct pathway for detecting electrochemical signals from both sides of the membrane.

(d) Ex situ Electrochemical Detection

- This method involves **cutting out a section** of the NC membrane (after the sample has reacted) and then performing electrochemical detection on this segment. The excised part is connected to a **potentiostat**, which measures electrochemical signals (current/voltage) and sends the data to a computer for analysis.

(e) External Electrodes Integrated with LFSs

This section shows different types of **external electrodes** used in LFSs, with various designs for improving sensitivity and performance. These include:

5. **IDE (Interdigitated Electrodes)**: Feature multiple fingers of conductive material to increase surface area and sensitivity.
6. **SPGE (Screen-Printed Gold Electrode)**: A common type of electrode where gold is used as the conductive material.
7. **SPCE (Screen-Printed Carbon Electrode)**: Uses carbon as the electrode material, which can be combined with nanomaterials to enhance signal detection.
8. **CNT Paper (Carbon Nanotube Paper)**: Features a "forest structure" of carbon nanotubes, providing a large surface area and excellent conductivity for electrochemical reactions.
9. **ITO Electrodes (Indium Tin Oxide)**: Transparent conductive materials often used for applications where optical transparency is required.
10. **Pt Wire (Platinum Wire)**: A traditional material used in electrodes due to its stability and high conductivity.