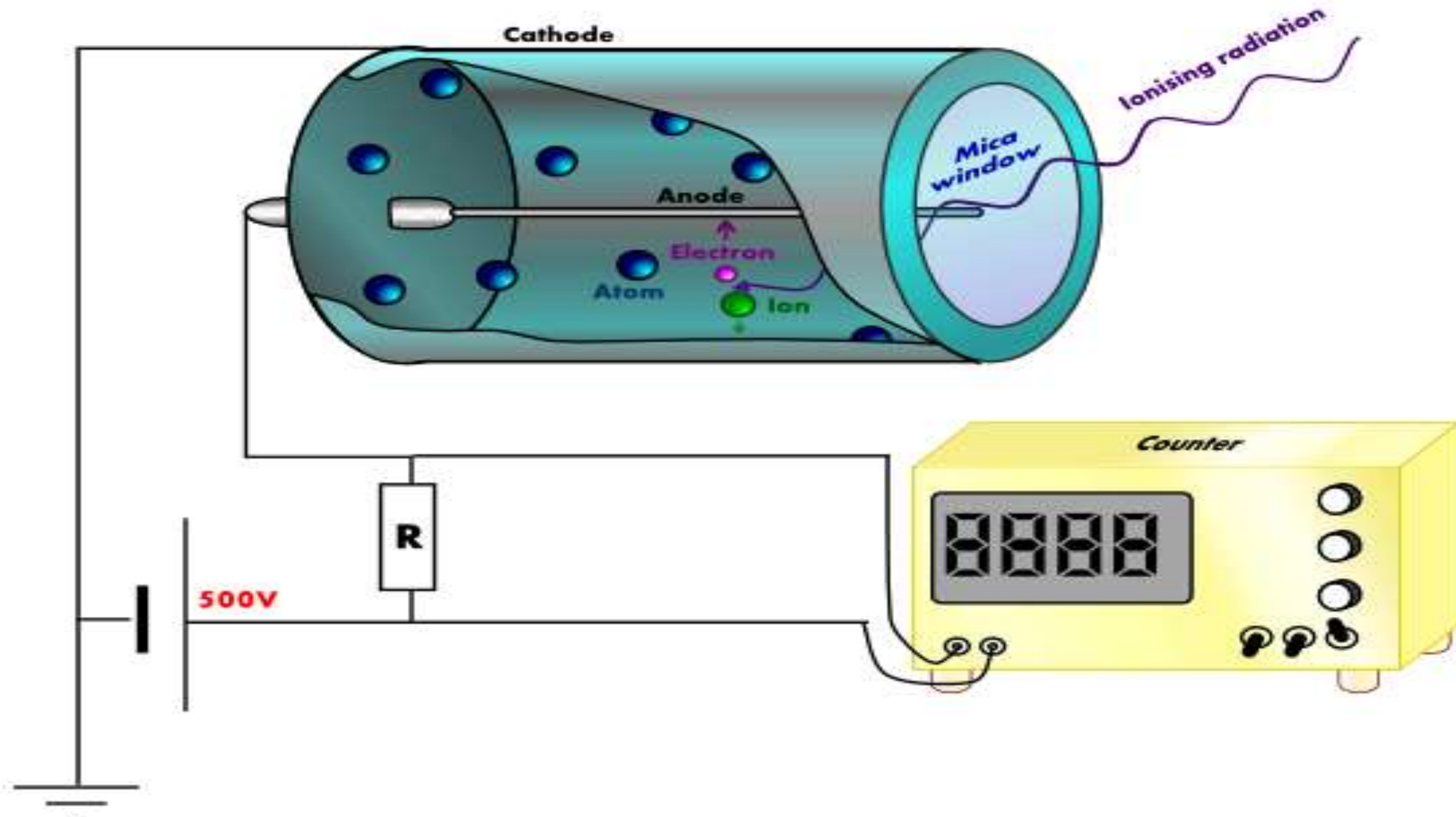
PHYSICS OF RADIOACTIVE IN MEDICINE

BASIC INSTRUMENTATION AND ITS CLINICAL APPLICATION

In nuclear physics used Geiger counter to detect radiations. The principle of GM counters. Even the small amount of ionization produced by a single beta ray entering the tube can trigger discharge, producing a large pulse of electricity that can be heard and a loudspeaker or counted electrically.

Geiger – counter



Geiger tube consists of a wire anode surrounding by a mental cathode, the space between them being filled with a mixture of gases (often argon or neon with a little bromine or chlorine) at low pressure. There is usually a small glass bead on end of the wire anode to prevent discharge from a point.

When radiation enters the tube via the thin (and fragile) mica window it ionizes the enclosed gas, and a large potential difference maintained between the electrodes causes the ion produced to accelerate rapidly to produce further ionization of the gas by collision, resulting in an a valance of electrons along the whole length of the wire, and resulting pulse of current is fed to a counting apparatus.

If the counter is a scalar each randomly distributed ionization event and resulting current pulse is recorded as a unit of an electrical counting device, and a stop-watch is required in order to calculate the mean rate of received pulses. The mean ionization current measured in counts per minute. If the counter is a rate meter, it dispenses with the need for a stop-watch and gives the count-rate directly.

CLINICAL APPLICATIONS:

Nuclear Medicine:-

The clinical uses of radioactivity for the diagnosis of disease.

- **The most useful radio-nuclides for nuclear medicine are those that emit gamma rays.**
- **Since γ – rays is very penetrating γ emitting radioactive element inside the body can be detected outside the body.**

In nuclear physics used Geiger counter to detect radiations.

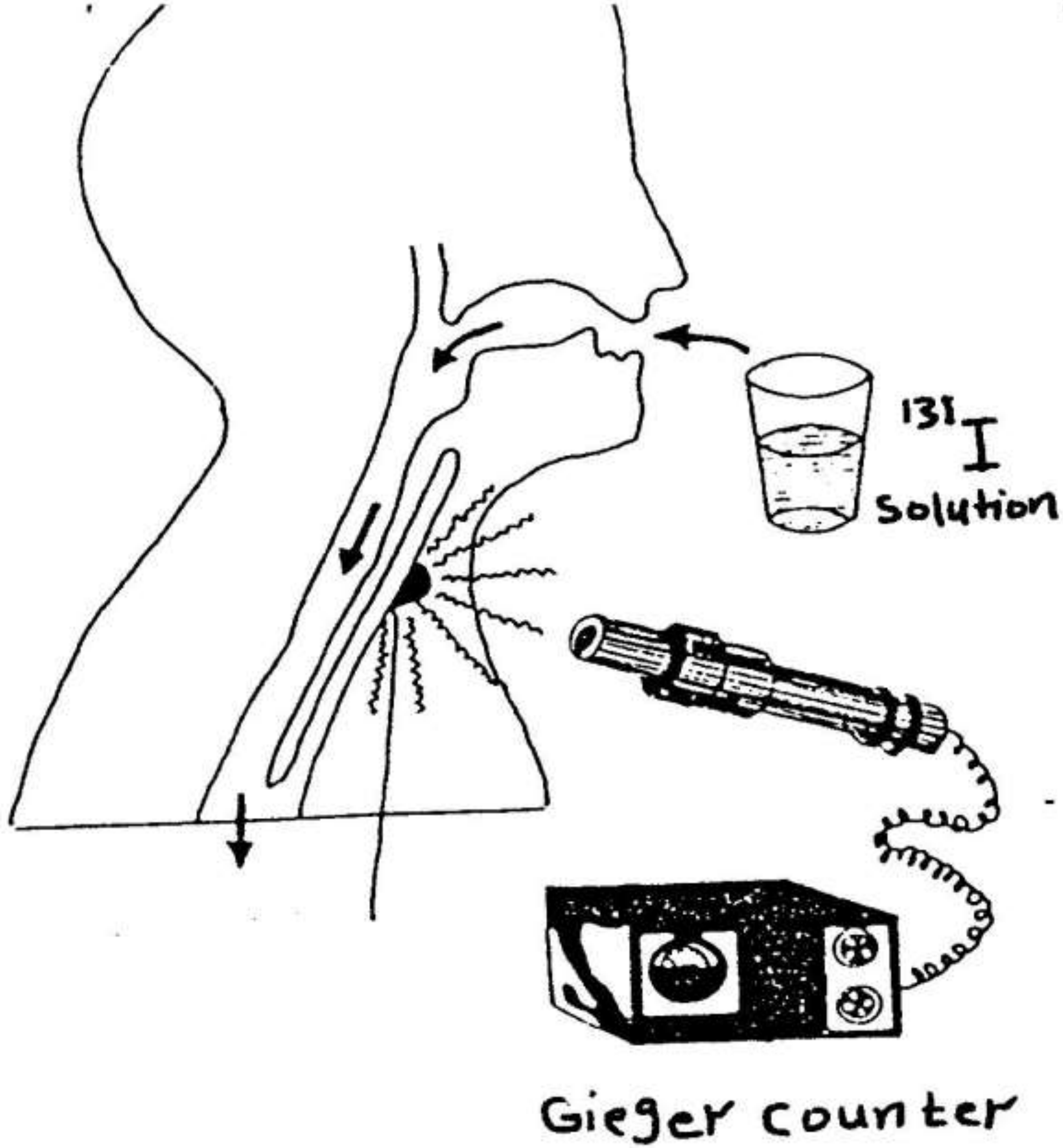
Evaluate thyroid function (24 hours uptake test).

The thyroid uses iodine in the production of hormones that control the metabolic rate of the body:

Hypothyroid- a person with underactive thyroid will take up less iodine than a person with normal thyroid function **(euthyroid).**

Hyperthyroid- a person with over active thyroid will take more iodine

For the 24hr uptake to test, a small amount of ^{131}**I** about 300KBq (~ 8µci) in a liquid or capsule, is given by mouth, and 24hr later the amount of ^{131}**I** in the thyroid is counted for 1 min. The same original amount of ^{131}**I** …the standard……. Is set aside at the beginning of the study and 24hr later it is placed in a neck phantom and also counted for 1 min.


131 I
Solution
Gieger counter

Since the ^{131}I in the patient and in the standard decay at the same rate, no correction needs to be made for the decay of the ^{131}I. After correction are made for background counts. The ratio of the thyroid counts to the standard counts times' 100 gives percent 24-hr uptake.

Normal 10 – 40 % ----------------→ average 20 %

Hyperthyroid -----------------→ above 40 %

Hypothyroid ------------------→ less than 10%

values for euthyroids range from about 10 to 40%, with an average of around 20%, If the uptake is above 40% the patient may be hyperthyroid, patients with uptakes of less than 10% may be hypothyroid or may have recently taken in a lot of stable iodine and temporarily oversupplied.

Example -1

In 24 hours uptake test the standard counts rate is 2000 c/min and the thyroid counts rate is 20 c/sec. What is the type of thyroid?

Solution

20 x 60 = 1200 c/min

(Thyroid counts/standard) x 100

= (1200/2000) x 100 = 60%

Thyroid is hyperthyroid

Example-2

In 24 hour uptake test, the standard counts rate is 2000c/min and background counts rate is 200 c/min and the thyroid counts rate is 20 c/sec. What is the type of thyroid?

Solution

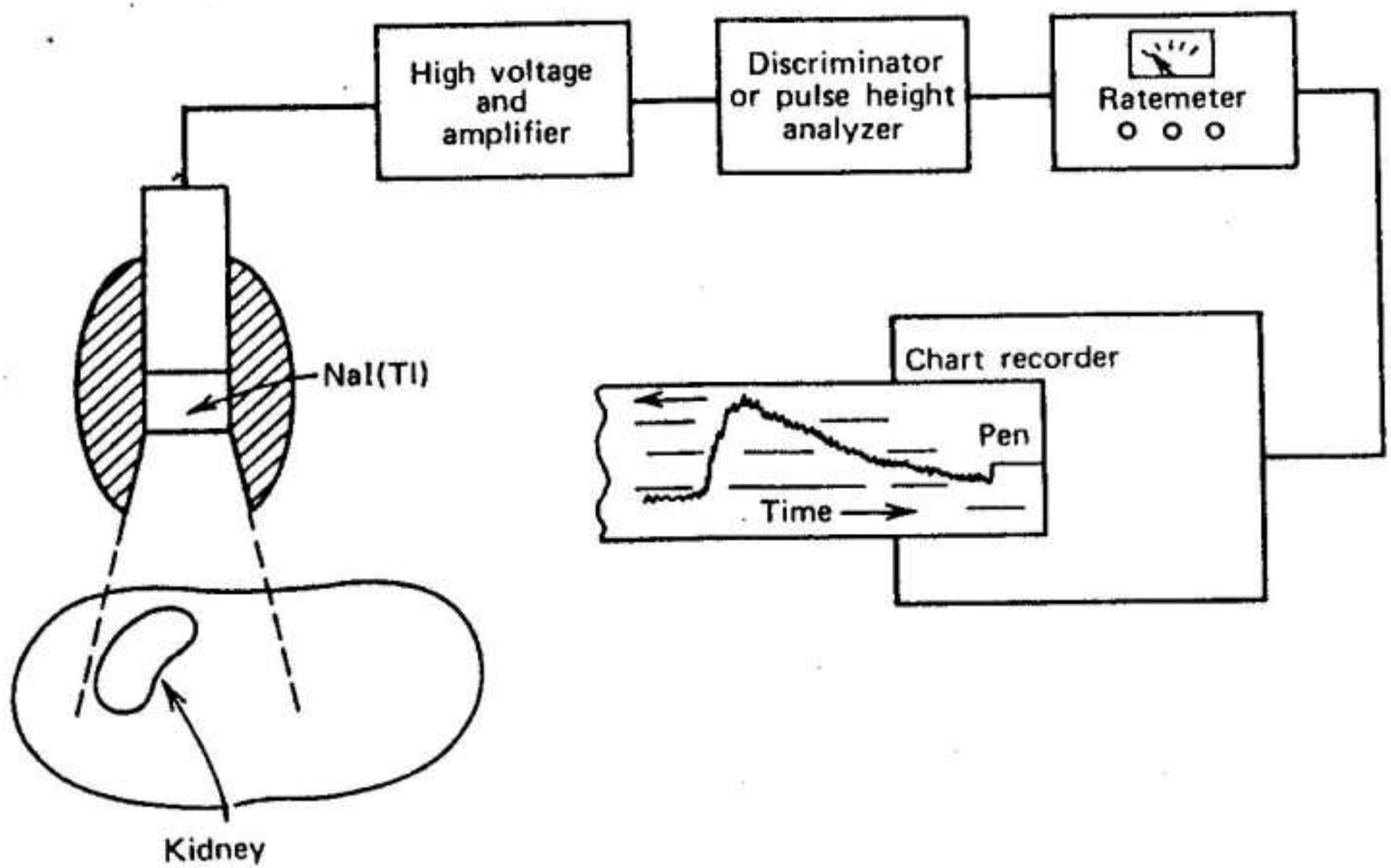
20 x 60 = 1200 c/min

(Thyroid counts – background)/(standard counts – background) x 100

(1200 – 200)/(2000 – 200) x 100 = 55%

So thyroid is hyperthyroid.

TO TEST KIDNEY FUNCTION



Kidney function is also often studied with scintillation detectors. About 7MBq (∼200μci) of ^{131}I labeled hipuric acid is injected into the bloodstream, and a sit is removed from the blood by the kidneys the radioactivity of each kidney is monitored and record the change in the radioactivity with time.

TO MEASURE BLOOD VOLUME

Dilution techniques

The technique is used to determine the blood volume. About 200KBq(5μ ci) of ^{131}I labeled albumin is injected into an arm vein, and after about 15 min. A blood sample is drawn from the other arm and counted (if the patient's blood contains radioactivity from a previous study, a pre-injection sample of the blood must also be drawn and counted). The net count rate and volume of the sample is compared to the count rate and volume of the injected material to determine the blood volume.

It is common to dilute an equal amount of radioactive material in a known volume of water and then count a sample after the water and material have mixed well.

For example:

If 5ml of ^{131}**I** labeled albumin, as used in example was diluted in 1 liter of water, it would be found that a 5ml sample of water would have account rate of about **5×10^2** counts/s.

EXAMPLE:

What is the blood volume of a patient if **5ml** of ^{131}**I**-labled albumin with net count rate of $\mathbf{10^5}$ counts/s was injected into the blood and the net count rate of a 5ml blood sample drawn 15 min later was $\mathbf{10^2}$ counts/s?

Solution:

$\mathbf{V_{blood} \times count\ rate_{blood} = V_{injected\ albumin} \times Count\ Rate_{injected\ albumin} = X \times 10^2 = 5 \times 10^5}$

$\mathbf{X = 5000ml}$