

Anesthesia Machine

Omar Shaban — IEEE EMBS Biomedical



Introduction: Anesthesia



Why is Anesthesia needed?



Why is Anesthesia needed?

Fear

Pain

Body
Movement



Why is Anesthesia needed?

Fear

Pain

**Body
Movement**

Sedation

Analgesia

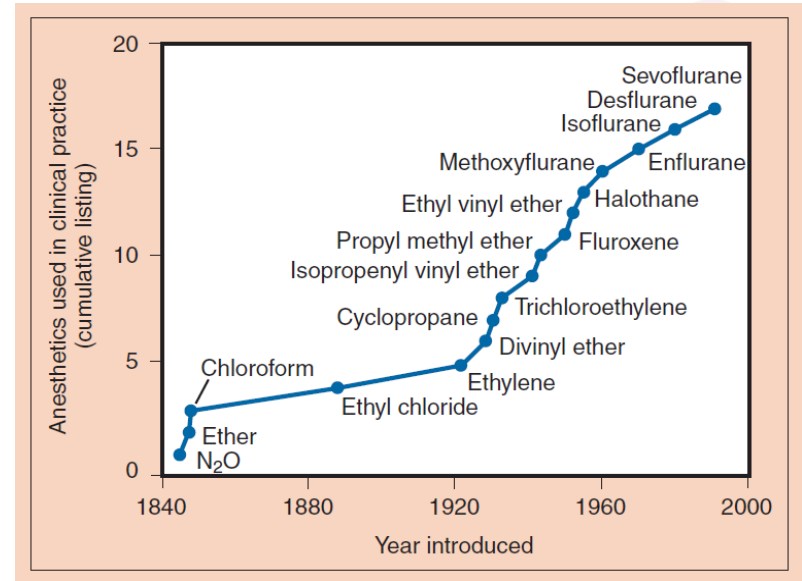
**Muscle
Relaxation**



Anesthetic Agents

Different properties for each type

- Onset and duration of action
- Mechanism of clearance
- Safety
- Flammability



Outpatient surgeries
requiring rapid recovery



Desflurane

Blue

Pediatric anesthesia

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Overview

What is Anesthesia Machine?

02

Components

What are AM Components?
How does AM work?

03

Monitoring, Sensors and Safety



What is Anesthesia Machine?

01

Function

02

Structure

03

Location

What is Anesthesia Machine?

Function

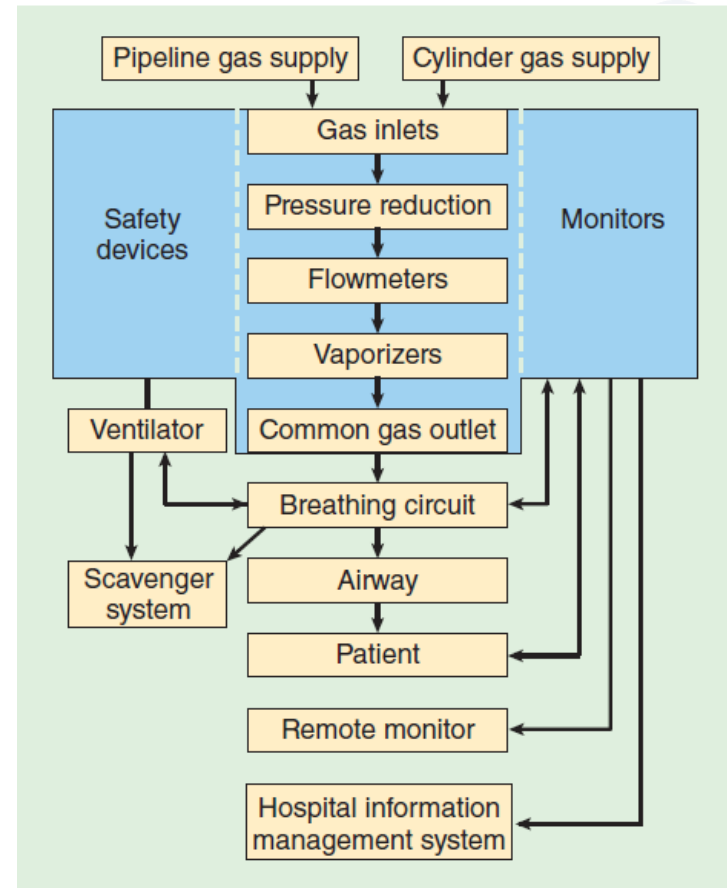
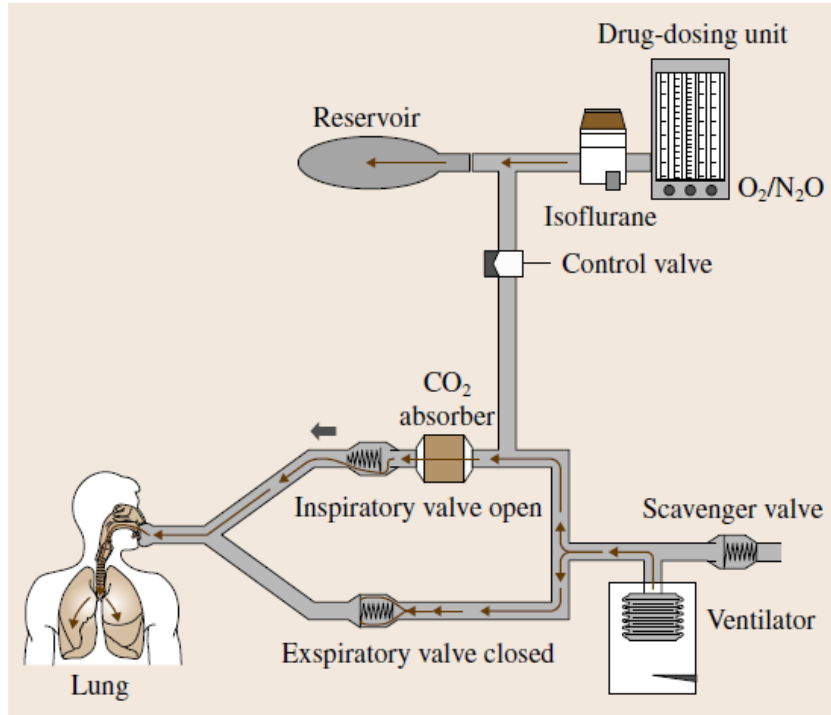
01

Accurately mixes anesthetic gasses and vapors

02

Provides O2 and Enables patient ventilation

Structure



What is Anesthesia Machine?

Location

Where?



What is Anesthesia Machine?

Location

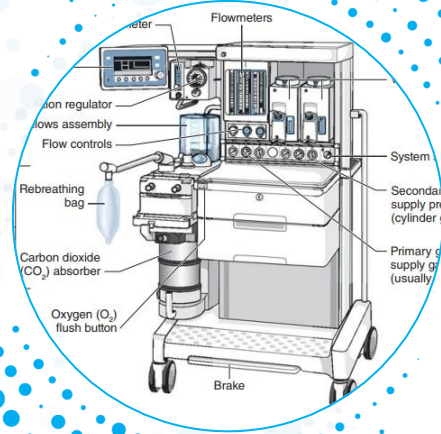
01

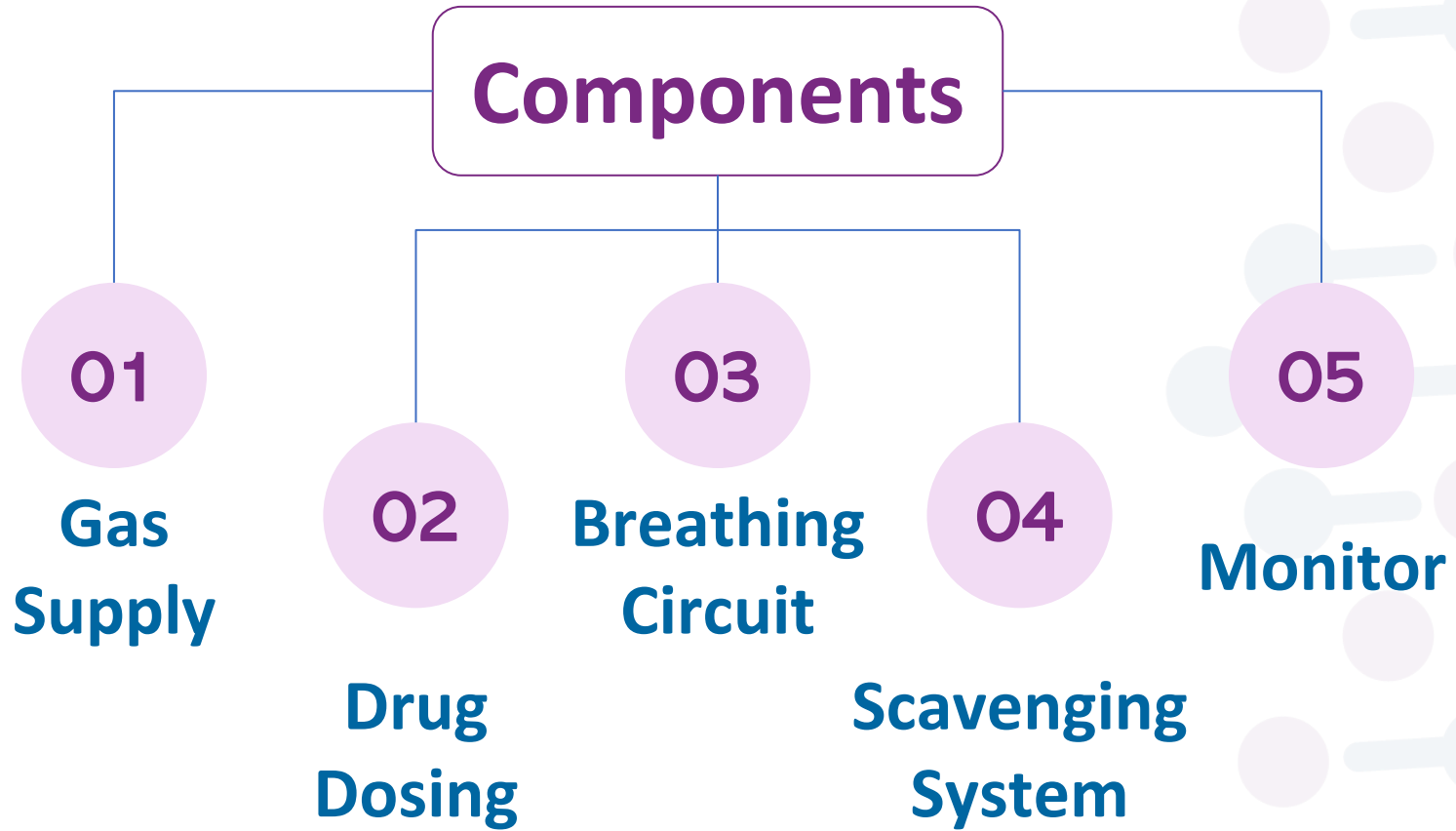
Operation Room
(Essential)

02

**Others: ICU, PACU and
Emergency Department**

Components

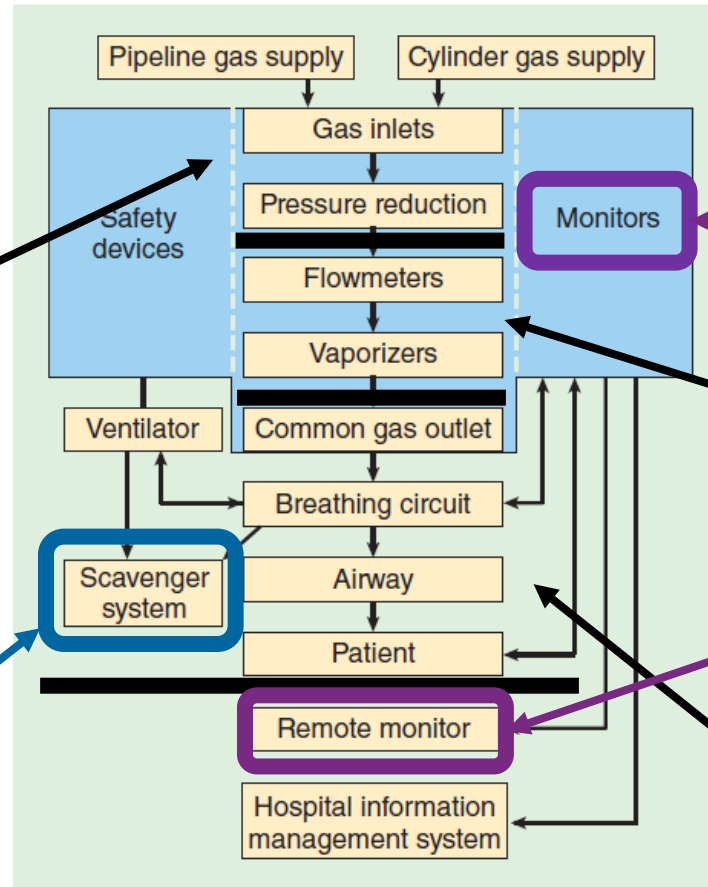




Structure

Gas Supply

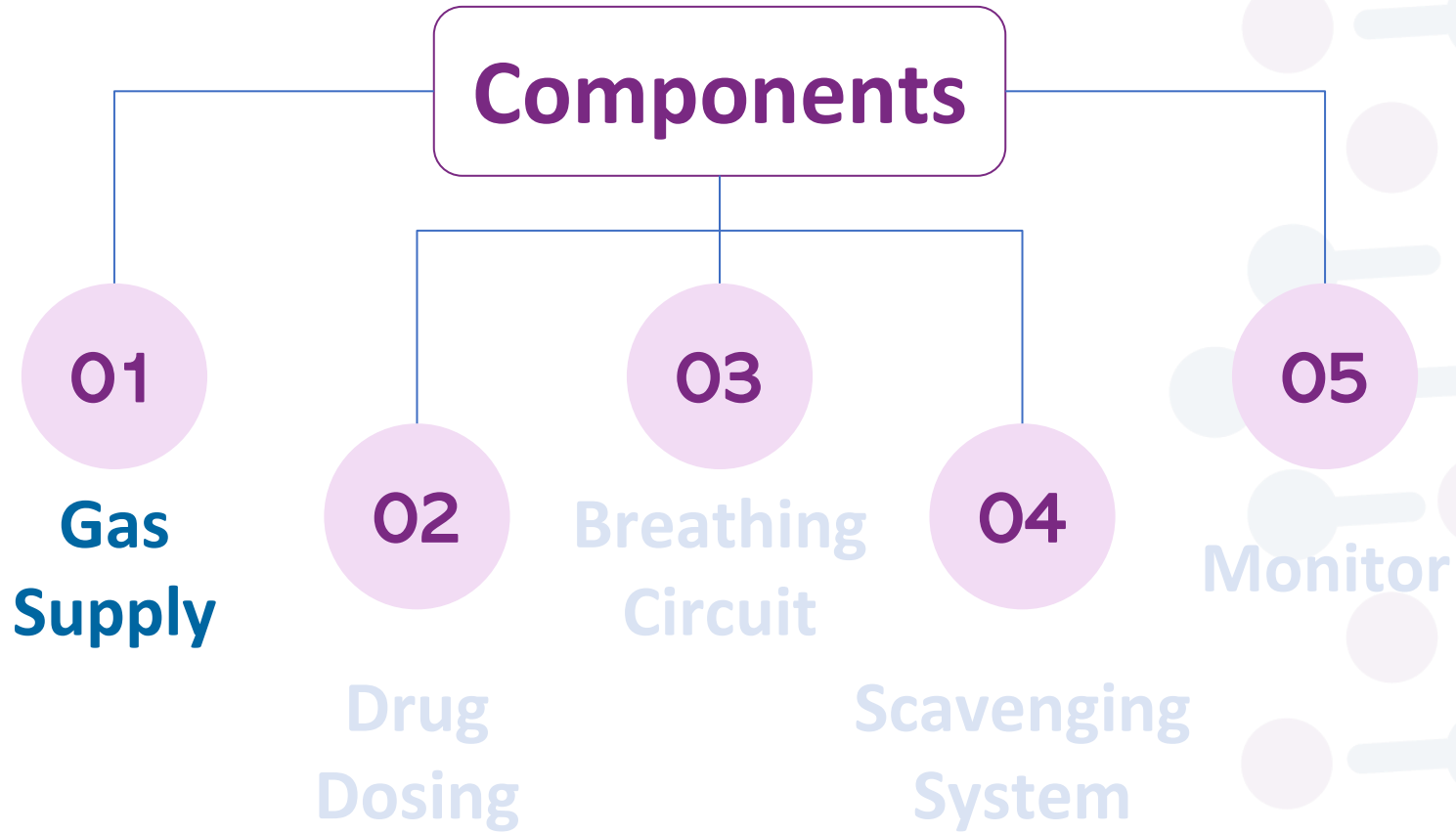
Scavenging System



Drug Dosing

Monitor

Breathing Circuit



Gas Supply – Gases

01

O_2

Essential for patient life support

02

N_2O

Commonly used for its anesthetic properties

03

Air

Often used to dilute the concentration of anesthetic gases



Gas Supply – Gases Sources

01

Central Medical
Gas Supply

02

Cylinders

Gas Supply – Gases Sources

01

Central Medical Gas Supply

02

Cylinders



Gas Supply – Gases Sources

01

Central Medical
Gas Supply

02

Cylinders



Gas Supply – Pressure Control

For Pressure Control,
AM has:

**1. Pressure Regulators
(Reducing Valves)**

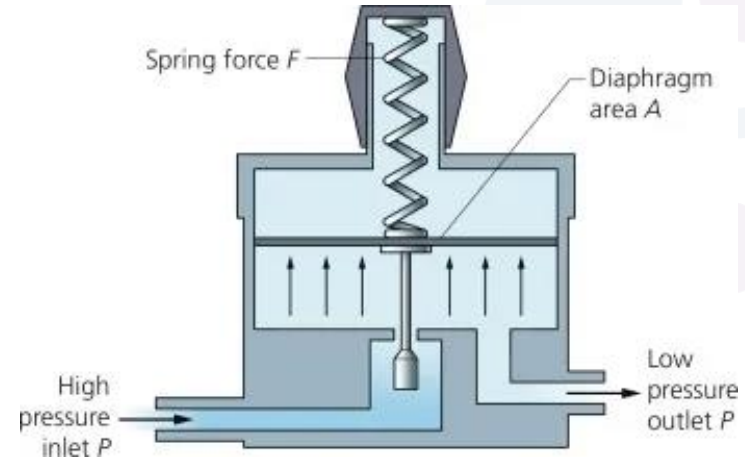
2. Pressure Gauges



Gas Supply – Pressure Control

1. Pressure Regulators (Reducing Valves)

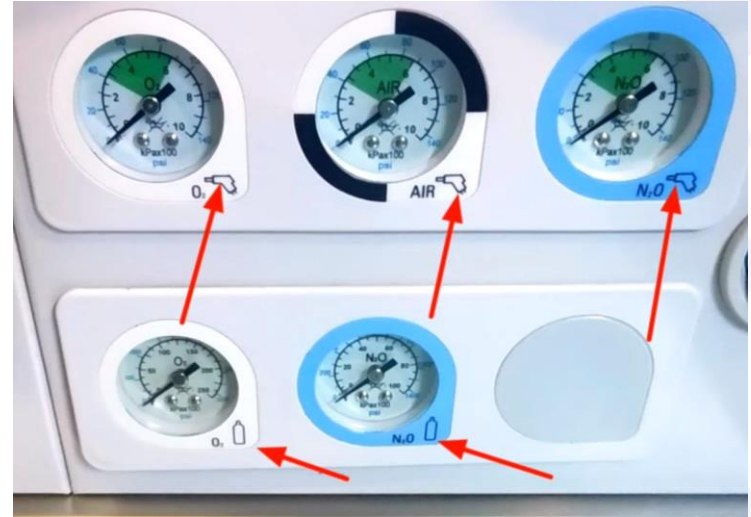
- Spring vs Pressure
- High Pressure \rightarrow Components Damage
- O_2 : 13700 kPa \rightarrow 400 kPa



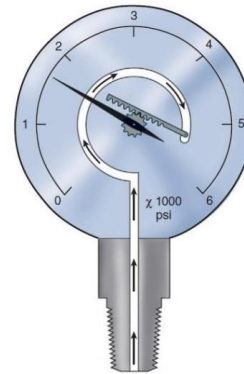
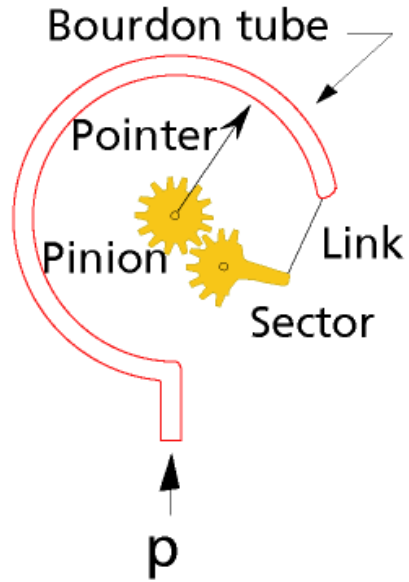
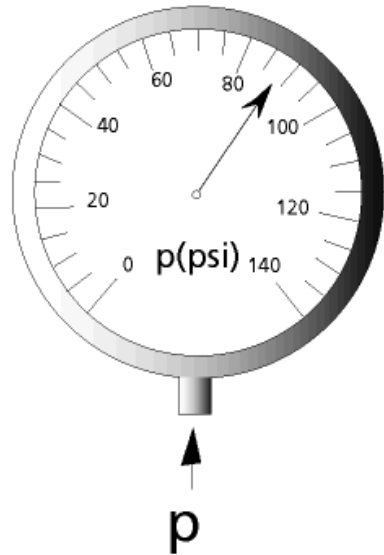
Gas Supply – Pressure Control

For Pressure Control,
AM has:

1. Pressure Regulators
(Reducing Valves)
2. Pressure Gauges



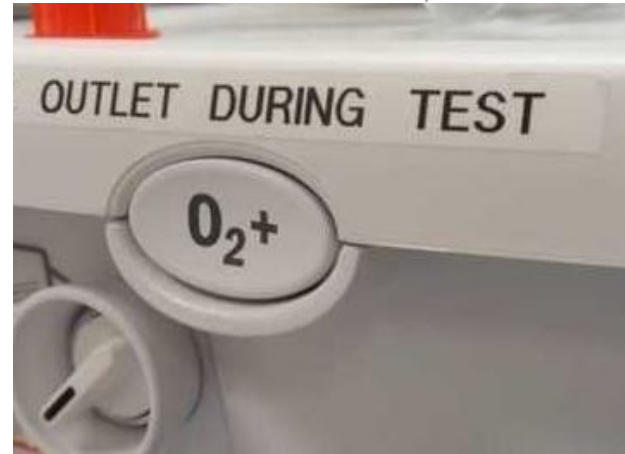
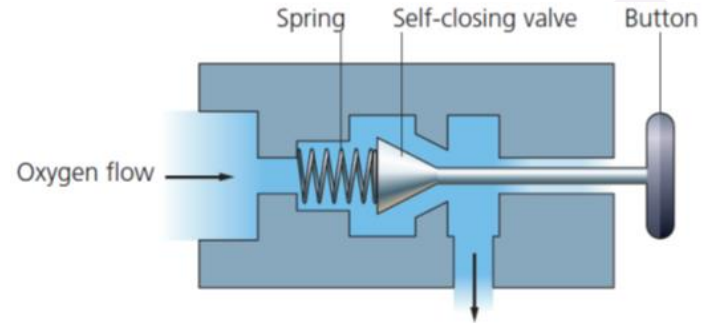
Gas Supply – Pressure Control



Gas Supply – Emergency O₂ Flush

? AM reduce the Pressure from 400 to ??? kPa

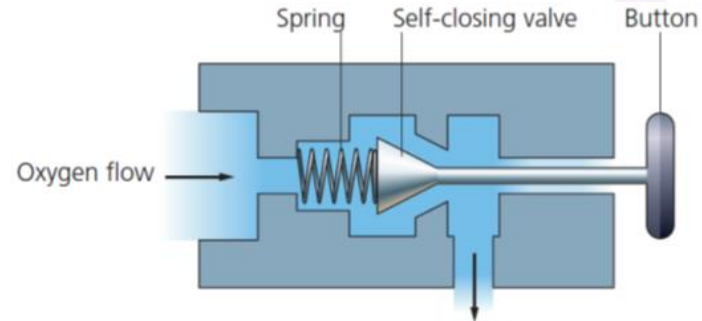
- Allows for the rapid delivery of a high flow of oxygen to the patient.
- Flowrate: 35 – 75 L/min
- Pressure: 400 kPa



Gas Supply – Emergency O₂ Flush

Usage:

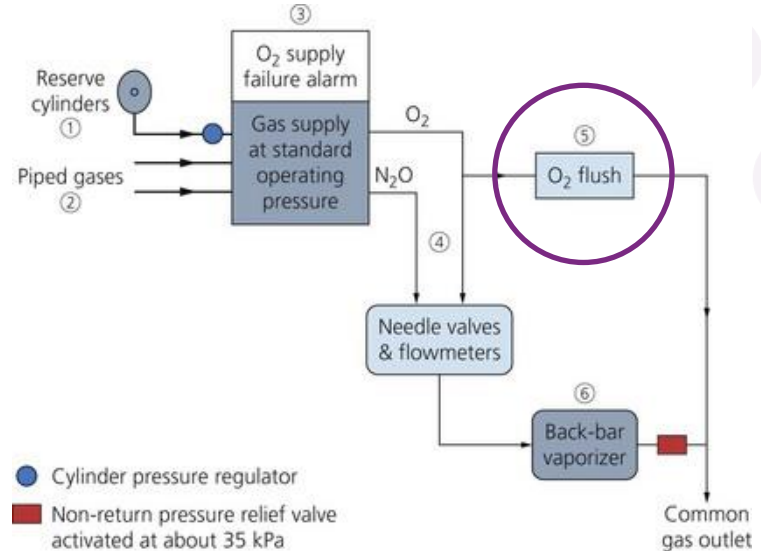
- **Preoxygenation and Reoxygenation**
- **Ventilation Support:** Fill Ventilator Bag
- **Reduce Anesthetics Concentration:** in recovery: For lungs wash from anesthetics

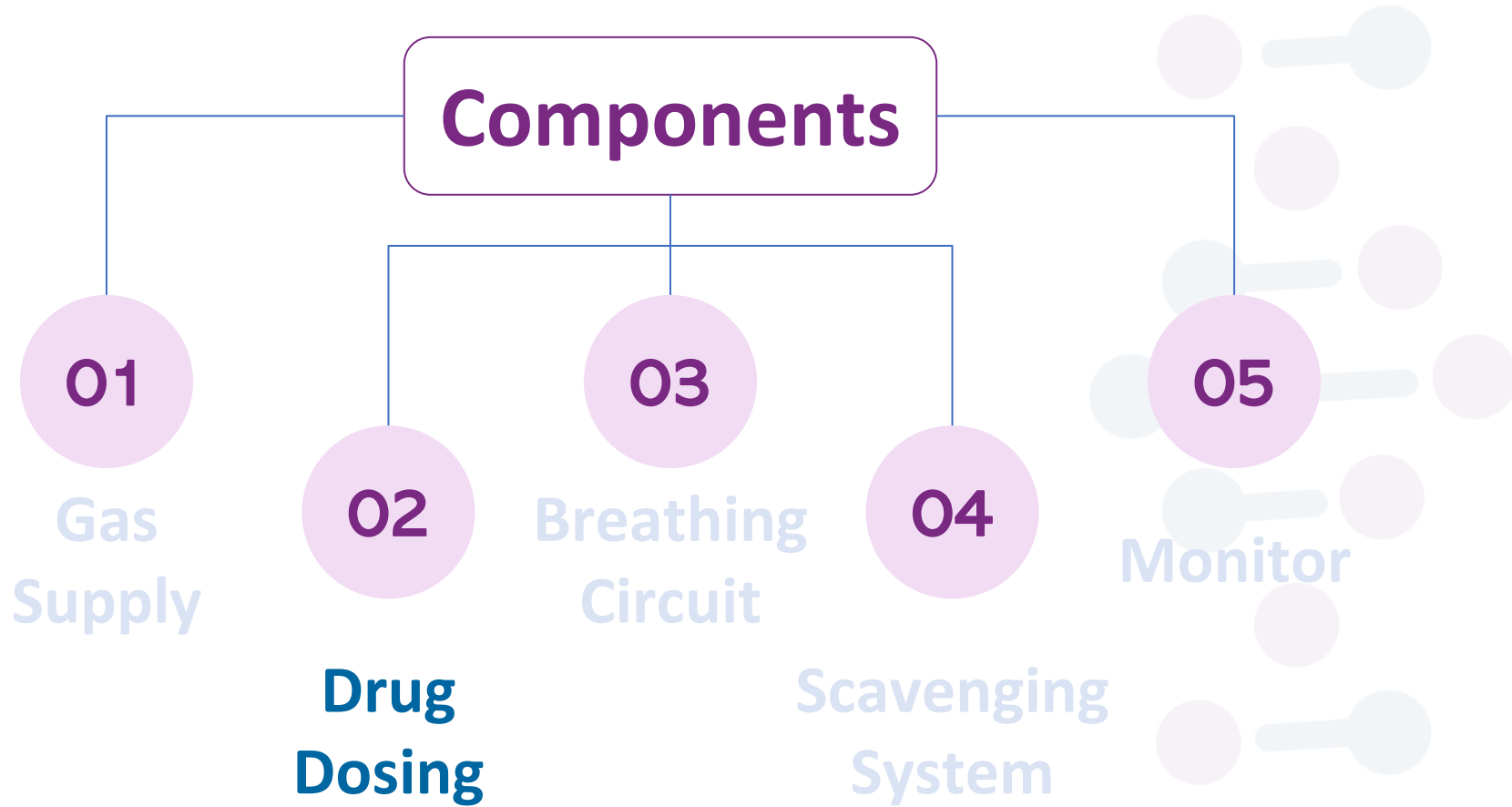


Gas Supply – Emergency O₂ Flush

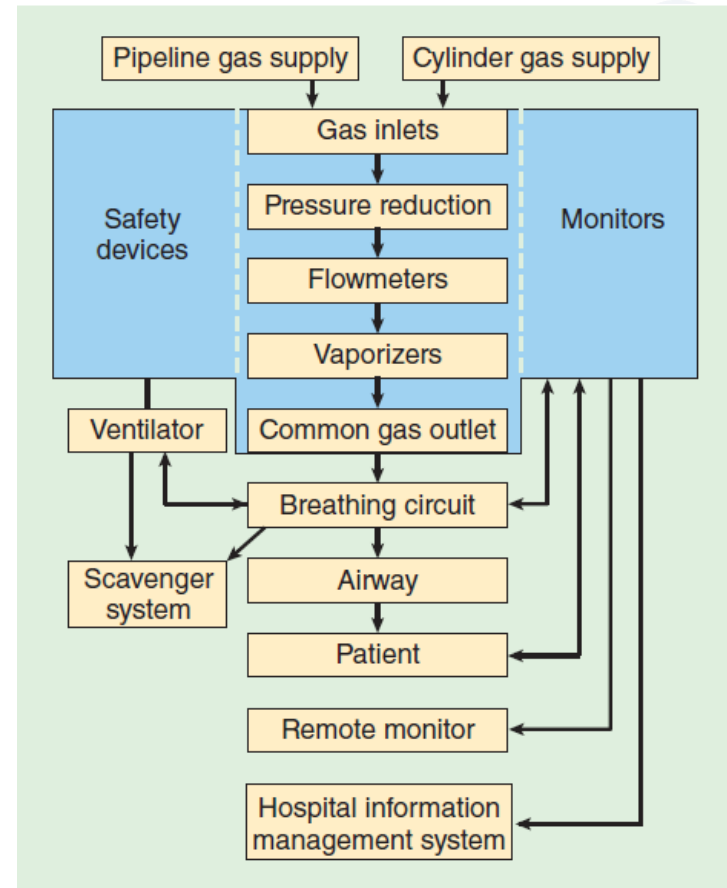
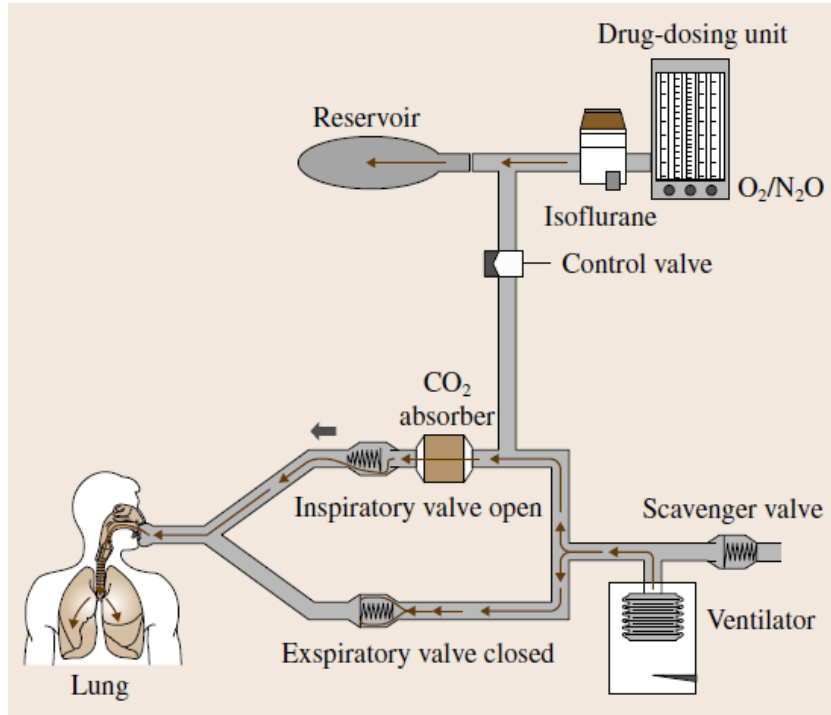
Notes:

- Don't use it if the breathing circuit is connected with the patient
- Press the button intermittently
- The O₂ flow directly to CGO

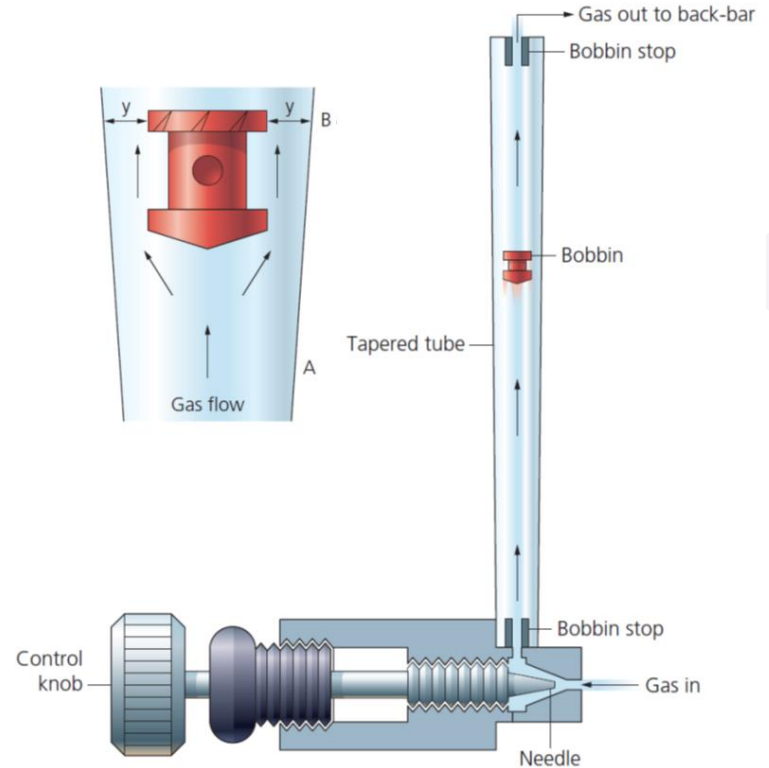
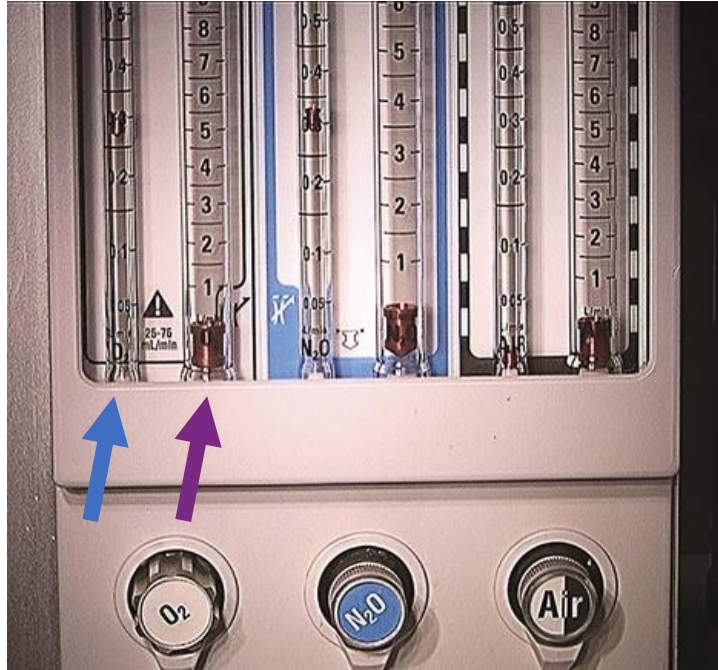




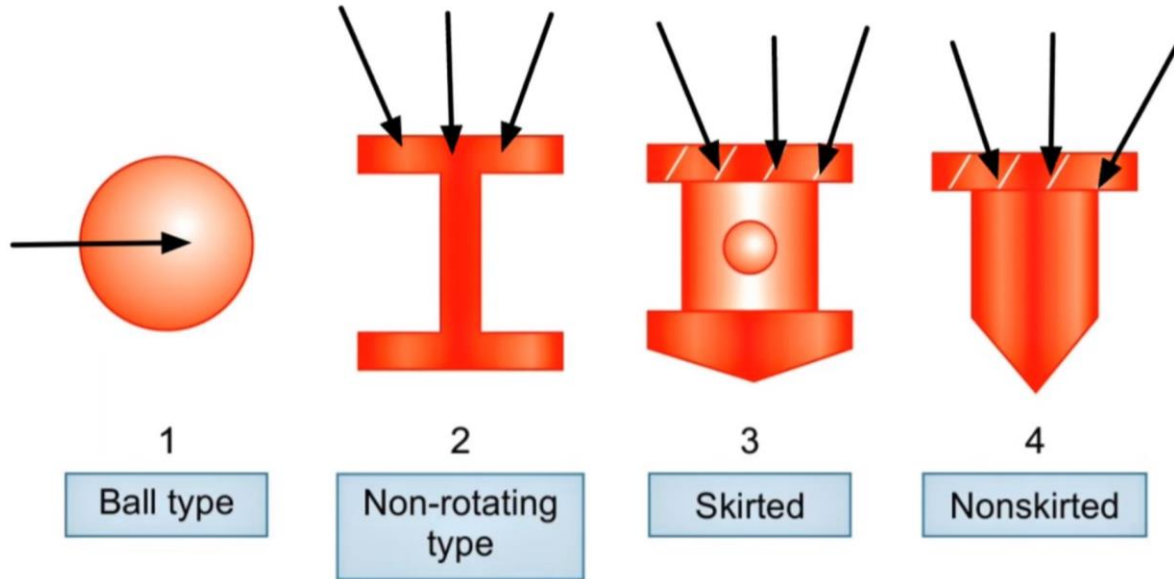
Structure



Drug Dosing – Flowmeter



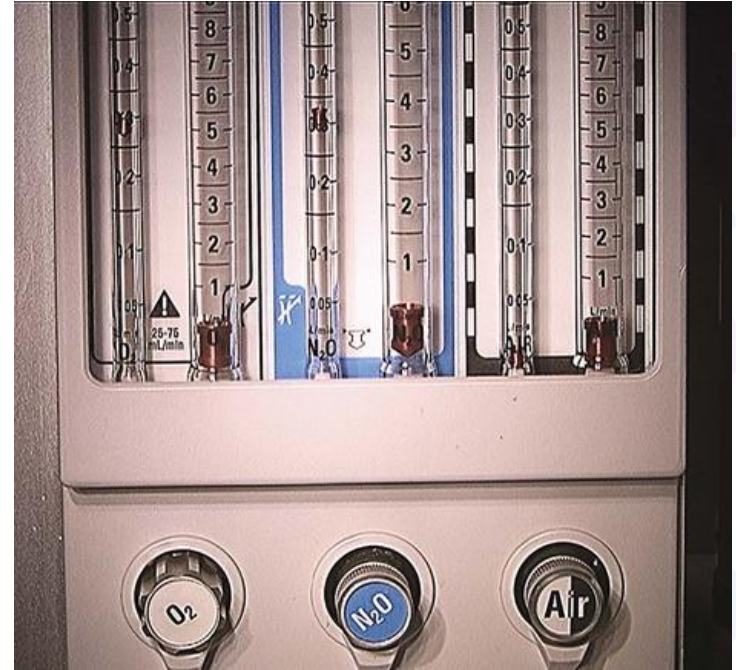
Drug Dosing – Flowmeter



Drug Dosing – Flowmeter

For Safety:

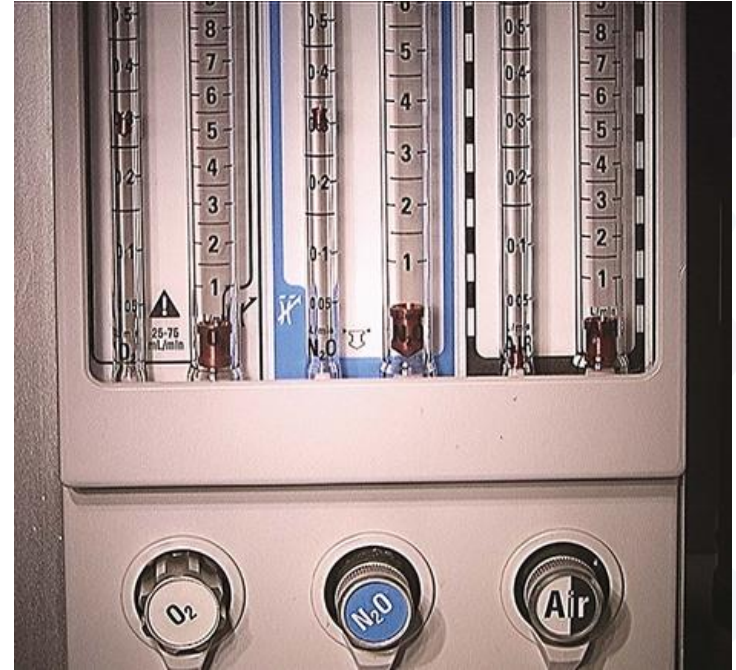
- Min O₂ Flow = 200 – 300 mL/min
- N₂O Dial Opens O₂
- O₂ Specific Line



Drug Dosing – Flowmeter

For Safety:

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Drug Dosing – Flowmeter

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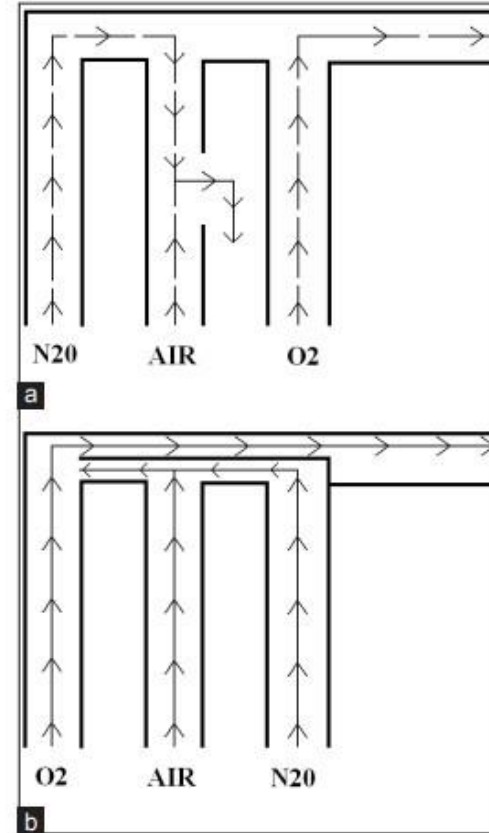
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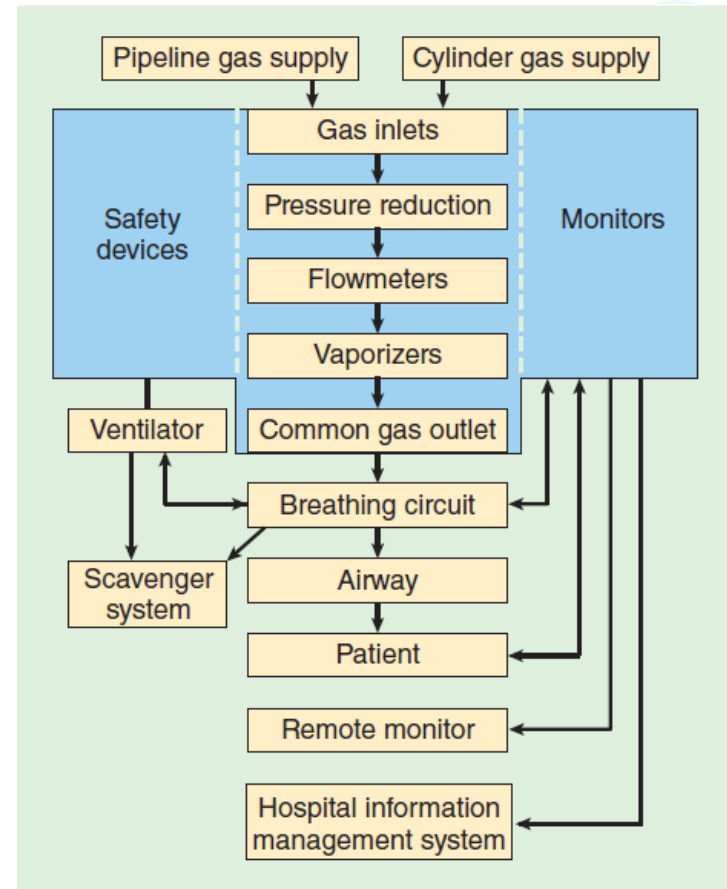
Drug Dosing – Flowmeter

For Safety:

- Min O₂ Flow = 200 – 300 mL/min
- N₂O Dial Opens O₂
- O₂ Specific Line



Structure



Drug Dosing – Vaporizer

Function

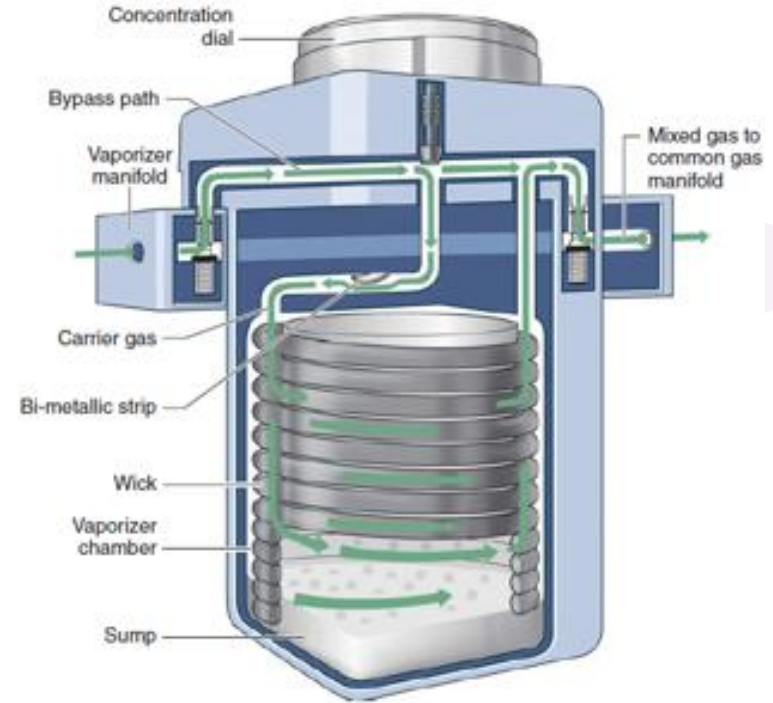
- To Convert anesthetic agent from liquid to vapor before add it into the fresh gas flow
- Delivers the set concentration of anesthetic agent accurately.



Drug Dosing – Vaporizer

Structure

- Two Paths: By-pass pathway and Vaporizer chamber
- High Contact → Turn the tube
- Increasing fresh gas flow → Increasing Temperature → Bi-metallic Valve



Drug Dosing – Vaporizer

Structure

- One-way Valve

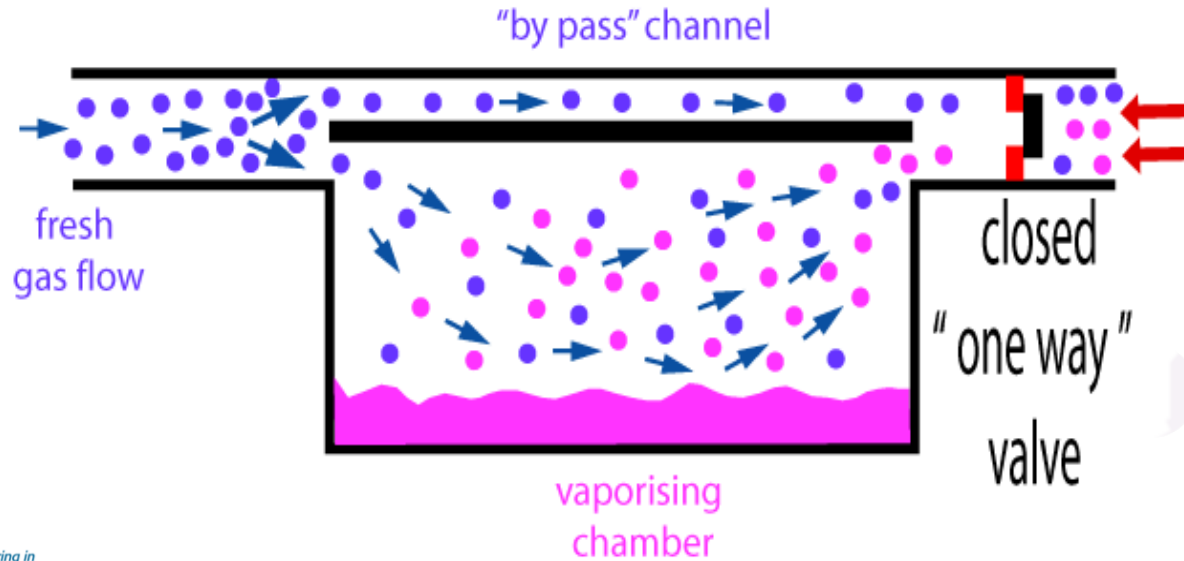


Diagram illustrating the movement of a cell. A red arrow points to the right, indicating the direction of movement. The cell is shown as a light blue circle with a darker blue nucleus. The cell is moving towards the right, as indicated by the red arrow.

The diagram illustrates a microfluidic setup. A syringe (1) on the left pumps a fluid (blue dots) into a network of channels. The fluid enters a chamber (2) containing a porous medium (3, yellow zigzag line) and a green cloud (4). A control dial (5) at the top right regulates the flow of a second fluid (red arrow, 6) into a chamber (7) containing a porous medium (8). A green cloud (13) is positioned between chambers 2 and 7. A yellow box (12) is connected to the green cloud (13) by a red arrow. A blue cloud (11) is located in a chamber (10) between chambers 7 and 8. Red arrows indicate the flow direction from chamber 2 to chamber 7, and from chamber 7 to chamber 10. A red arrow (9) indicates the flow direction from chamber 10 to the right.

Drug Dosing – Vaporizer

Structure

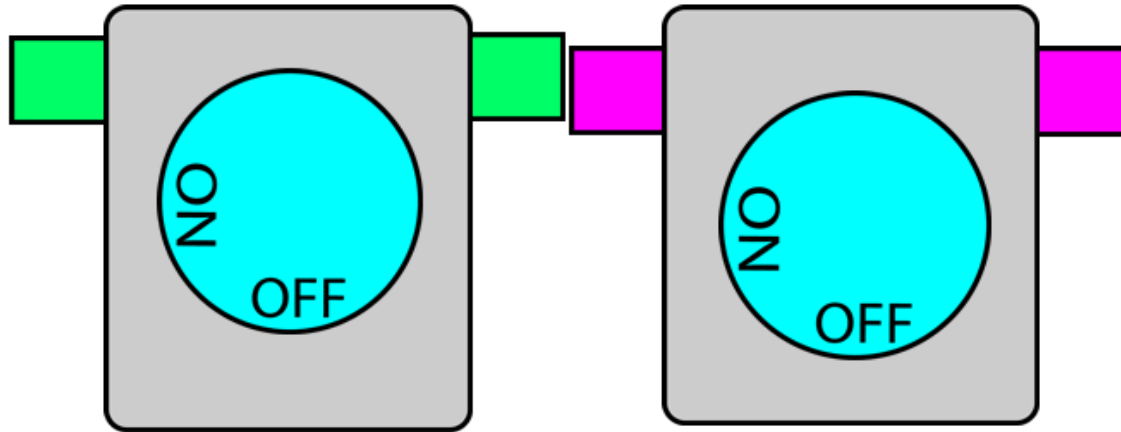
- Specific Color and Connection for each agent



Drug Dosing – Vaporizer

Structure

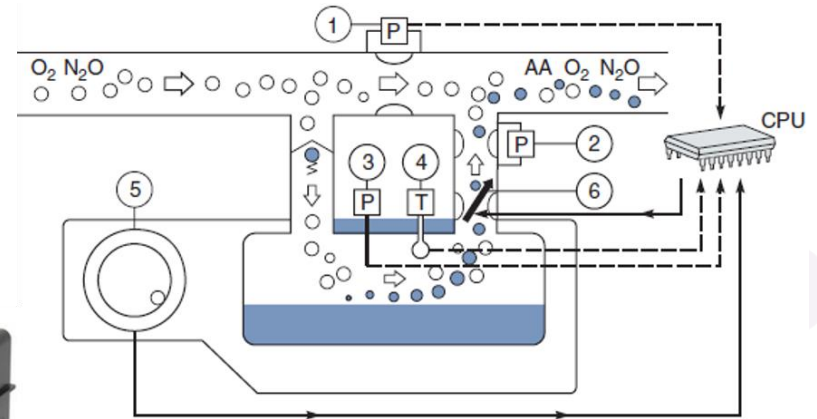
- One single Anesthetic Agent only → Interlock



Drug Dosing – Vaporizer

Types

Mechanical vs
Electronic

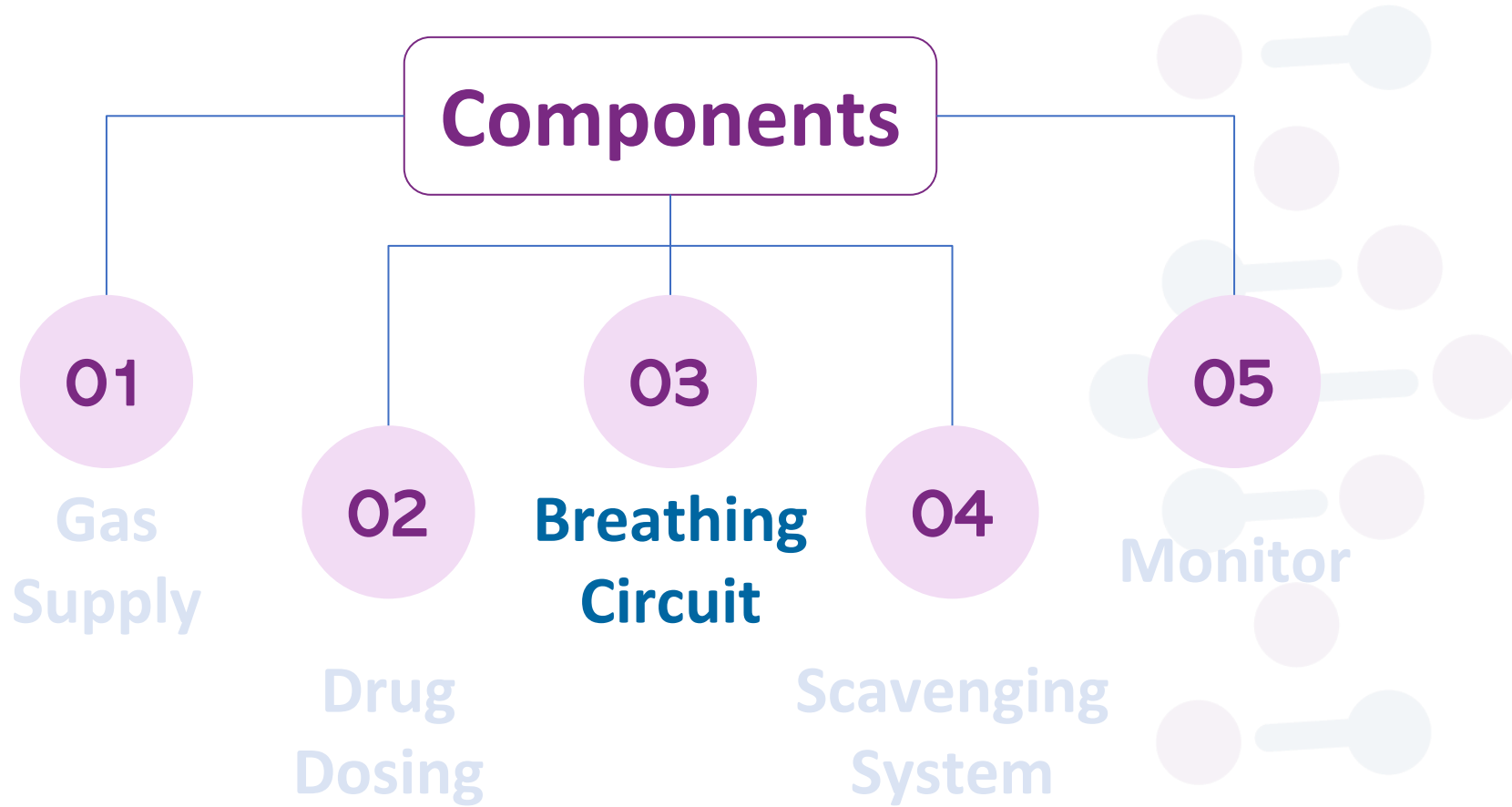


Measurement part

- (1) Bypass flow
- (2) Flow through the cassette
- (3) Cassette pressure
- (4) Cassette temperature

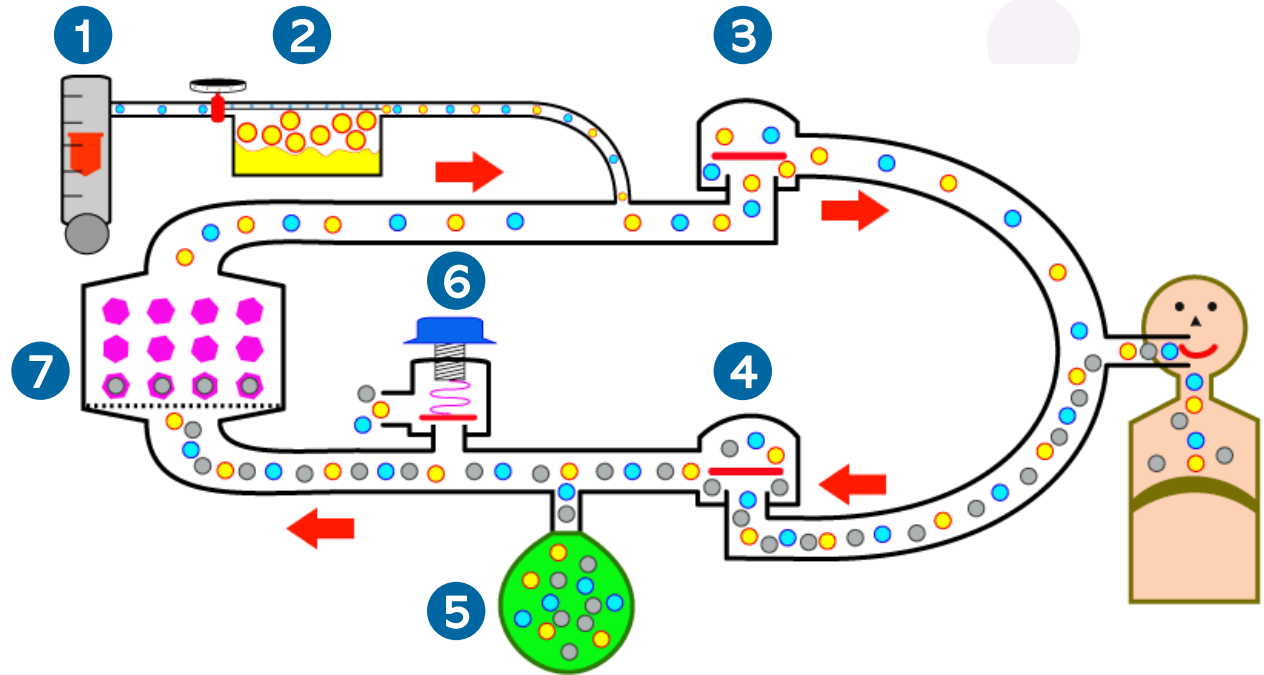
Agent control

- (5) Agent setting
- (6) Control valve

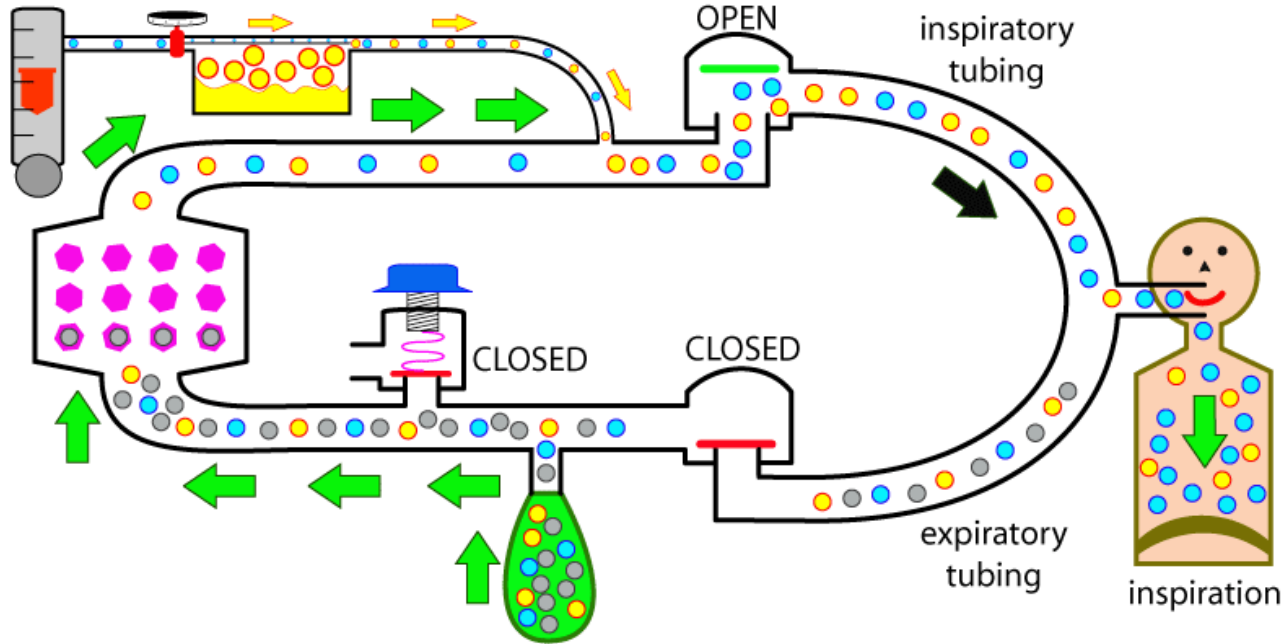


Breathing Circuit

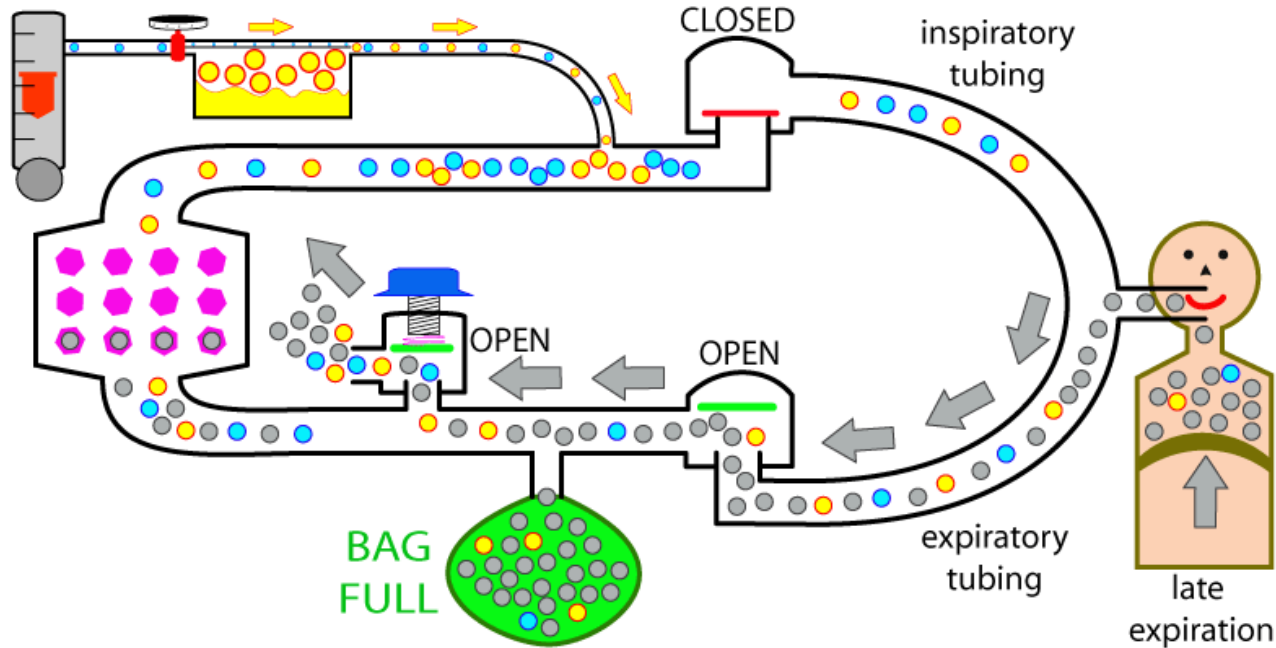
1. Flowmeter: Fresh gas flow
2. Vaporizer
3. Inspiration Valve: One-way valve
4. Expiration Valve: One-way valve
5. Reservoir Bag
6. APL valve ???
7. CO₂ Absorber



Breathing Circuit - Inspiration



Breathing Circuit - Expiration

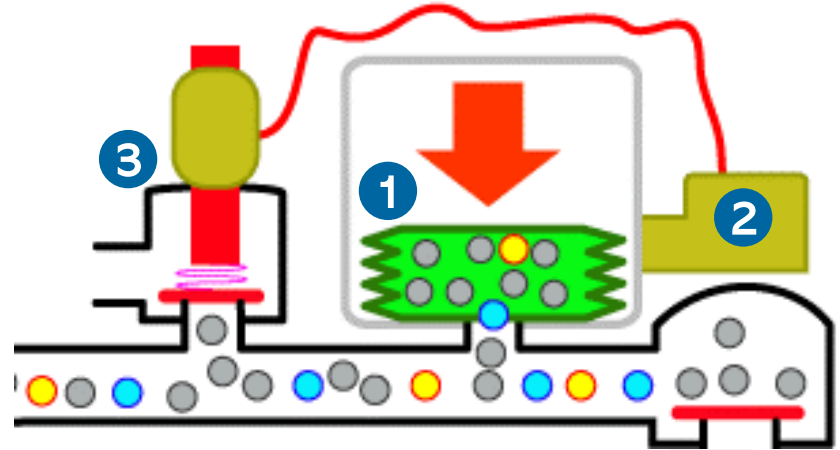


Breathing Circuit - Ventilator

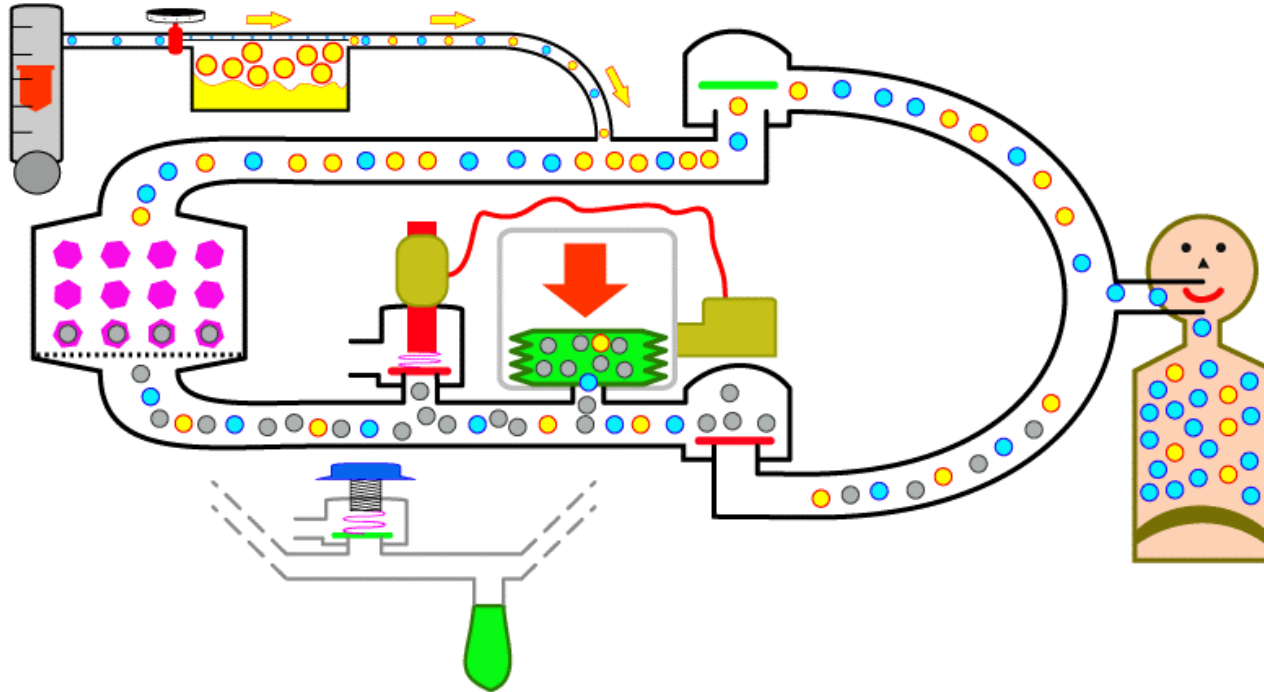
Instead of Manual Ventilation by Reservoir bag

Ventilator is used:

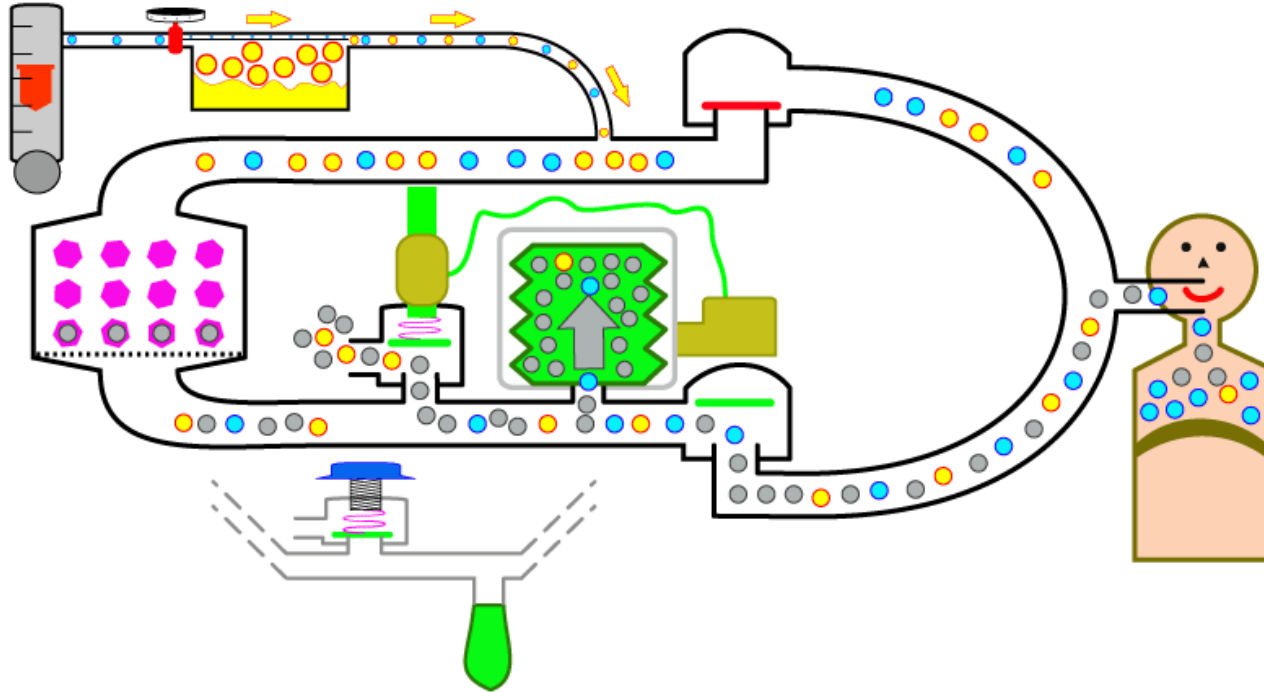
1. Collapsible Bag: Collapsed by the device (O_2 Pressure)
2. Controller
3. Control the APL valve

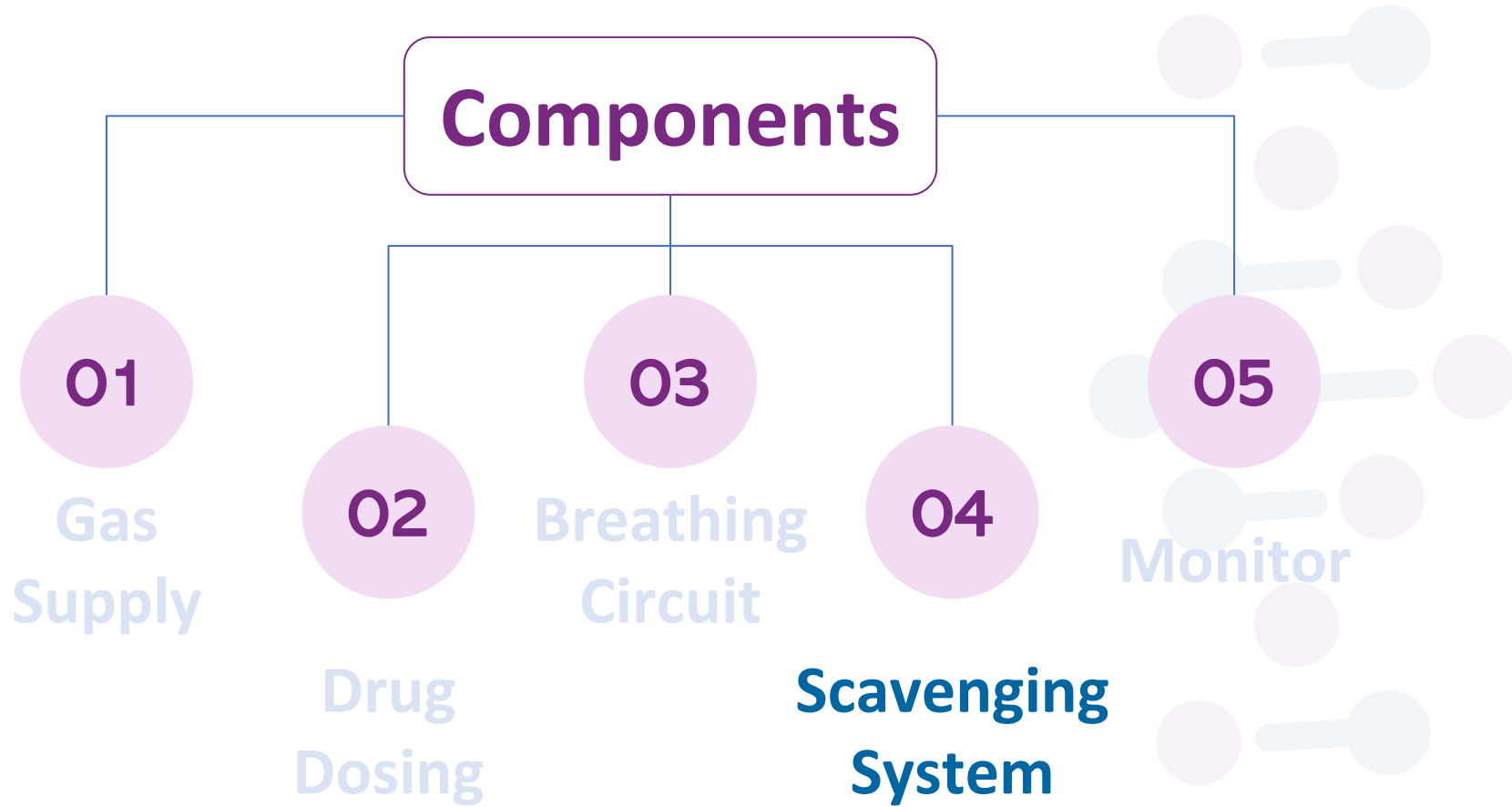


Breathing Circuit - Ventilator



Breathing Circuit - Ventilator





Scavenging System

- **Why we need Scavenging System?**



Scavenging System

- Chronic exposure to low concentrations of inhaled anesthetics may pose a health hazard to operating room personnel

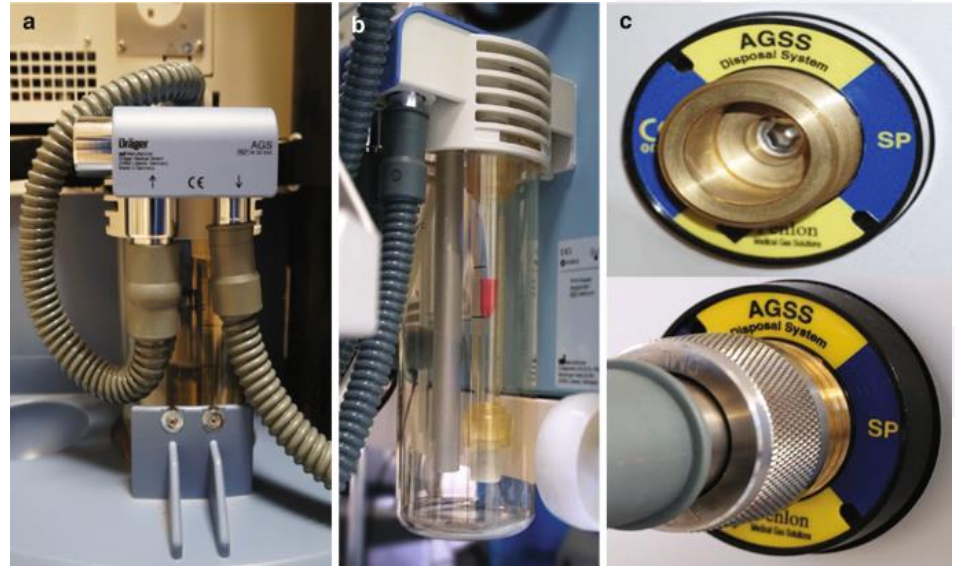
Maximum environmental levels for anaesthetic gases in the workplace

Gas	Maximum concentration (parts per million)
Nitrous oxide	100
Enflurane	50
Isoflurane	50
Halothane	10

Scavenging System

1. Active System
2. Passive System

- Adequate operating room ventilation is still necessary



Active	Passive
Vacuum Pump	Relies on exhalation flow and Patient's effort
More Effective	Simpler and less expensive

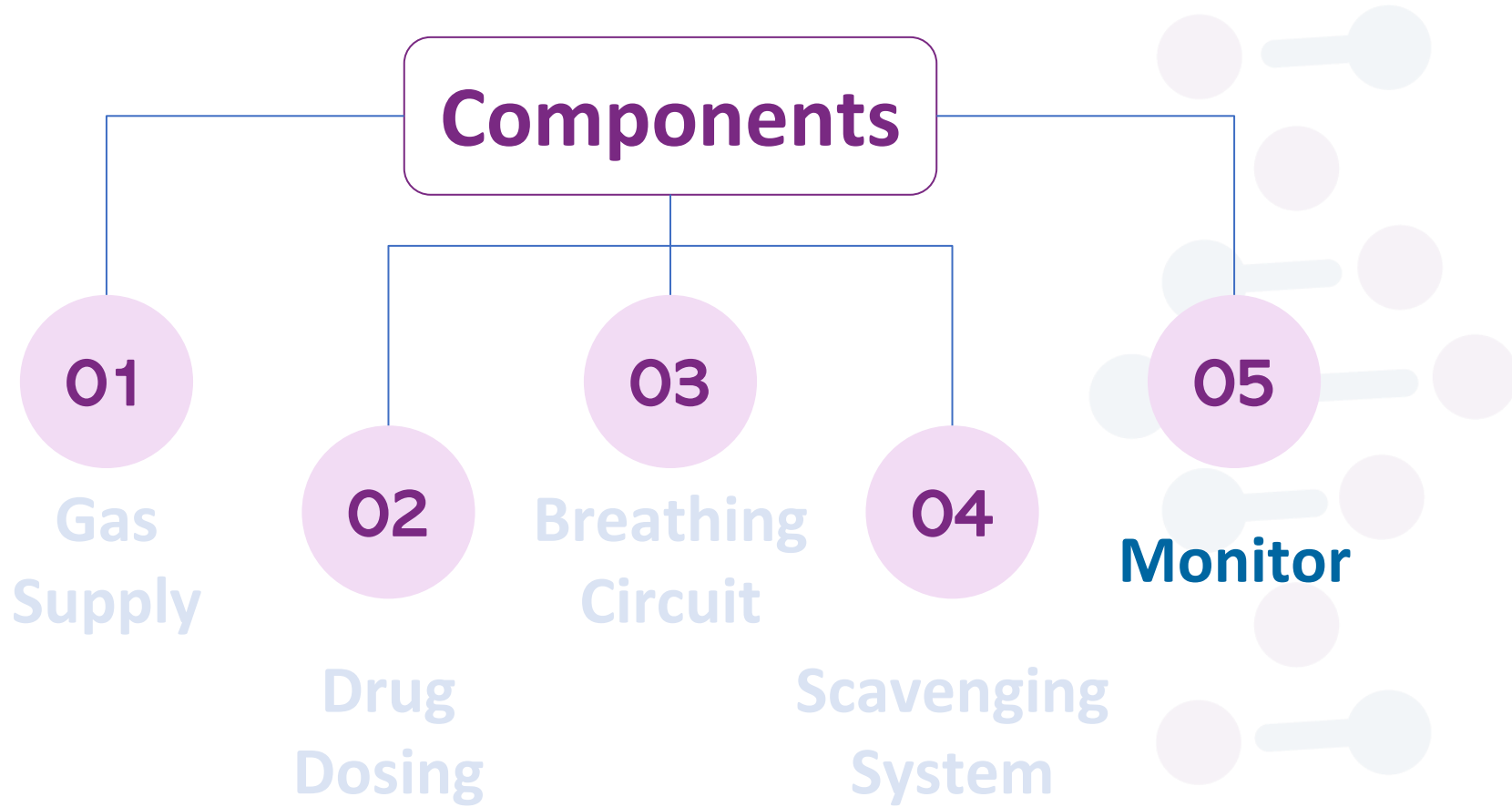


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What are AM Components?
How does AM work?

03

Monitoring, Sensors and Safety

Monitoring

Patient



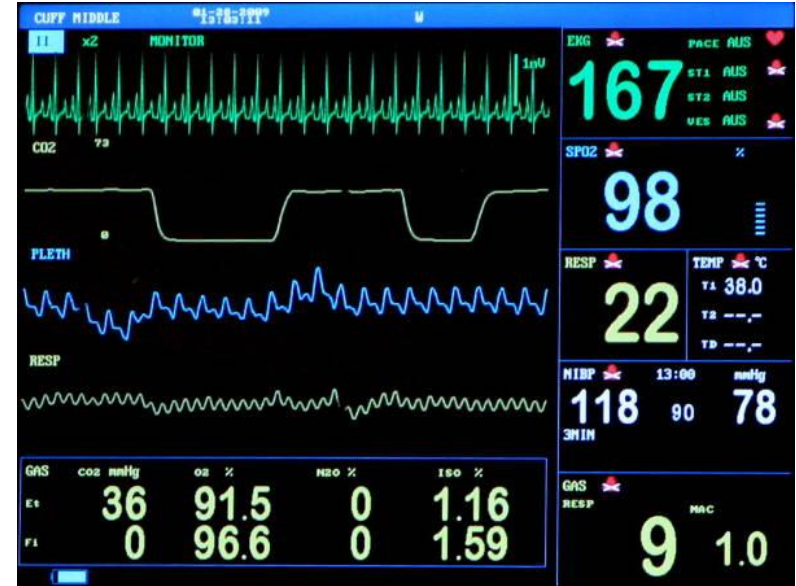
Device

Anesthesia

Monitoring

Patient Monitoring (4 Signals):

1. SpO_2
2. Temperature
3. ECG
4. NIBP



Monitoring

Device Monitoring



Monitoring

Device Monitoring:

1. O_2
2. CO_2
3. Anesthetic Concentration
4. Pressure
5. Flowrate/Volume

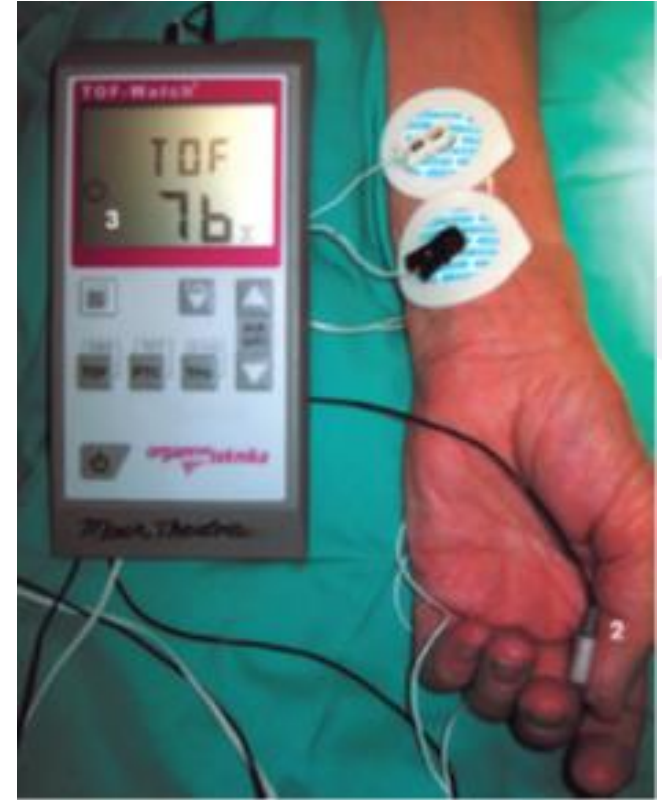


Sensors

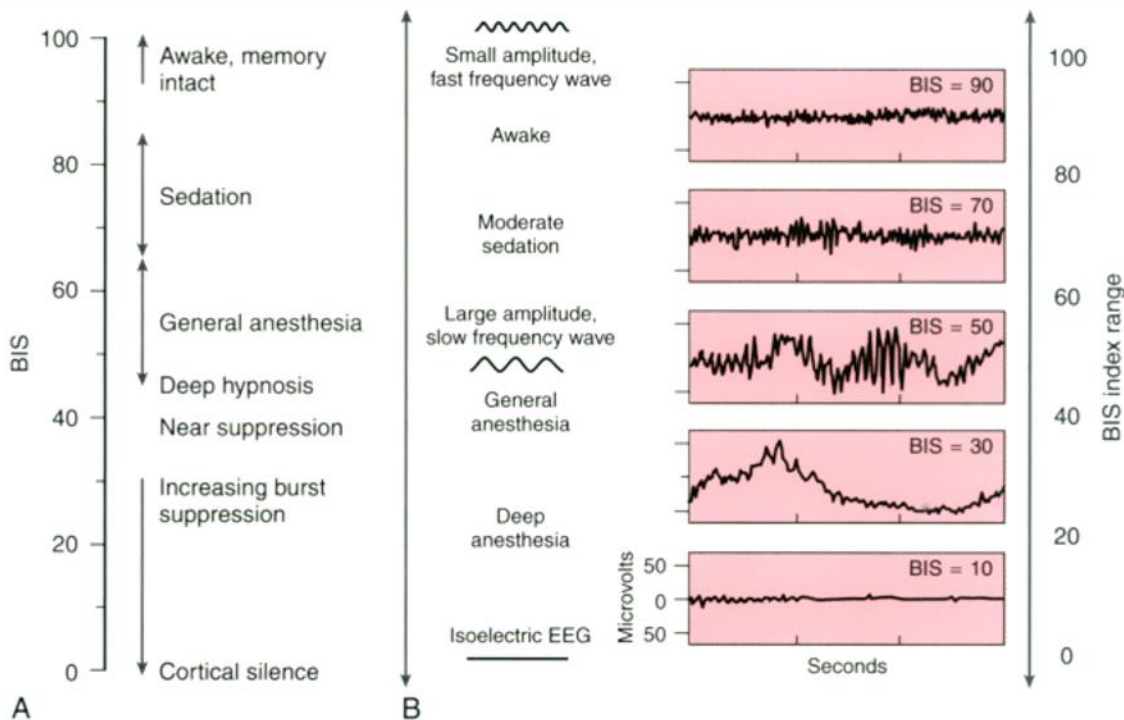
Sensor	Measure	Figure
IR Absorption Spectroscopy	CO ₂ , O ₂ , Agent Concentration	
Polarographic	O ₂	
Galvanic		
Paramagnetic		
Pneumotachograph	Flowrate	
Spirometer		
Bourdon Tube	Pressure	Pressure Gauge

Monitoring

Anesthesia Monitoring:

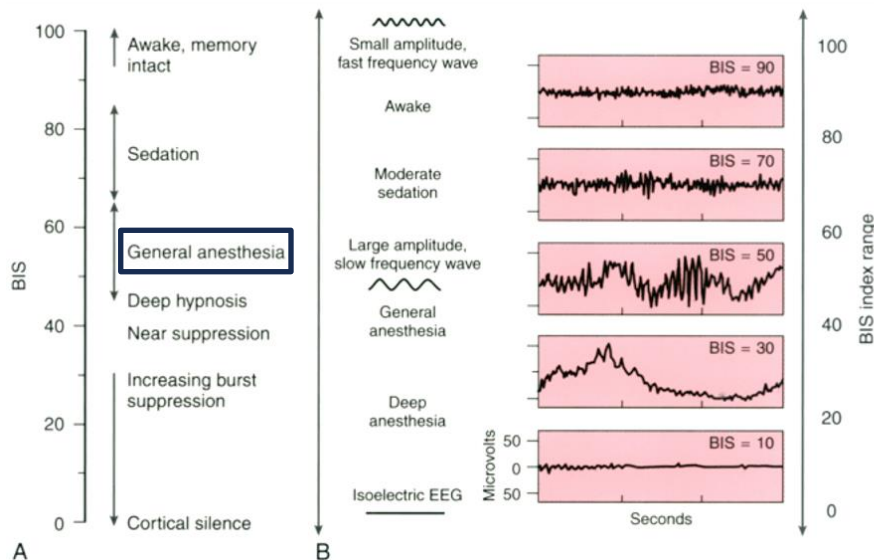


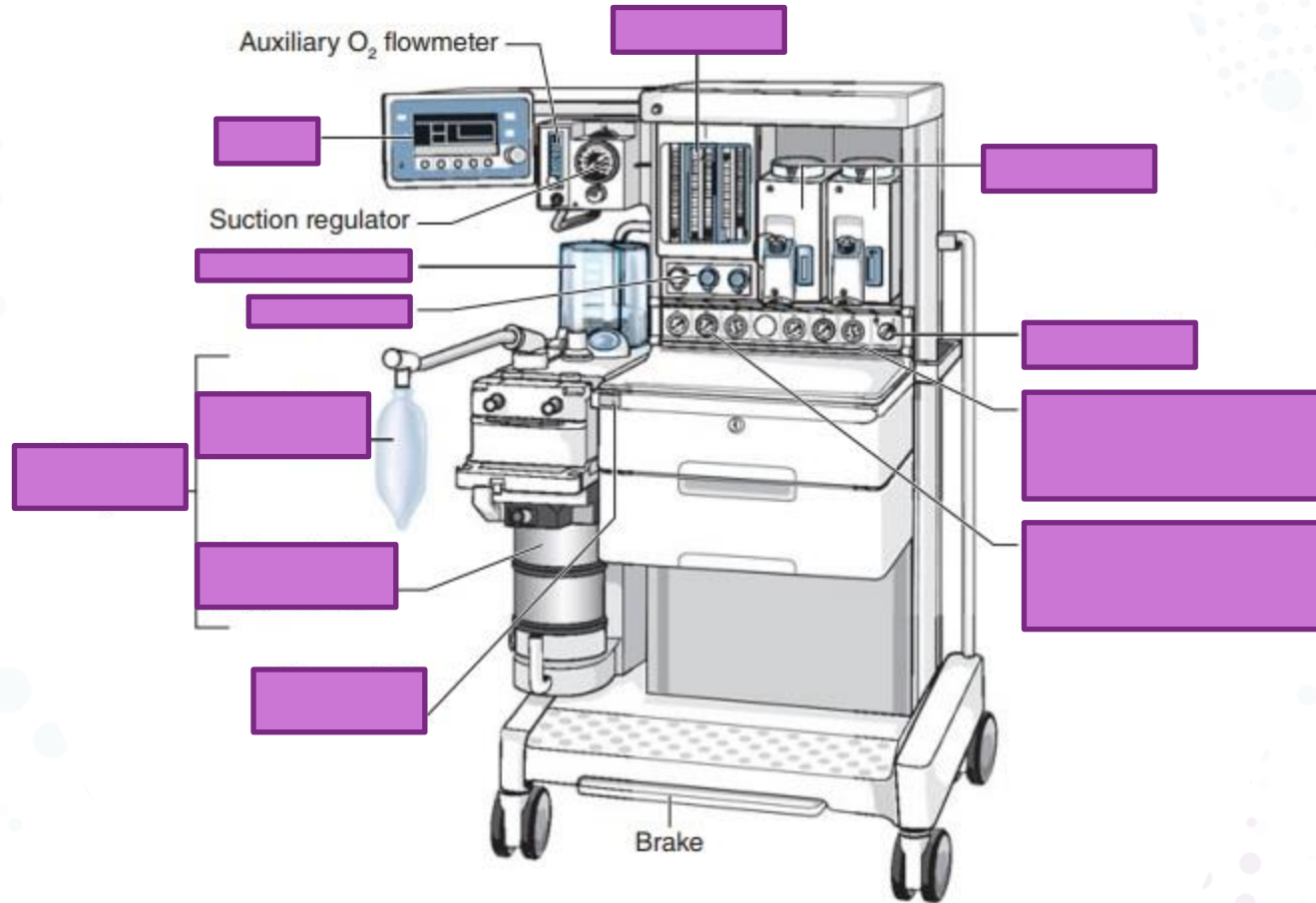
Monitoring - Anesthesia Monitoring

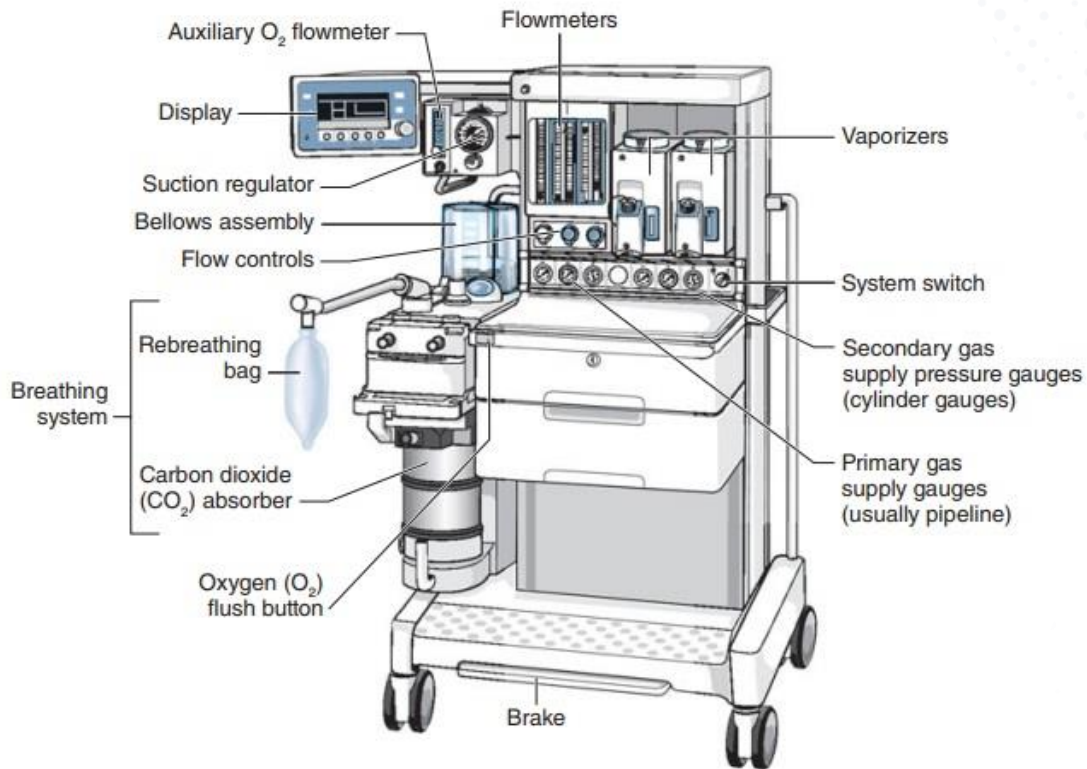


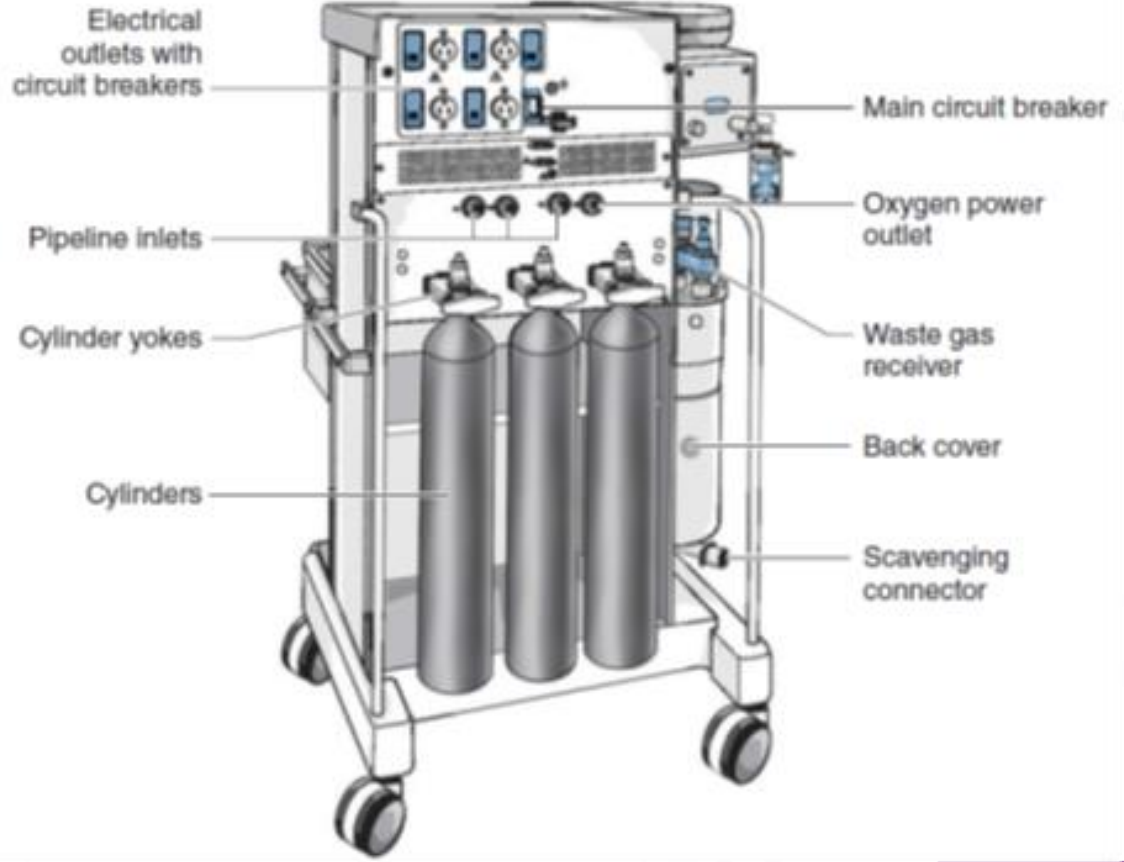
Monitoring - Anesthesia Monitoring

45 – 65
BIS









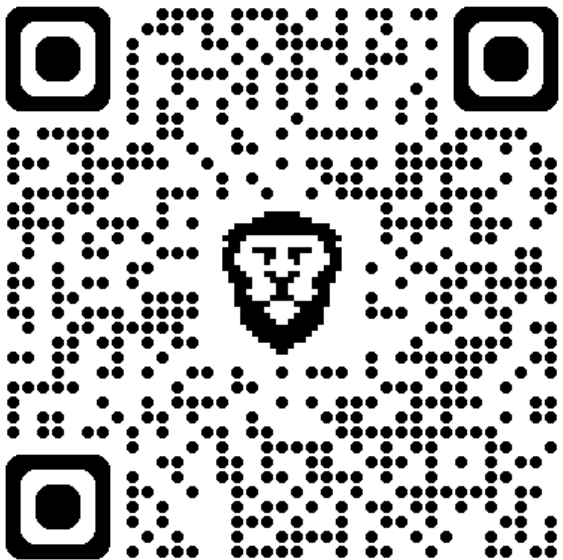
Any Questions?

Thank you!

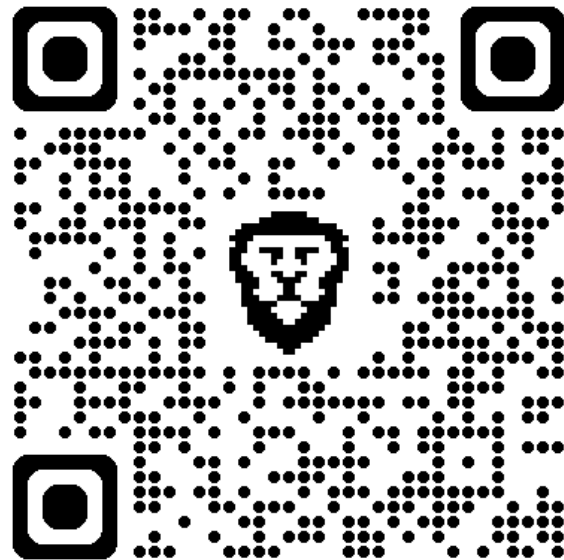




Resources



LinkedIn

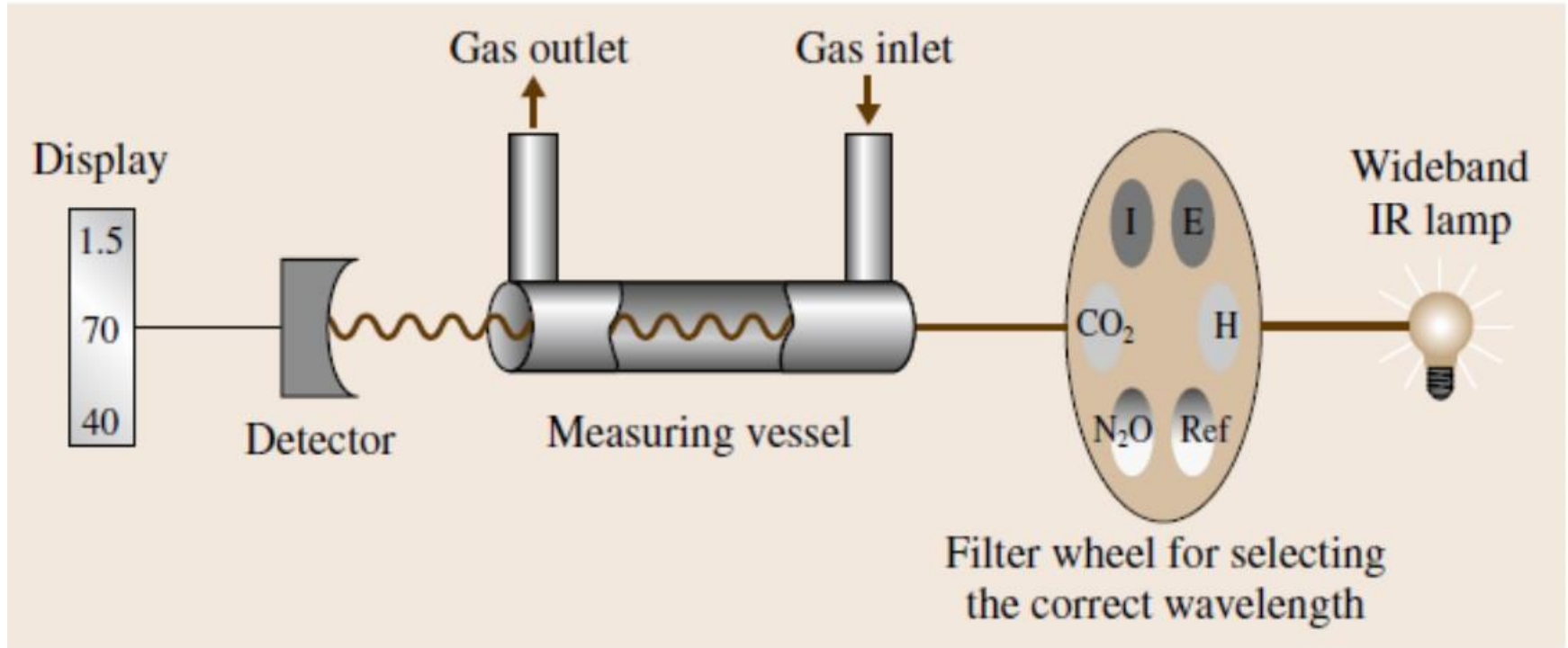


GitHub

Sensors

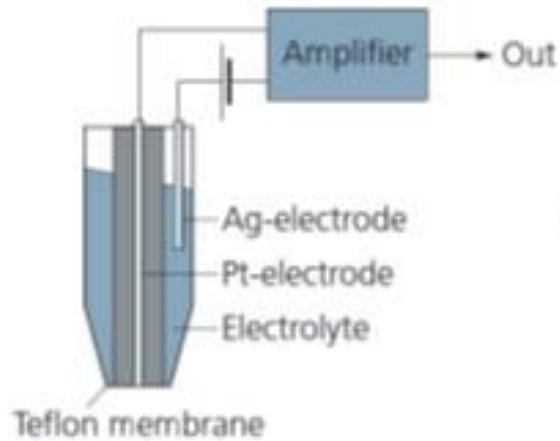
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Sensors

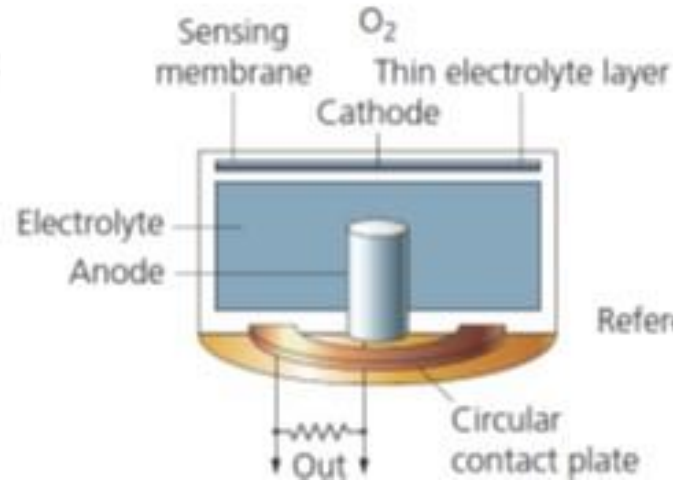


Sensors

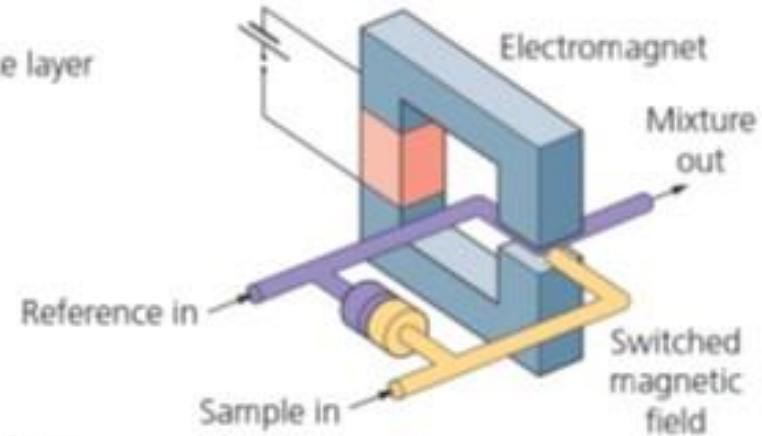
Polarographic



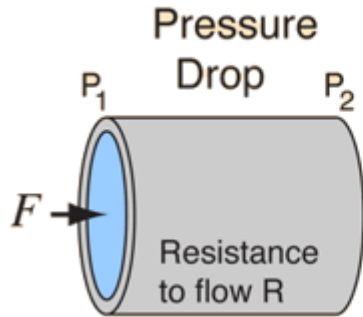
Galvanic (fuel cell)



Paramagnetic

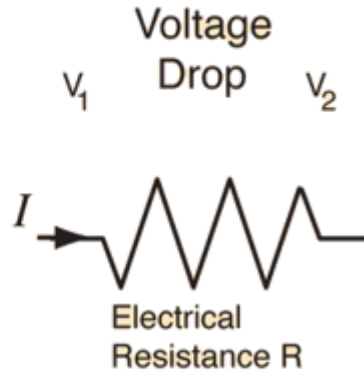


Sensors



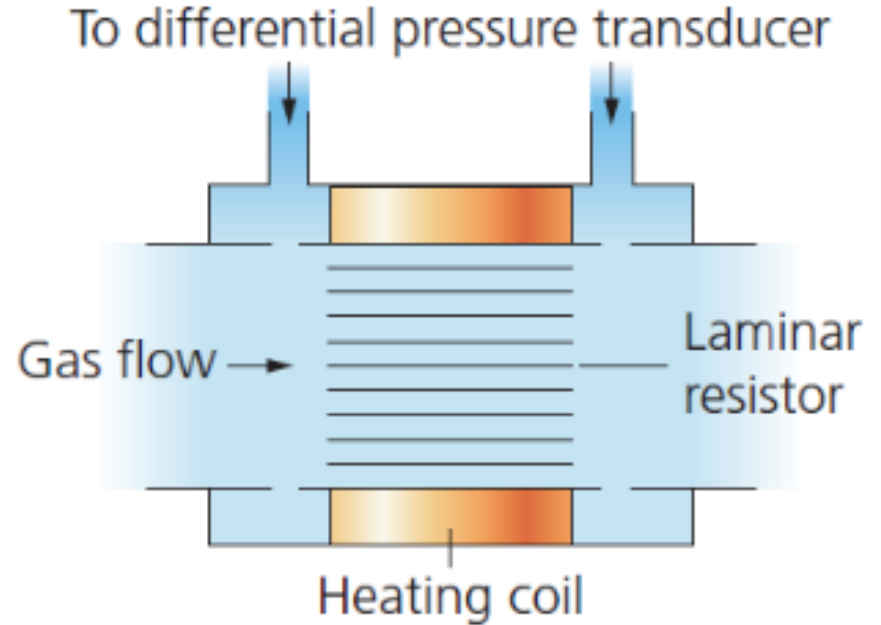
$$F = \frac{P_1 - P_2}{R}$$

*Poiseuille's law
for fluids*



$$I = \frac{V_1 - V_2}{R}$$

*Ohm's law
for electric circuits*



Sensors

