

~~##~~ 01/06/20

(1 u.m.u = 931 MeV)

## Radiotracer Technique → Defination

It can be defined as technique which ~~utilizes~~ ~~uses~~ a labelled compound to find out or to trace the diff. intermediates and various steps in biosynthetic pathways in plants, at a given state & time.

OR

In this technique diff. isotopes mainly the radioactive isotopes which are incorporated into presumed precursor of plant metabolites are used as marker

OR

A radio active tracer or radioactive label is a chemical compound in which one or more atoms have been replaced by a radioactive decay it can be used to explore the mechanism of rxn by tracing the path that the radioisotope follows from reactant to products. To radiolabeling in this the radioactive form of isotopes labelling.

Tracers Techniques -

Methods

Detection limit

1. The nuclear methods  $10^{-6}$  g (or 1  $\mu$ m)
2. Atomic absorption spectroscopy  $10^{-9}$  g (0.1 ppb)
3. Radioactivity  $10^3$  thousands of atoms

e.g., Seaborg detected some of Technetium elements less than 10 atoms.

Example - Surface area determination of a porous or pre-adsorbate -

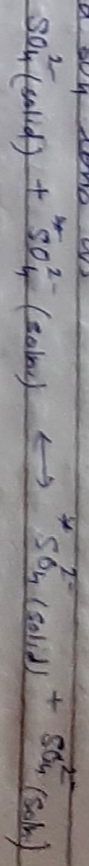
Principle - When a ppt is in contact with it satu-  
rated soln, there is a rapid exchange of ions b/w the surface of the solid phase and the soln. The extent of exchange depends on the surface area of the porous & intrinsic readily measured

if the soln is initially labelled with a radio active isotope. At equilibrium total active atoms on surface = total amount of substance on surface

1. Tracers are used to study the mechanism of rxn in soln.

Procedure - 20.0g Barium Sulphate

- A saturated soln of sod sulphate is added with 0.1 g solid tracer  $Na_2^{35}SO_4$  (i.e.  $^{35}S$  isotope) of high specific activity.
- Let the soln ~~possess~~ possess specific activity  $S_1$  counts/min/ml
- 1 g of given  $BaSO_4$  ppt sample is taken and to it are added say V ml of labelled  $Na_2SO_4$  soln.
- A rapid isotopic exchange occurs b/w the labelled & unlab-  
elled  $SO_4^{2-}$  ions as



Therefore,

$$\frac{\text{Total } SO_4^{2-} \text{ on surface}}{\text{" " in soln}} = \frac{\text{Active } {}^{35}SO_4^{2-} \text{ on surface}}{\text{" " in soln}}$$

- Total sulphate stands for active + inactive sulphate.
- The ppt is centrifuged & the reduced specific activity of the soln is measured (=  $S_2$  counts/min/ml)
- The activity transferred from the soln to the surface of  $BaSO_4$  ppt is  $(S_1 - S_2)$  & that remaining in soln is  $S_2$
- Since each sulphate ion corresponds to one  $BaSO_4$  entity in ppt. and one  $Na_2SO_4$  in soln.

$$\frac{\text{Total } BaSO_4 \text{ entities on surface}}{\text{" " in soln}} = \frac{S_1 - S_2}{S_2}$$

But, all the quantities except the numerator of the left hand side are known (only it is 'a')

on dividing the formula with respect of  $BaSO_4$  (= 233) by its density ( $d$  g/cm<sup>3</sup>) & by the Avogadro constant (L), one obtains the surface area b of one  $BaSO_4$  entity.

$$b = (M/dL)^{2/3}$$

Date: \_\_\_\_\_ Page No.: \_\_\_\_\_  
 Total surface area of BaSO<sub>4</sub> =  $a \times b$

Ex 2 Direct isotope dilution Analysis (DIDA)

Principle - The technique was developed by Herys & Hobbs in 1930. The technique is based on addition of radioactive species same as the unknown species. The sample containing say X g of (unknown) of species, Y g of a radioactive isotope from through mixing. a small amount of the species is isolated from the mixture and its final specific activity is determined. obviously S<sub>f</sub> would be less than S<sub>i</sub>. Just with these two measurements the unknown amount X is calculated on the principle of conservation of total radioactivity i.e. initial total activity is equal to the final total activity.

	Amount	Specific activity
Initial	X g of compound	0
	Y g of labelled compound added	S <sub>i</sub>
Final	(X+Y) g of mixture	S <sub>f</sub>
Since	initial total radioactivity = final total radioactivity	
	$YS_i = (X+Y) S_f$	
	$X = Y \cdot (S_i - S_f) / S_f$	

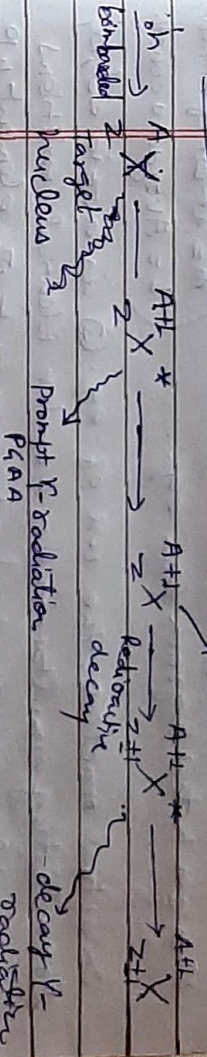
Inverse isotope dilution Analysis (IIDA)

Initial	X g of active compound	S <sub>i</sub>
	Y g of inactive compound added	0
Final	(X+Y) g of mixture	S <sub>f</sub>
Since	$XS_i = (X+Y) S_f$	

"Happiness is when you do not know what you are doing" - Albert Einstein

Ex 3 Neutron Activation Analysis (NAA)

Date: \_\_\_\_\_ Page No.: \_\_\_\_\_  
 ⇒ The analytical technique in which radioactive emission are monitored from a sample that has been bombarded with neutrons. ⇒ n-activation analysis is sensitive multielement analytical technique used for both qualitative and quantitative analysis of major, minor or trace and rare elements. ⇒ NAA is a method for qualitative quantitative determination of elements based on measurement of characteristic radiation from radionuclides formed directly or indirectly by neutron irradiation of substance. ⇒ NAA was discovered in 1936 by George de Hevesy (Hungary) and Hilda Levi (Denmark).



S<sub>f</sub> is also called as Non-destructive Technique.

The element which permit n-activation analysis include Na, P, Ca, Sc, Cr, Mn, Co, Cu, Zn, Fe, At, Se, Ag, In, W, Ir, Pt, Au & others. Some of rare earth elements as Sm, Eu, Gd, Dy, Ho, Yb are also. The activity A<sub>t</sub> produced is given by

$$N = x \cdot \phi \cdot \sigma \cdot (1 - e^{-\lambda t})$$

where  $\phi$  = neutron flux (No. of neutrons/cm<sup>2</sup>/s)  
 $\sigma$  = neutron capture cross section in cm<sup>2</sup>  
 $\lambda$  = The decay constant (s<sup>-1</sup>)  
 $A_t$  = measurable produce activity for length t sec

The no. of the product nuclei produced, N, is given by  $A_t / \lambda$  which is not necessary to know

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$A_t$  is activity of product if measured immediately at the end of the irradiation (time  $t$ ). This is practically not possible at a finite time  $t'$  lapses b/w the end of irradiation & start of counting, during which time some of the activity would have decayed. The activity now actually measured after an interval of  $t'$  after irradiation is given by

$$A_{t'} = A_t e^{-\lambda t'} = N \phi \sigma (1 - e^{-\lambda t}) e^{-\lambda t'} \quad \text{--- (2)}$$

If  $w_t = w$  g of particular element present in  $x$  g of sample is known from  $w = \frac{NM}{L} = \frac{m A_{t'}}{L \phi \sigma (1 - e^{-\lambda t}) e^{-\lambda t'}} \quad \text{(3)}$

(Input value  $\frac{m A_{t'}}{L \phi \sigma (1 - e^{-\lambda t}) e^{-\lambda t'}}$  from eq (2))

$w$  is computed in gram from eq.

( $m = \text{wt of element}$   
 $L = \text{Avogadro const.}$ )

In actual practice, the use of eq. (3) is avoided, by irradiating simultaneously & under identical conditions two samples, one standard a known amt. of element  $w^0$  & other unknown  $w$ . If the resulting are  $A_t^0$  (known) &  $A_t$  (unknown)

$$\frac{w}{w^0} = \frac{A_t^0}{A_t}$$

Alternatively, a series of known sample containing  $w_1, w_2, \dots, w_n$  of the element & unknown are irradiated together & form the linear plot of  $w$  versus  $A_t$ , the content of unknown is determined.