



SNS COLLEGE OF TECHNOLOGY

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Department of Biomedical Engineering

Vision Tit 2

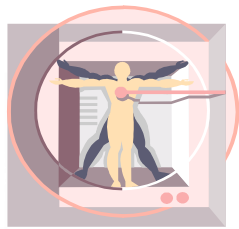
Vision Title 3

Course Name: 19BMT204 Biomedical Instrumentation

II Year : IV Semester

Unit V – Patient Safety

Topic : Macroshock and Microshock

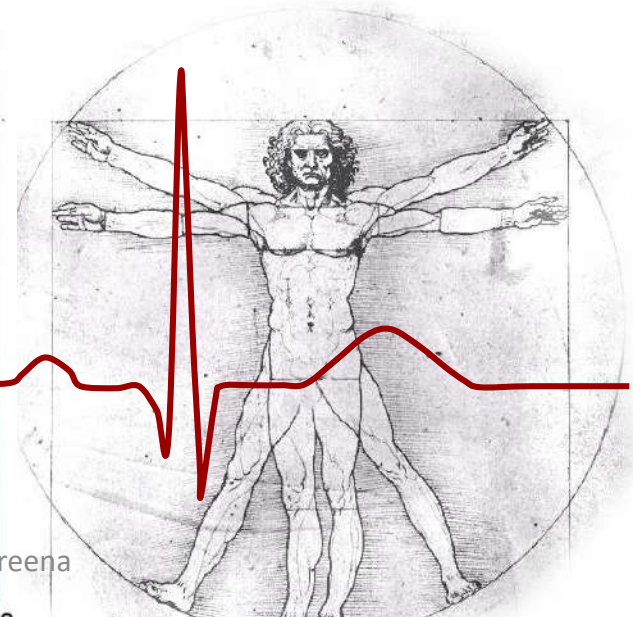
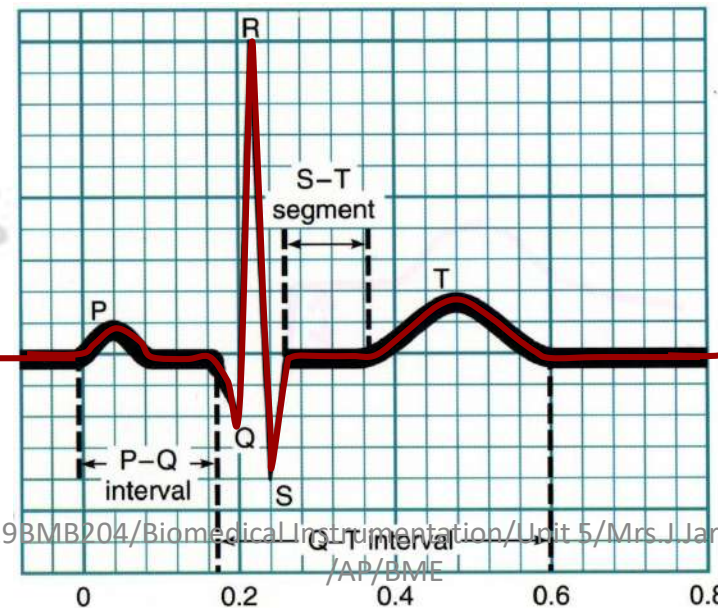
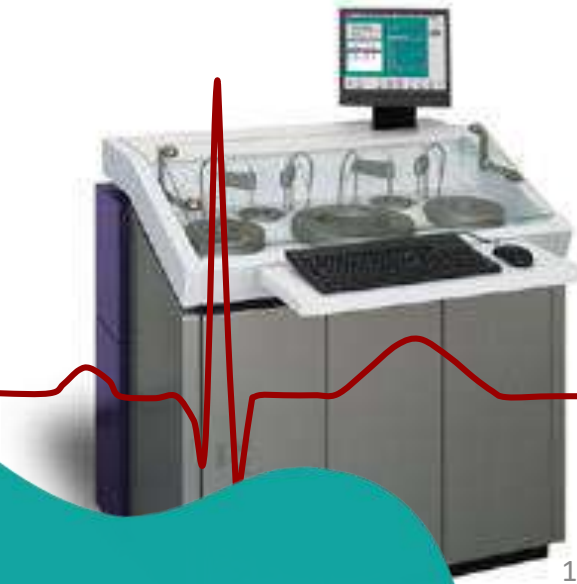


PRINCIPLES OF BIOMEDICAL SYSTEMS & DEVICES

PBS&D – Fall 2004 – Polikar

<http://engineering.rowan.edu/~polikar/CLASSES/ECE404>

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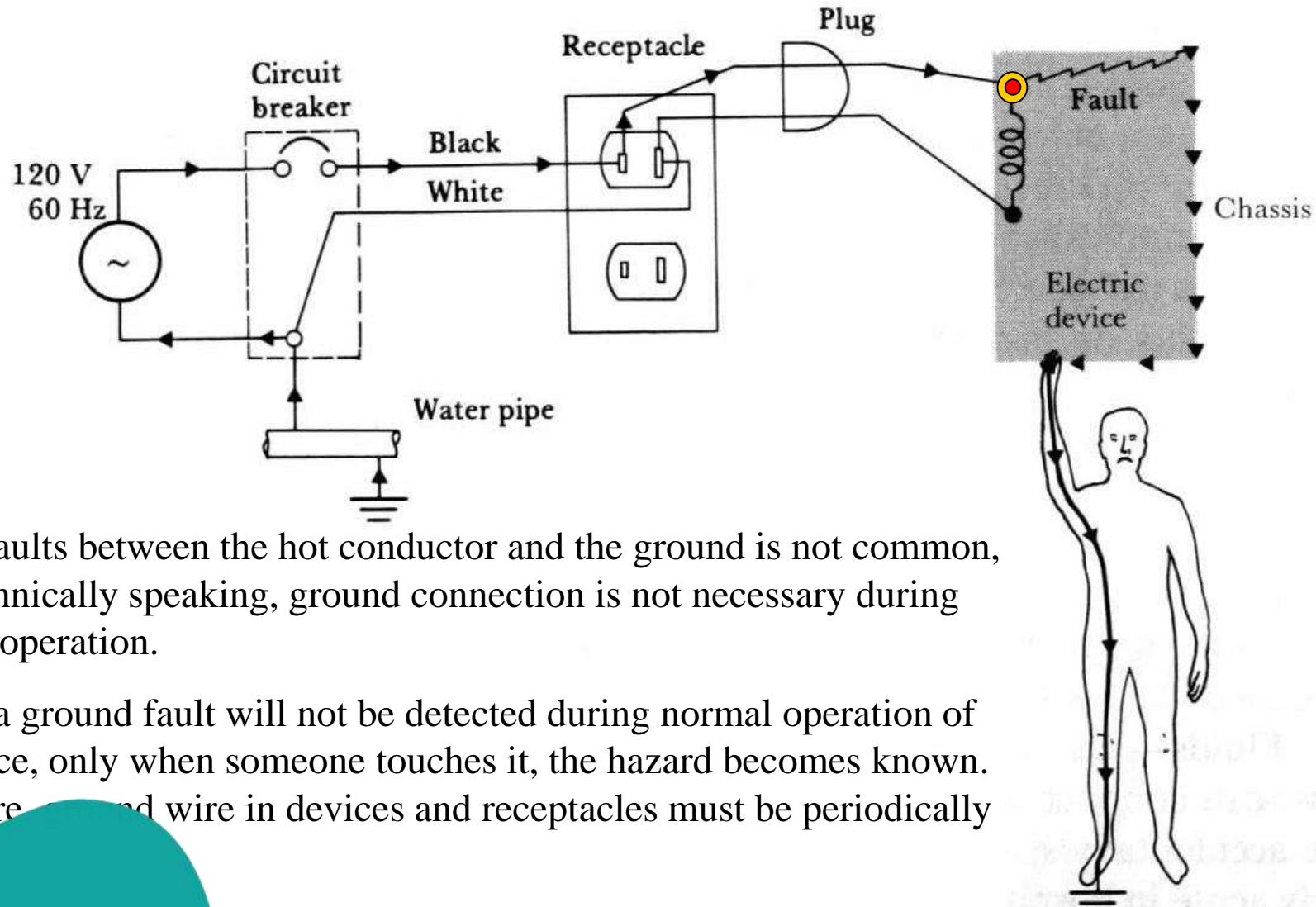


Macroshock

- Most electrical devices have a metal cabinet, which constitutes a hazard, in case of an insulation failure or shortened component between the hot power lead and the chassis. There is then 115 ~ 230 V between the chassis and any other grounded object.
- The first line of defense available to patients is their skin.
 - The outer layer provides 15 k Ω to 1 M Ω depending on the part of the body, moisture and sweat present, 1% of that of dry skin if skin is broken,
 - Internal resistance of the body is 200 Ω for each limb, and 100 Ω for the trunk, thus internal body resistance between any two limbs is about 500 Ω (somewhat higher for obese people due to high resistivity of the adipose tissue)!
 - Any procedure that reduces or eliminates the skin resistance increases the risk of electrical shock, including biopotential electrode gel, electronic thermometers placed in ears, mouth, rectum, intravenous catheters, etc.
- A third wire, grounded to earth, can greatly reduce the effect of macroshock, as the resistance of that path would be much smaller than even that of internal body resistance!



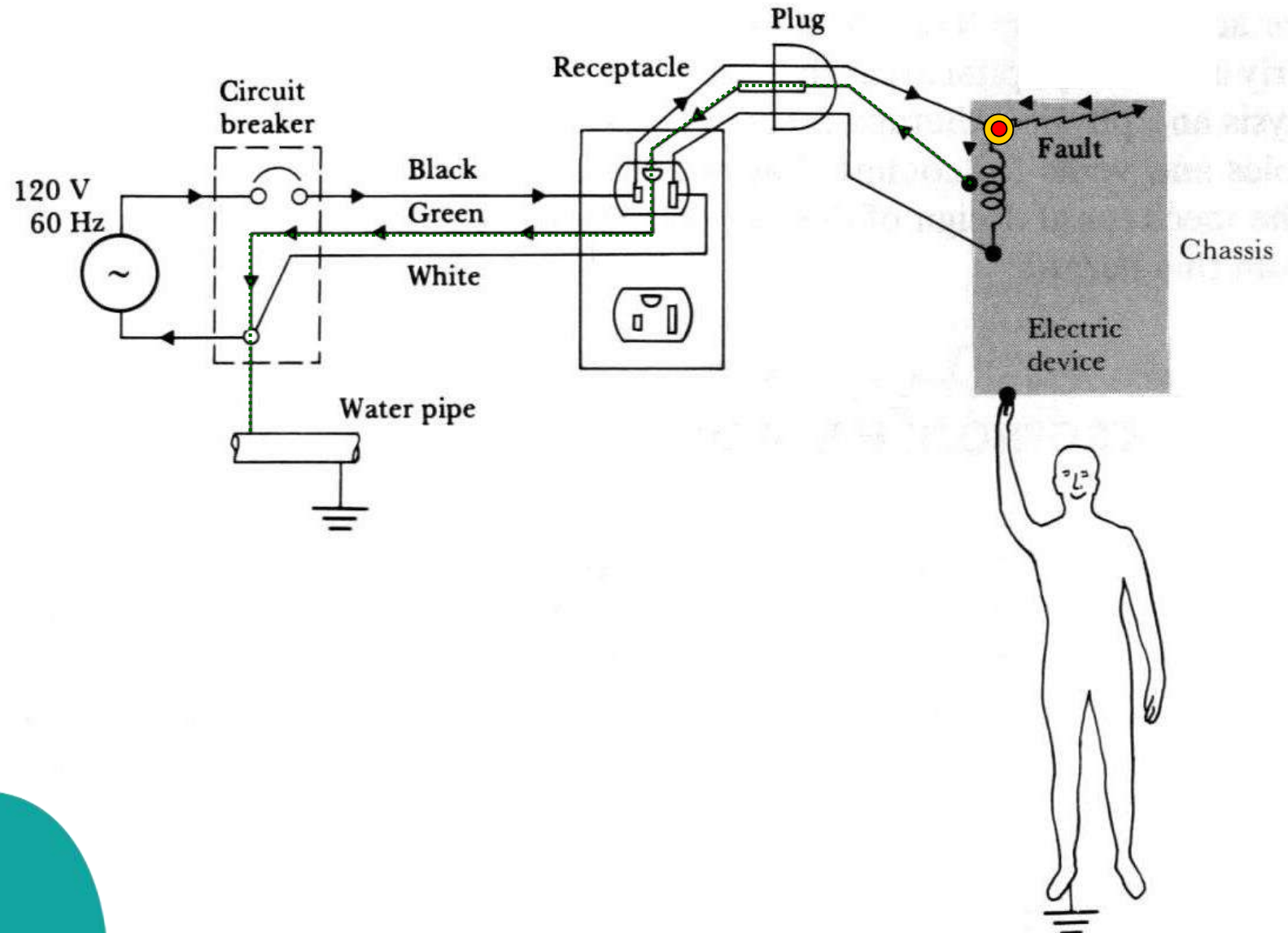
Macroshock Hazards



- Direct faults between the hot conductor and the ground is not common, and technically speaking, ground connection is not necessary during normal operation.
- In fact, a ground fault will not be detected during normal operation of the device, only when someone touches it, the hazard becomes known. Therefore, ground wire in devices and receptacles must be periodically

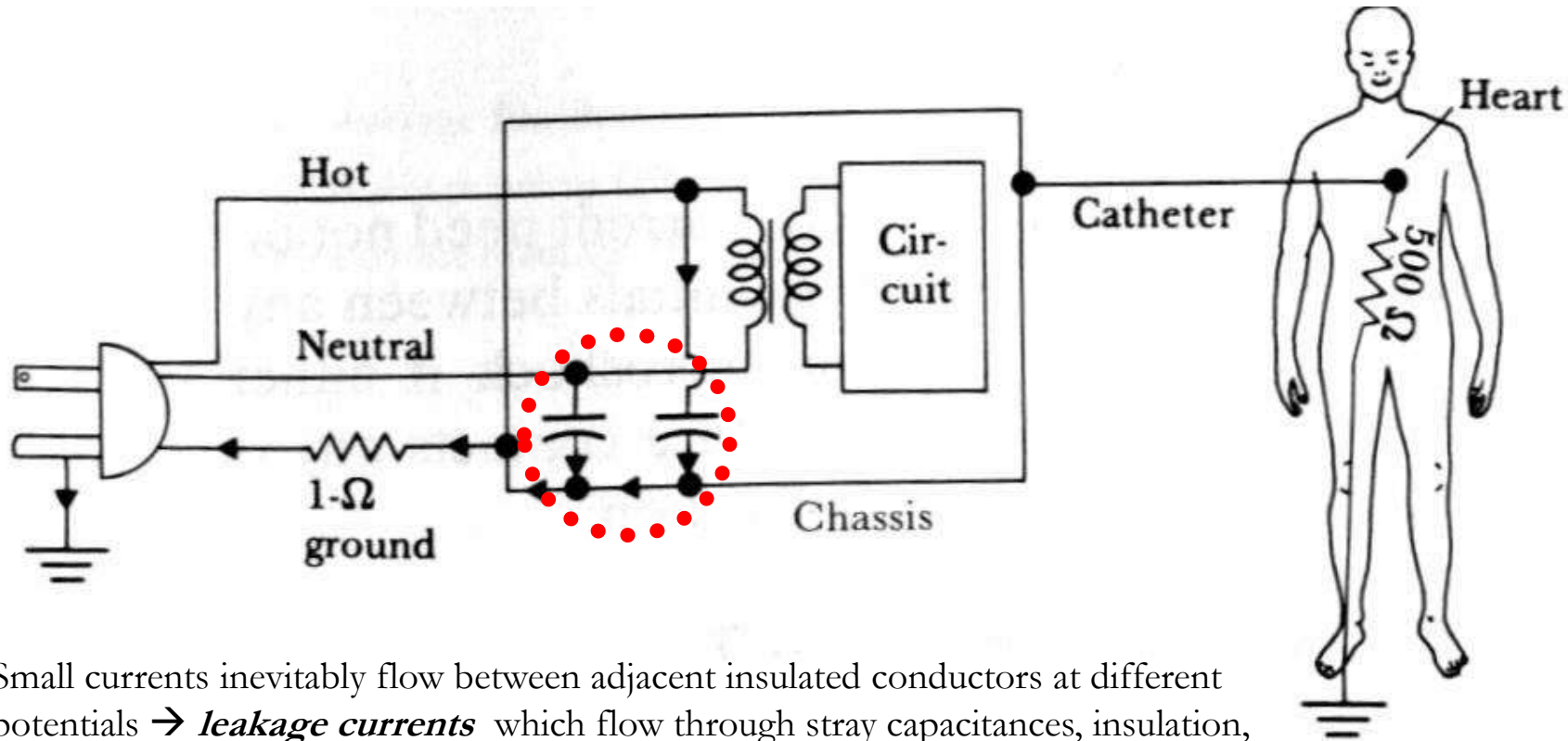


Macroshock Hazards





Microshock Hazards



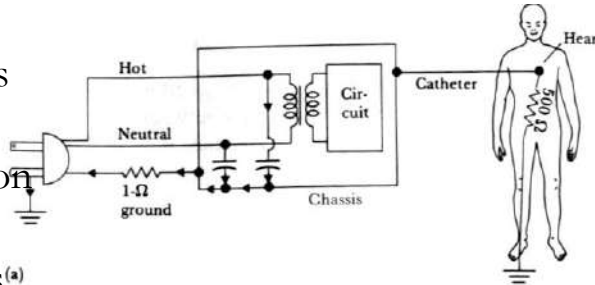
Small currents inevitably flow between adjacent insulated conductors at different potentials → **leakage currents** which flow through stray capacitances, insulation, dust and moisture

Leakage current flowing to the chassis flows safely to the ground, if a low-resistance ground wire is available.

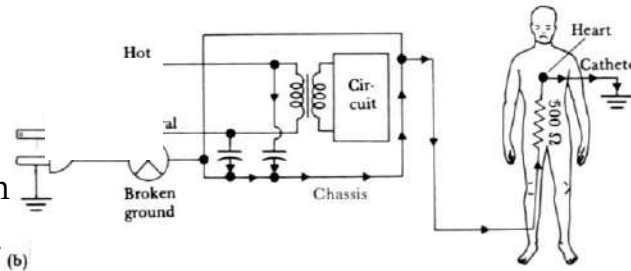


Microshock Hazards

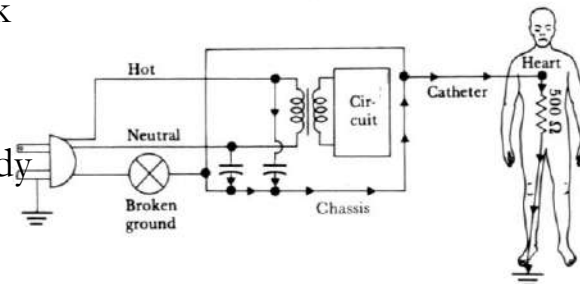
- If ground wire is broken, the chassis potential rises above the ground; a patient who has a grounded connection to the heart (e.g. through a catheter) receives a microshock if s/he touches^(a) the chassis.



- If there is a connection from the chassis to the patient's heart, **and** a connection to the ground anywhere in the body, this also causes microshock.



- Note that the hazard for microshock only exists if there is a direct connection to the heart. Otherwise, even the internal resistance of the body is high enough to prevent the microshocks.





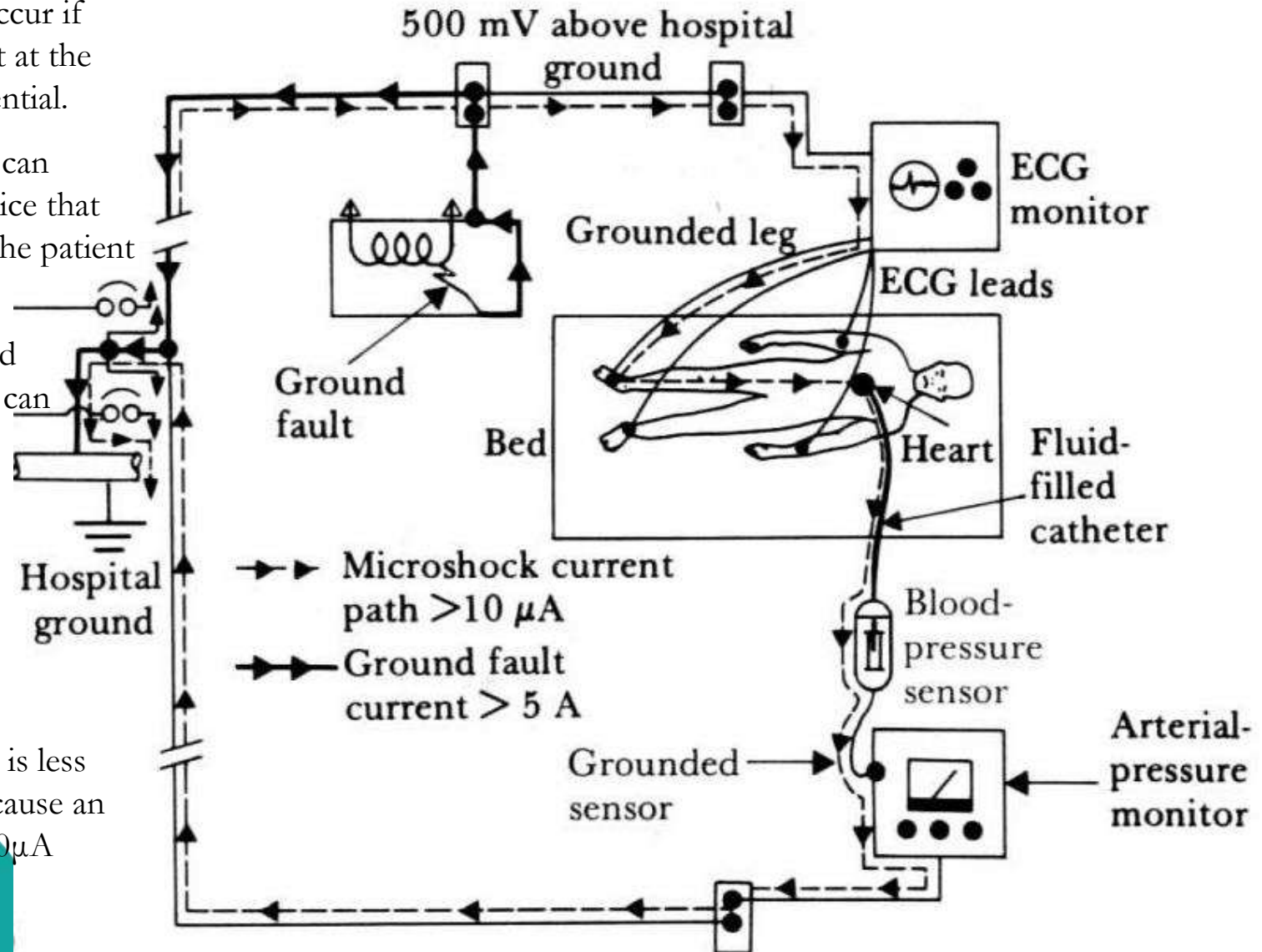
Microshock via Ground Potentials

Microshocks can also occur if different devices are not at the exact same ground potential.

In fact, the microshock can occur **even when** a device that does not connected to the patient has a ground fault!

A fairly common ground wire resistance of 0.1Ω can easily cause a 500mV potential difference if initiated due to a, say 5A of ground fault.

If the patient resistance is less than $50\text{k}\Omega$, this would cause an above safe current of $10\mu\text{A}$





Microshock Via Ground Potentials

