Liquid Scintillation Counting

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Liquid scintillation counting (LSC) is a major technique not only for measurement of pure beta emitting radionuclides, but also radionuclides decay by electron capture and alpha emission.

PRINCIPLE

Samples for liquid scintillation counting consist of three components:

(1) the radioactive material

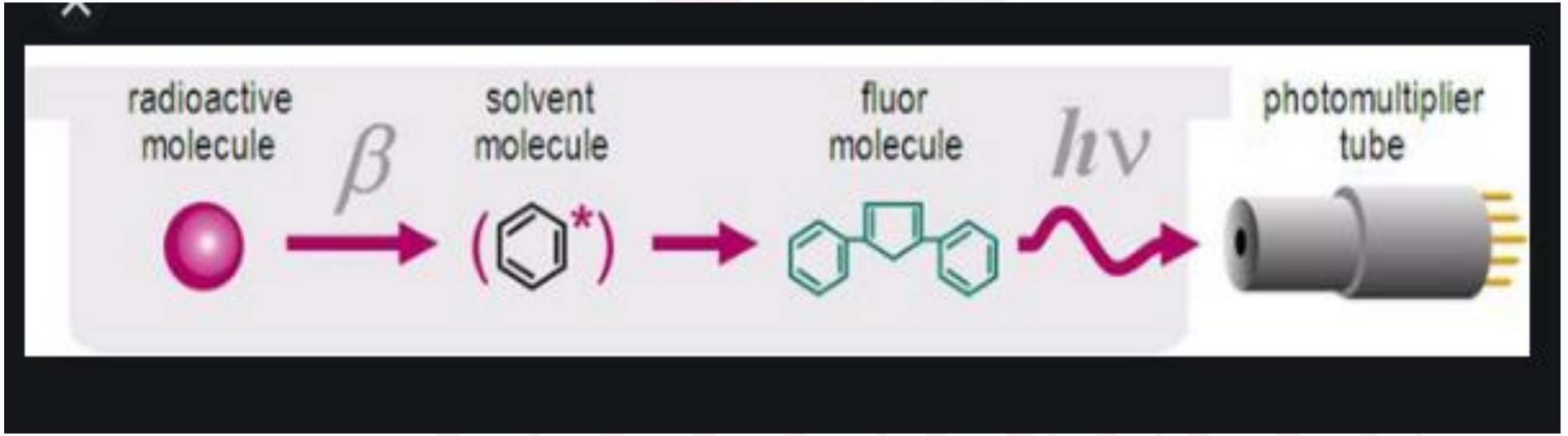
(2) a solvent, usually aromatic, in which the radioactive substance is dissolved or suspended

(3) one or more organic fluorescent substances.

Components 2 and 3 make up the liquid scintillation system or cocktail.

- **Radioactivity emitted from the radioactive sample interact with the scintillation system, producing small flashes of light, or scintillations.**

- **The light flashes are detected by a photomultiplier tube (PMT). Electronic pulses from the PMT are amplified and registered by a counting device called a scaler.**



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Procedure

- **The scintillation process, in detail, begins with the collision of emitted particles with solvent molecules, S**

$$\beta + S \longrightarrow S^* + \beta \text{ (less energetic)}$$

- **Contact between the energetic particles and S in the ground state results in transfer of energy and conversion of an S molecule into an excited state, Aromatic solvents are most often used because their electrons are easily promoted to an excited state orbital**

- **Photons from the typical aromatic solvent are of short wavelength and are not efficiently detected by photocells. A convenient way to resolve this technical problem is to add one or more fluorescent substances (fluors) to the scintillation mixture. Excited solvent molecules interact with a primary fluor, as**

$$S^* + F_1 \longrightarrow S + F_1^*$$

- **Energy is transferred from to resulting in ground state S molecules and excited molecules, molecules are fluorescent and emit light of a longer wavelength than**

$$F_1^* \longrightarrow F_1 + h\nu_1$$

- **If the light emitted during the decay of is still of a wavelength too short for efficient measurement by a PMT, a secondary fluor, that accepts energy from may be added to the scintillation system.**

$$F_1^* + F_2 \longrightarrow F_1 + F_2^*$$

$$F_2^* \longrightarrow F_2 + h\nu_2$$

- **The photon emitted by F2 is enough strong to be detected by photomultipier tube.**

- **The most basic elements in a liquid scintillation counter are the PMT, a pulse amplifier, and a counter, called a scaler. This simple assembly may be used for counting;**

Primary and secondary fluors used LSC

Two widely used primary and secondary fluors are:

1) 2,5-diphenyloxazole (PPO) with an emission maximum of 380 nm

1) 1,4-bis-2-(5-phenyloxazolyl)benzene (POPOP) with an emission maximum of 420 nm.

A more efficient but more expensive fluor is 2-(-t-butylphenyl)-5-(- biphenyl)-1,3,4-oxadiazole (Butyl-PBD).

Effect of Quench in LSC

Quenching is a term used to describe energy losses occurring in the energy transfer process.

There are three types of quenching:

(i) Physical quenching:

Physical quenching occurs when a barrier impairs contact between the radioactive particle and the scintillator solution, or when the photons of light generated are absorbed by some solid within the vial.

(ii) Chemical Quenching:

Colour quenching occurs after the fluorescence stage when light absorbing compounds interpose and lessen the number of photons leaving the scintillation vial. Fluorescence emission takes place in the blue region of the spectrum, therefore the order of severity of colour quenching is:

Red > orange > yellow > green > blue

(iii) Colour Quenching:

Any compound that does not have an aromatic structure will produce some quenching effect.

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THANK YOU