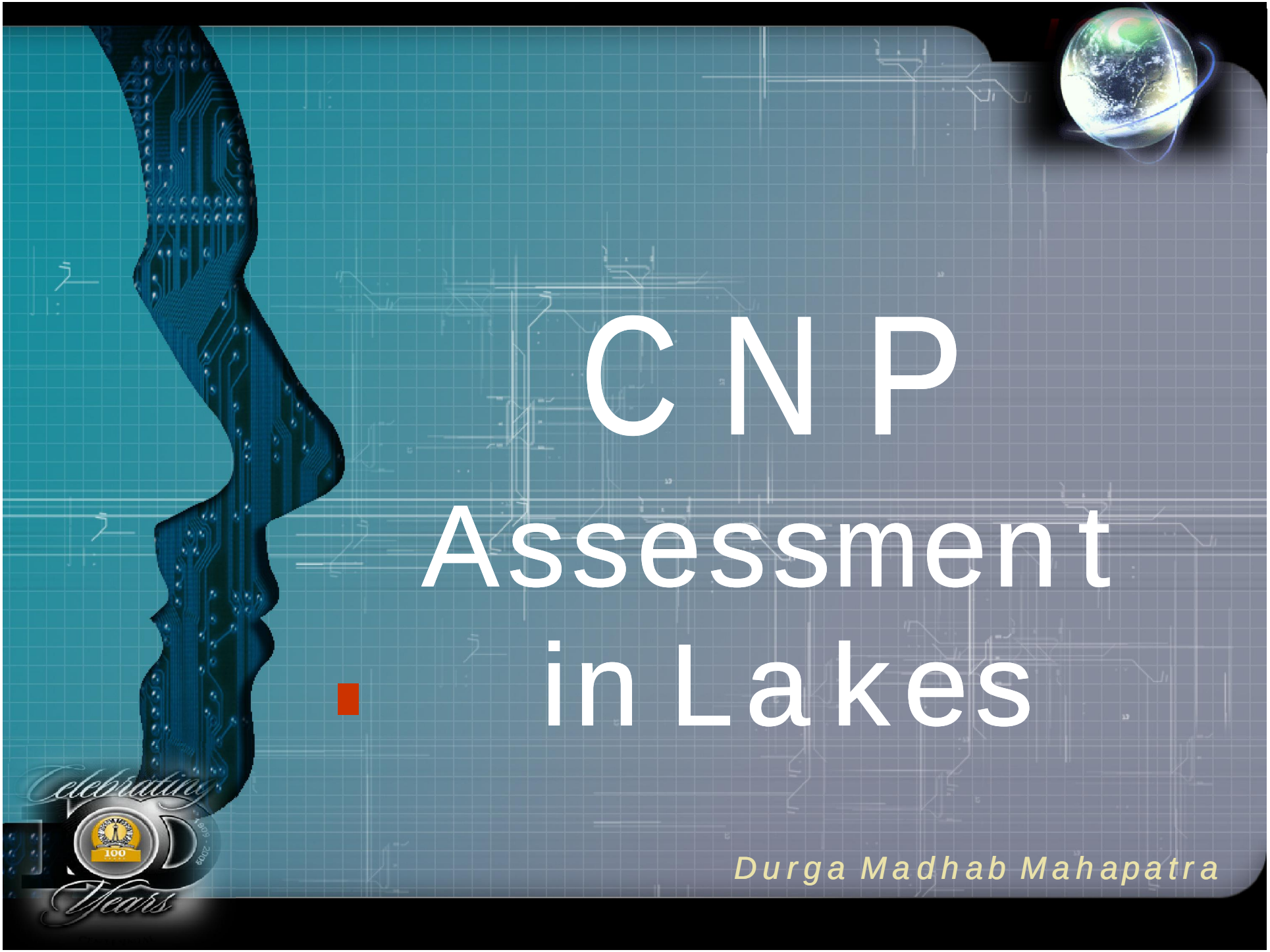
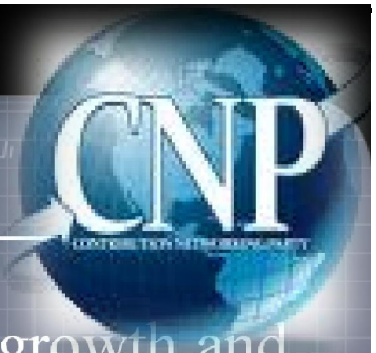

C N P
Assessment
in Lakes
Durga Madhab Mahapatra
Celebrating
100
Years

Contents

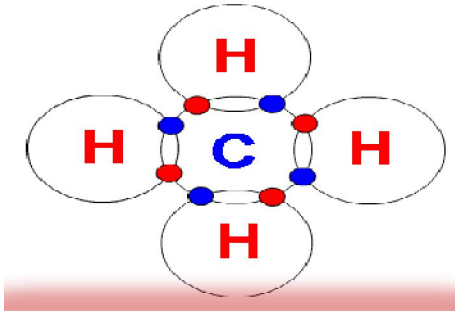
Introduction to C, N and P.



- These are the basic elements which is required for the growth and development of every living organisms.

- They form the part of cytoskeleton and thus helps in building structural components,
  - provides energy
  - supports metabolism

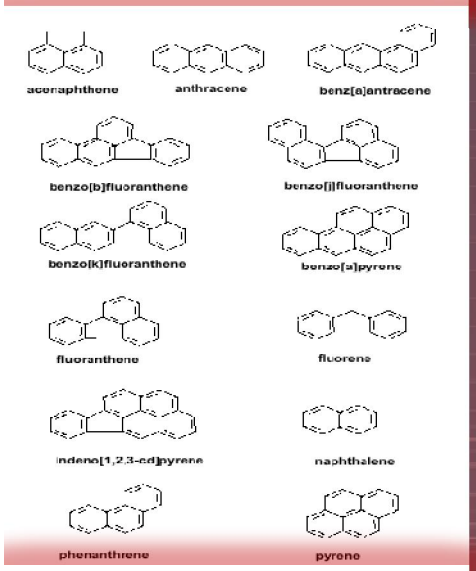
- C N and P are the building blocks of Organic nutrients as carbohydrates, fats, proteins (or their building blocks, amino acids), and vitamins.

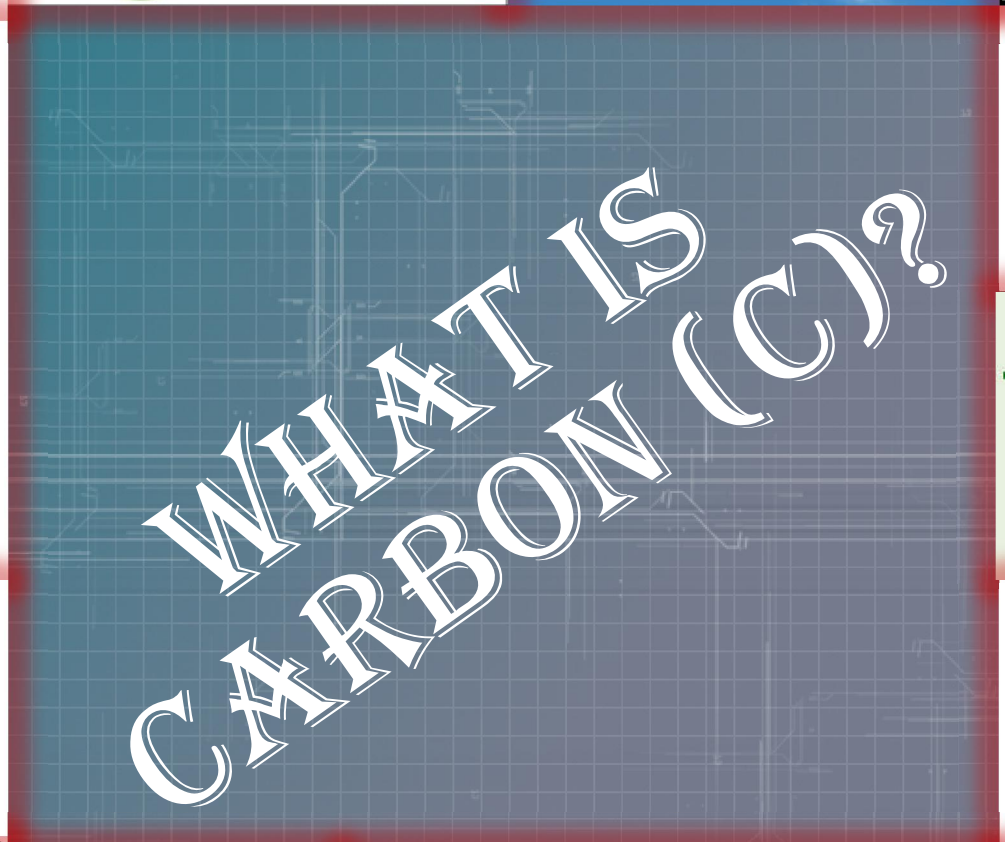

H
H
C
H
H


CO2

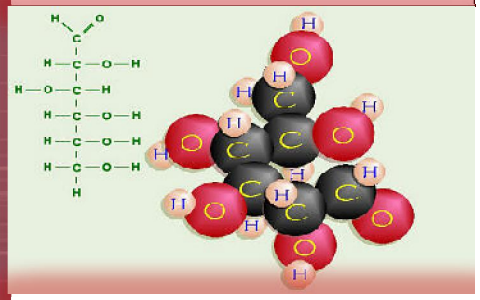

CARBON FOOTPRINT

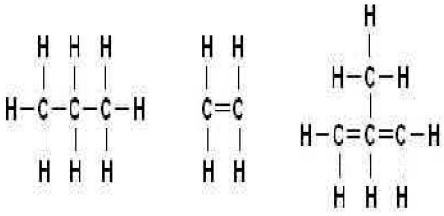

12.0107
6
C
Carbon

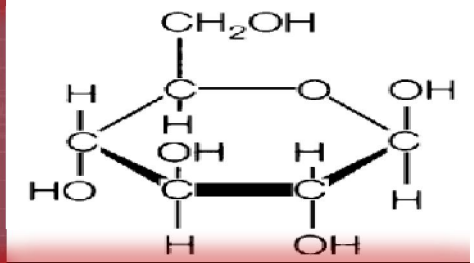

acenaphthene
anthracene
benz[a]antracene
benzo[b]fluoranthene
benzo[j]fluoranthene
benzo[k]fluoranthene
benzo[a]pyrene
fluoranthene
fluorene
indeno[1,2,3-cd]pyrene
naphthalene
phenanthrene
pyrene

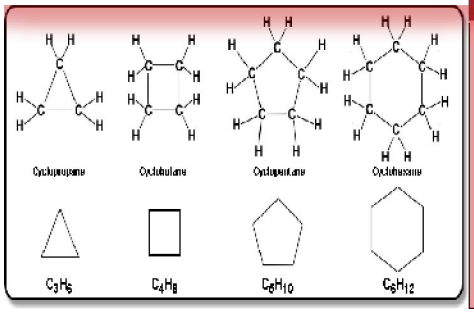

WHAT IS
CARBON (C)?

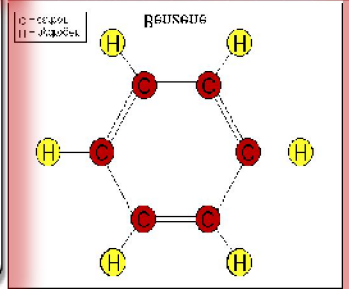

CARBON

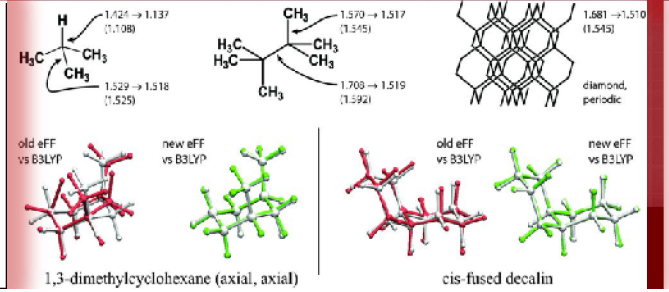


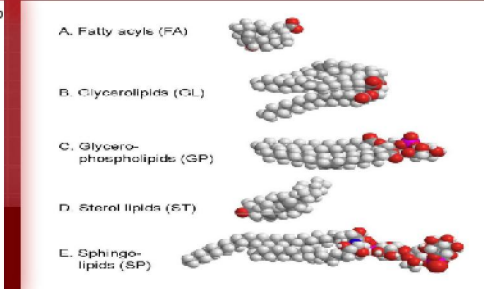



CH2OH
OH
HO
OH
OH


Cyclopropane
Cyclobutane
Cyclopentane
Cyclohexane
C3H6
C4H8
C5H10
C6H12


BENZENE


1,3-dimethylcyclohexane (axial, axial)
cis-fused decalin
diamond, periodic
old eFF vs B3LYP
new eFF vs B3LYP


A. Fatty acyls (FA)
B. Glycerolipids (GL)
C. Glycero-phospholipids (GP)
D. Sterol lipids (ST)
E. Sphingo-lipids (SP)

Carbon is the most essential element in various life forms,

- the building blocks of Carbohydrates;
- as R groups in proteins, and
- as ribose and deoxyribose sugars in case of nucleic acids (DNA, RNA) and as
- R groups in fats as esters and carboxylate derivatives.

- C acts as major structural element apart from the usual role of energy production and metabolism.

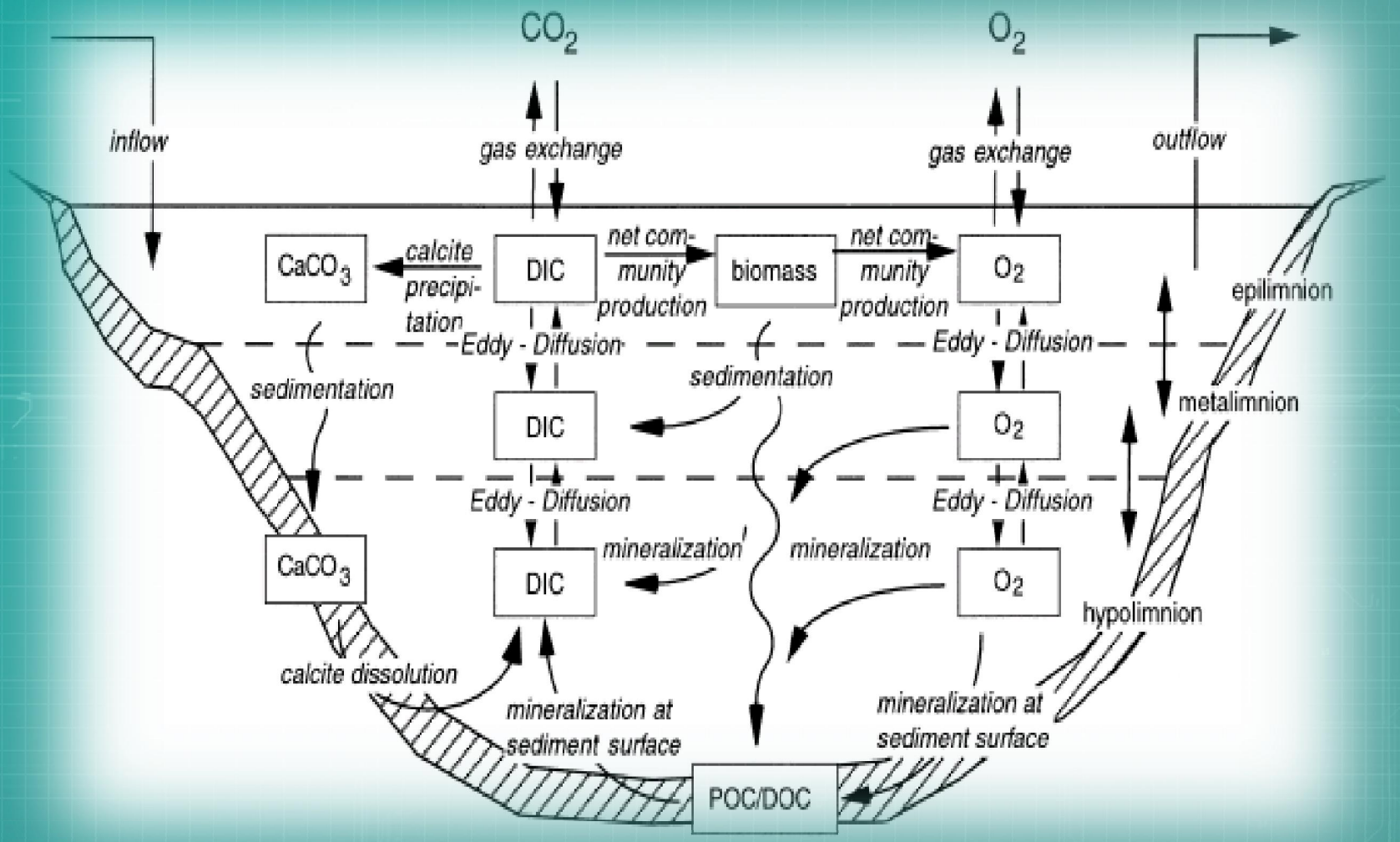
- The element carbon has an unique property of catenation due to which it forms chain like structures,.

- The carbon present in various forms mentioned earlier, after elimination from the body are decomposed by the bacteria's into simpler molecules.

- This carbon in the from of carbohydrates mainly is degraded by the bacteria's in two ways:

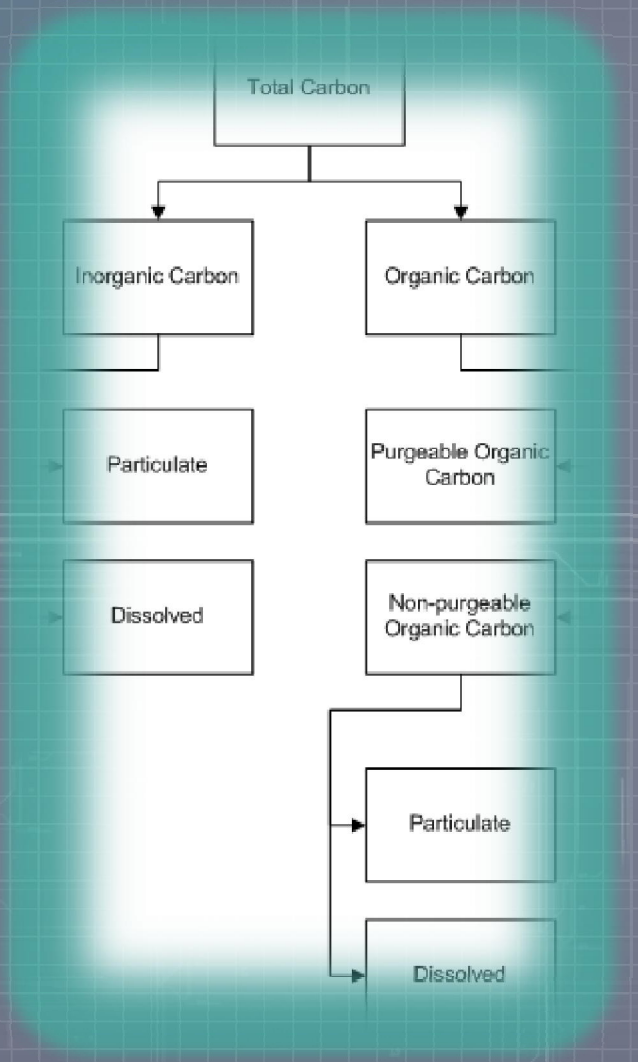
1. Aerobically è CO_2 + H2O +Enormous biomass
2. Anaerobically è CH_4 + CO_2 + Little biomass (sludge)

C dynamics in lakes and (aquatic systems)

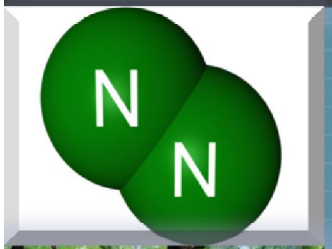


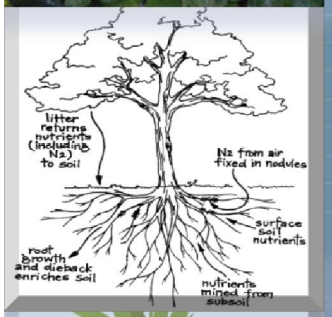
Methods of Estimation of Carbon

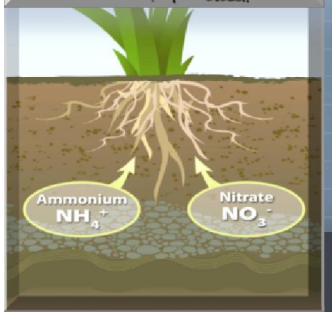
- Free CO_2 Measurement
- Total alkalinity Measurement
- Bio Assays as BOD
- COD
- TOC (Total Organic Carbon)

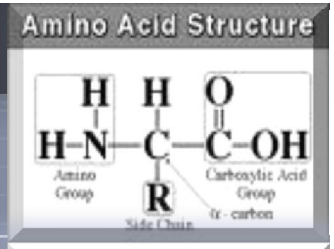


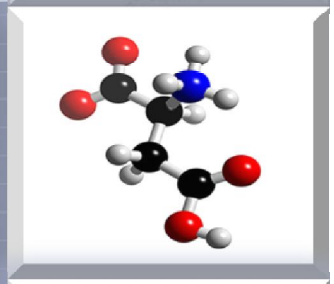
WHAT IS NITROGEN N?

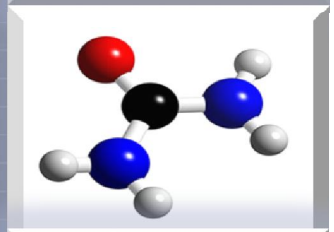


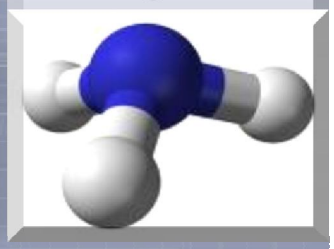


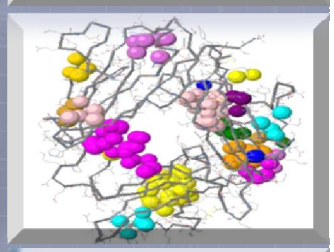


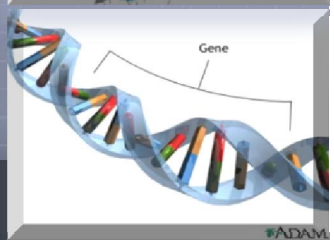












Sources of N:

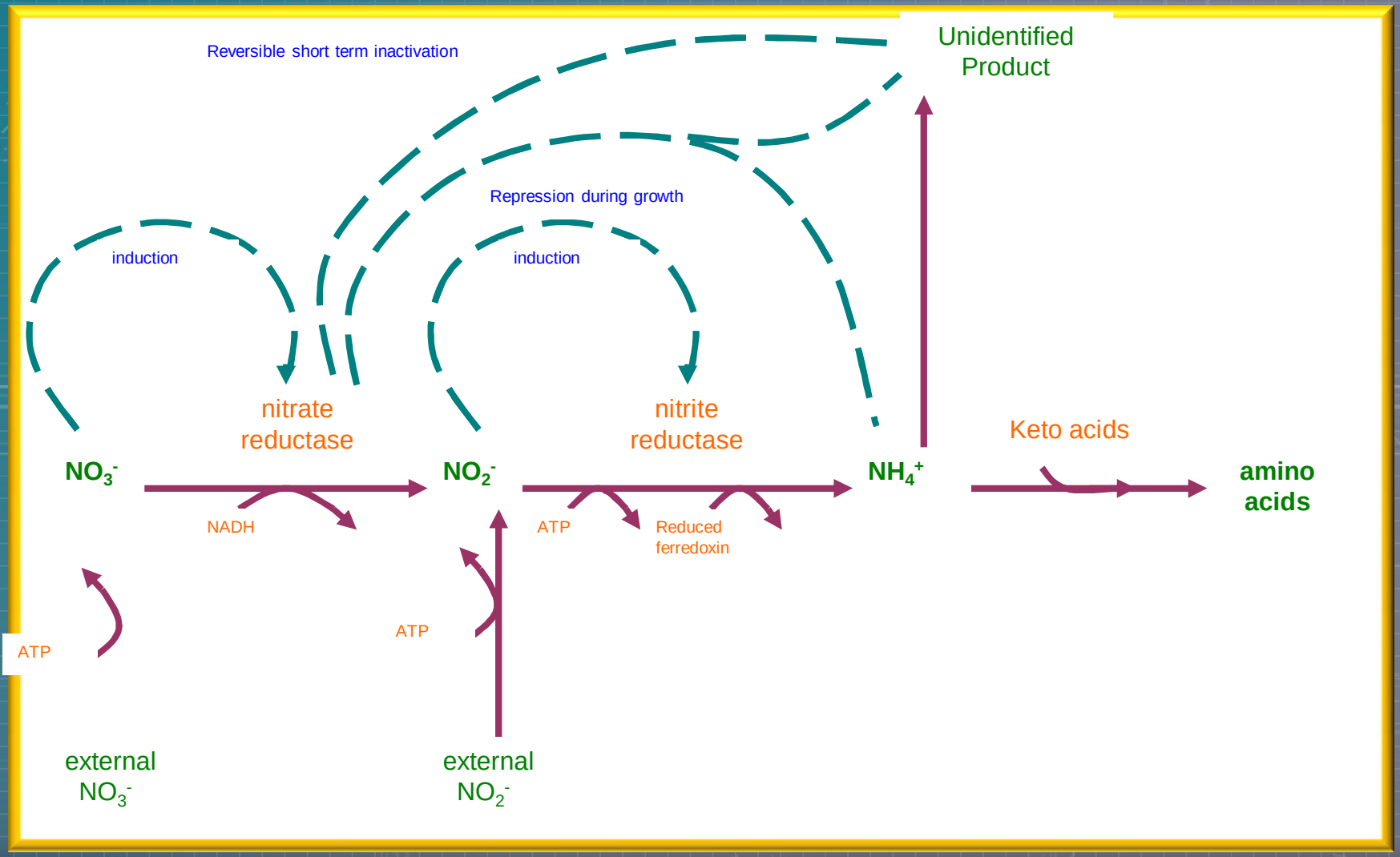
- molecular nitrogen (N_2)
- precipitation
- surface and groundwater flows
- excretion of N by terrestrial and aquatic consumers.

- In aquatic systems, nitrogen is found in multiple forms including molecular nitrogen (N2), ammonia, nitrate, nitrite, dissolved organic nitrogen (DON), and particular organic nitrogen (PON).

N transformations:

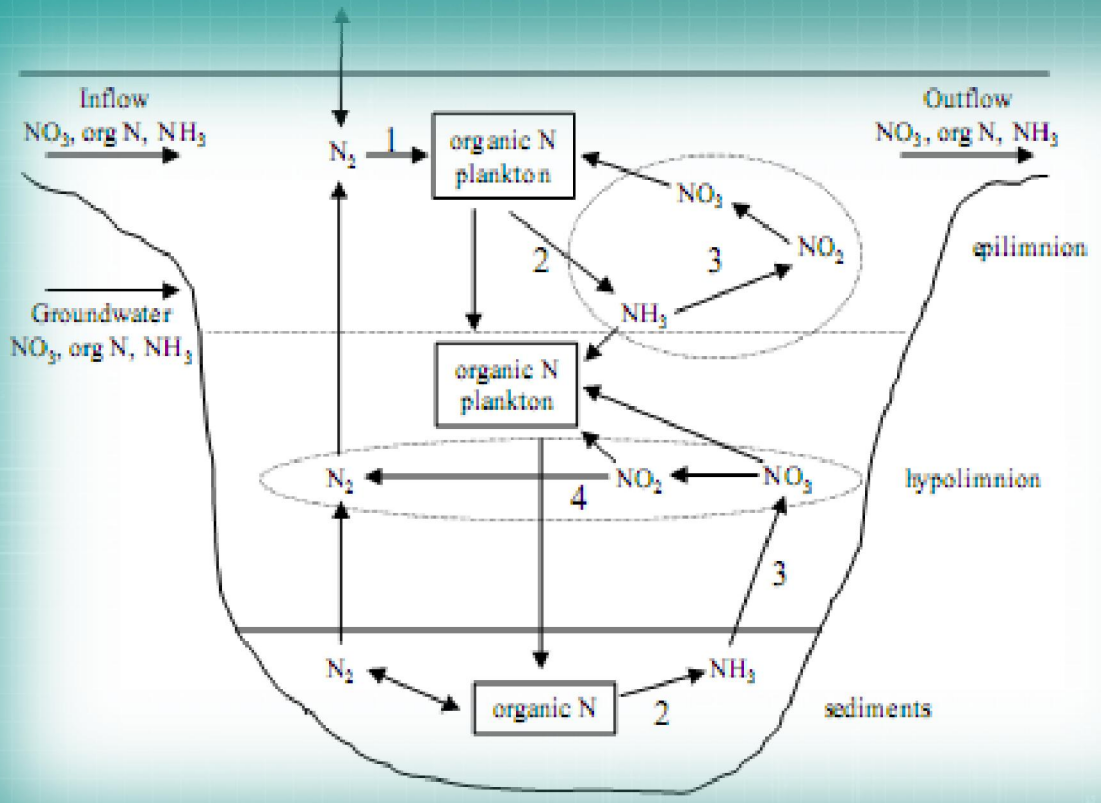
- N_2 è RNH_2 (Organic N)
- RNH_2 (Organic N) è NH_4^+
- NH_4 (ammonia) è NO_2^- (nitrite) è NO_3^- (nitrate)
- NO_3^-(nitrate) è NO_2^-(nitrite) è N_2O è N_2

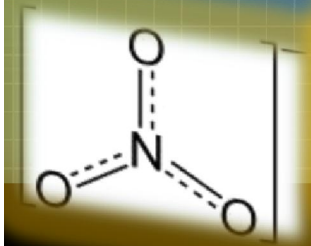
N assimilation in Plants

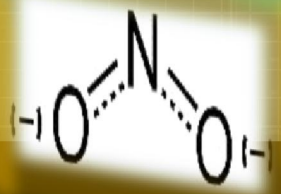


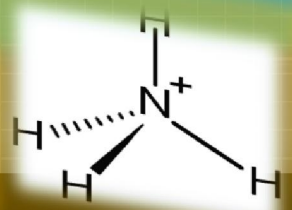
N dynamics in lakes (aquatic systems)

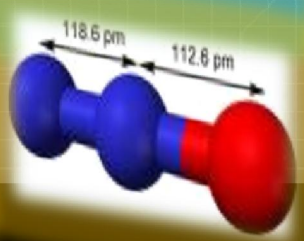
1: Nitrogen fixation
2: Ammonification
3: Nitrification
4: Denitrification

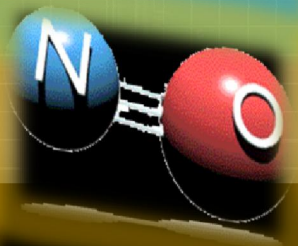


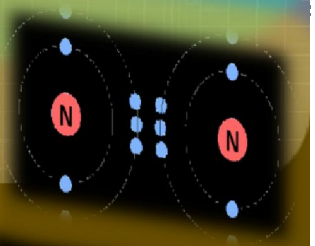




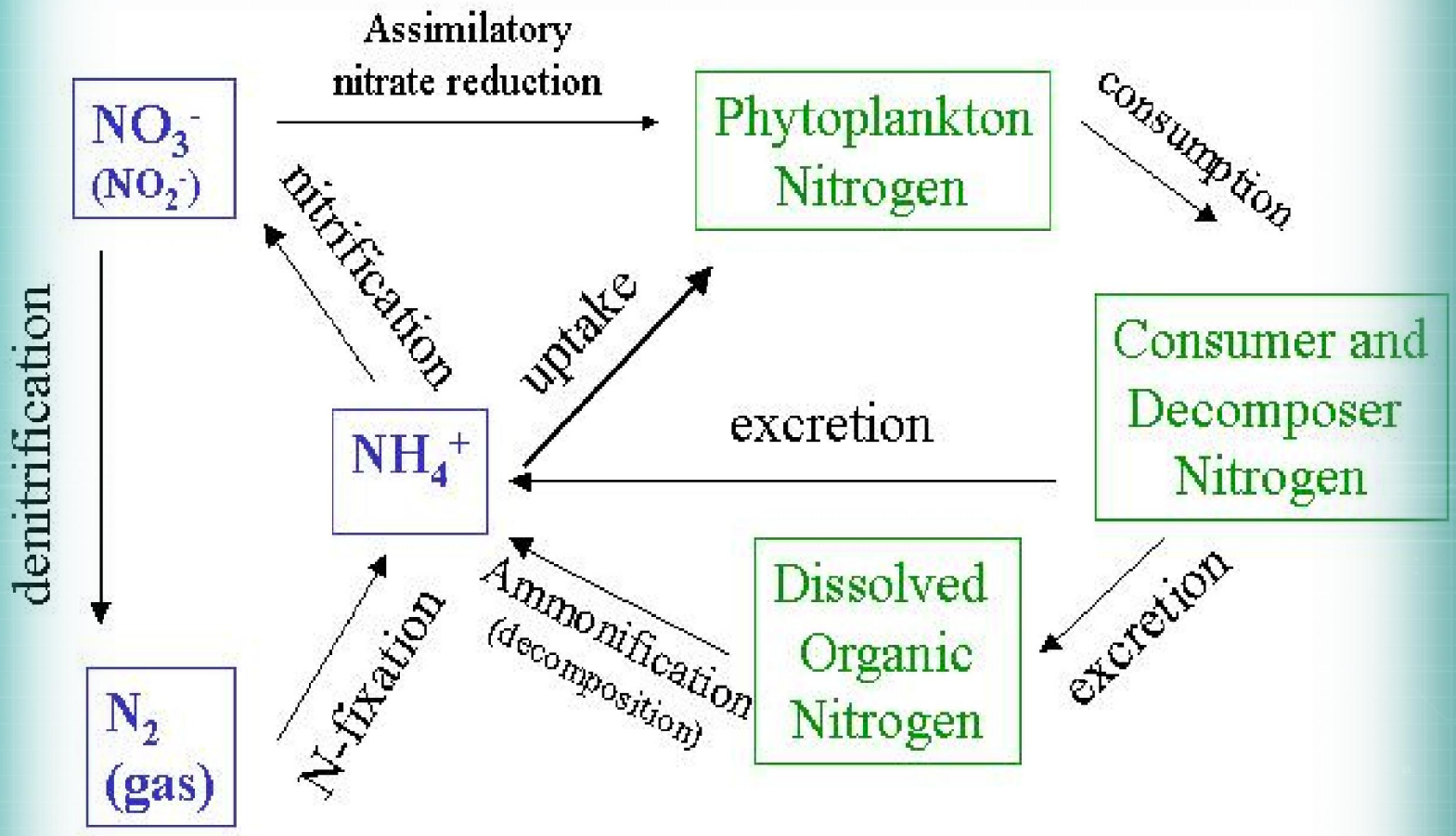






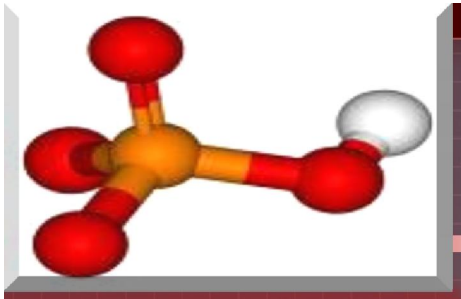


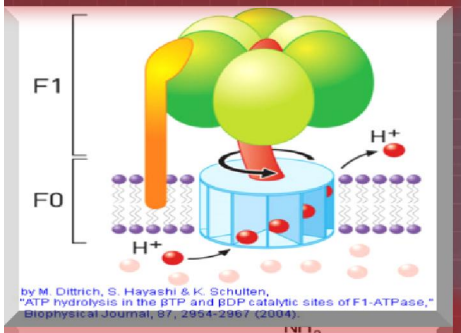
Aquatic Nitrogen Cycle

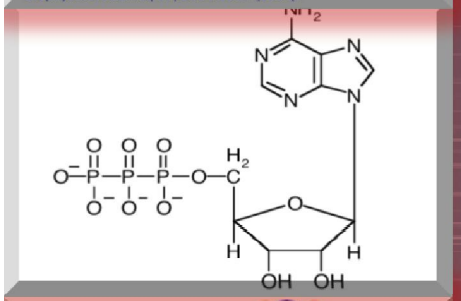


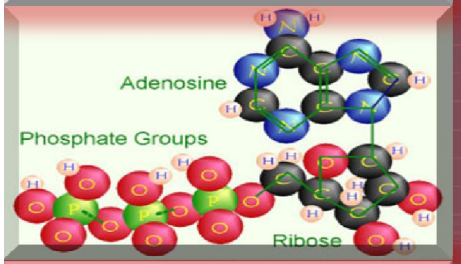
Methods of Estimation of Nitrogen

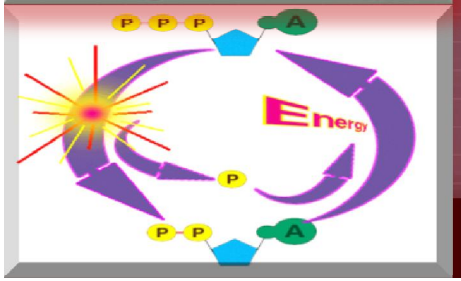
- 1. Ammonia Nitrogen (Nesslerisation/ Probes)
- 2. Nitartes (PDA/ Brucine method)
- 3. Nitrites (Electrode reduction method)
- 4. Organic nitrogen (N analysers)
- 5. TKN (Kjeldahl Digesters)
- 6. Total Nitrogen (Thermal conductivity sensors)



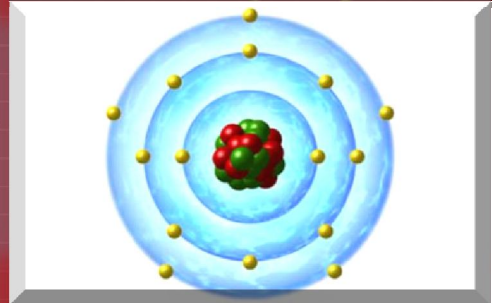








WHAT IS P?



15
P
30.97

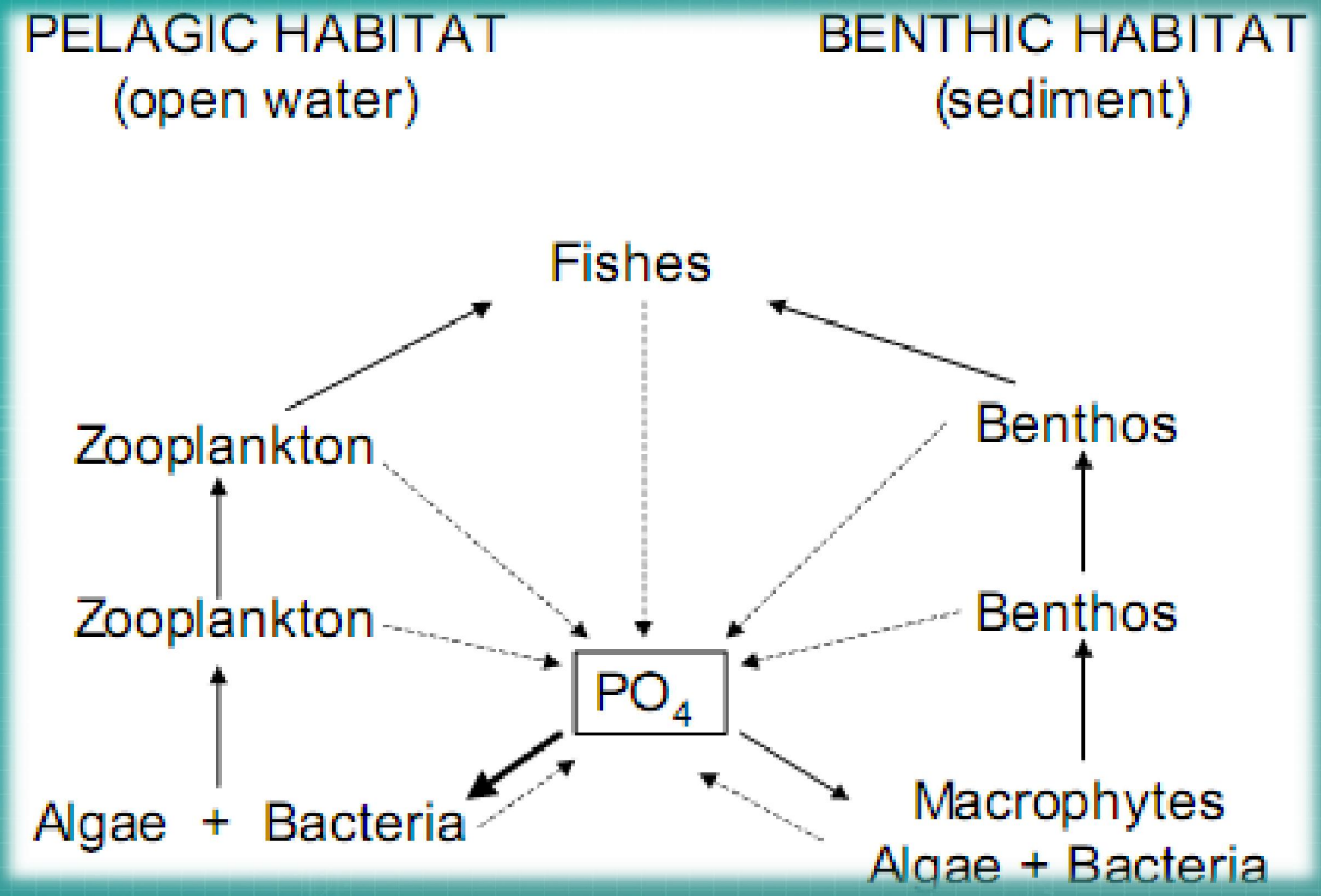
Sources of P:

- Sewage
- Several kinds of soaps, antifreezes and detergents.
- Phosphatic rocks
- Runoff from agricultural land(fertilizers), and latex paints.

Phosphate transformations:

- H_3PO_4 è $H^+ + H_2PO_4^-$
- $H_2PO_4^-$ è $H^+ + HPO_4^{2-}$
- HPO_4^{2-} è $H^+ + PO_4^{3-}$

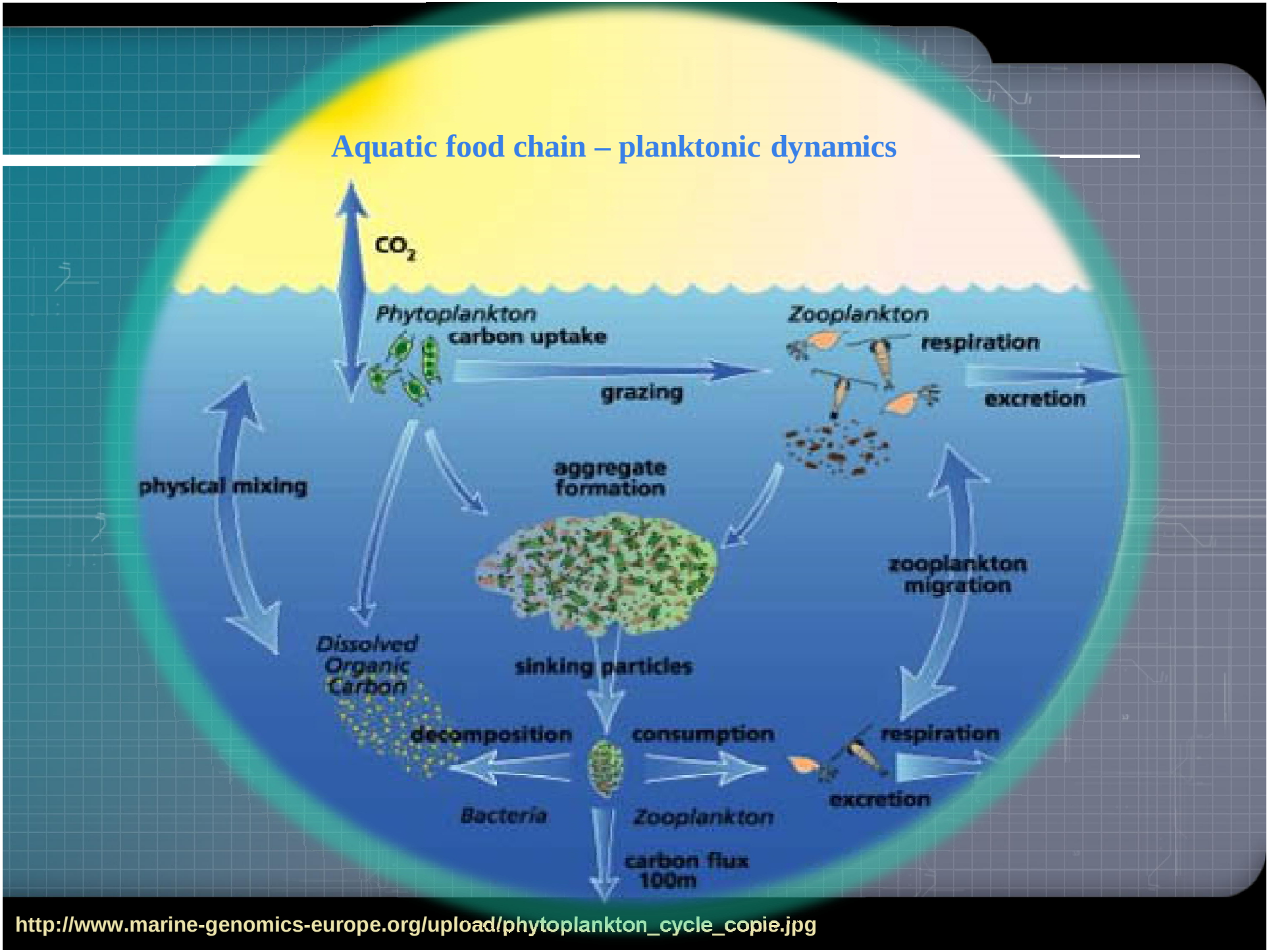
P cycle in Lakes (Aquatic Systems)



Methods of Estimation of Phosphates

- Inorganic Phosphates
  - Ammonium Molybdate Method
  - Vanadomolybdate Method
  -
- Particulate phosphates
- Total phosphate (Persulphate digestion)

Aquatic food chain – planktonic dynamics



http://www.marine-genomics-europe.org/upload/phytoplankton_cycle_copie.jpg

C, N and P dynamics in healthy aquatic systems; Lakes

- In aquatic systems, the C demand for the plants in planktons and plants is essentially maintained by the supply of DIC (dissolved inorganic carbon/ CO2).

  The dissolved inorganic C are in carbonate and bicarbonate forms.

- N forms are mostly present in oxidized conditions near the surface and the middle part, however they are denitrified in the bottom sediments.

- P are present in the form of orthophosphates mostly which are highly soluble and are up taken by planktons, algae and bacteria's.

Change in dynamics due to Anthropogenic perturbations

- **disturbance in c flows & transformations**

- C load to the system:
- The sewage adds a tremendous amount of C load to the system in addition to the existing DIC from the atmosphere, which accelerates the bacterial action as a result of surplus of biodegradable materials.

- Rapid degradation of organic materials requires a large amount of oxygen.(Increase in BOD).

- Depletion in DO leads to inefficient treatment facilities and deterioration of ecosystem.

Disturbances in N transformations

- N in different forms as Organic N, NH_4 N, Urea N. nitrite-N and nitrate-N enters the system, and imparts enormous nutrient loads to the aquatic system.

- Increase in macrophyte and algal growth à competition for nutrients.

- Increased algal and plant matter deposition and decomposition, further enhancing BOD and hence eutrophication è anoxic conditions

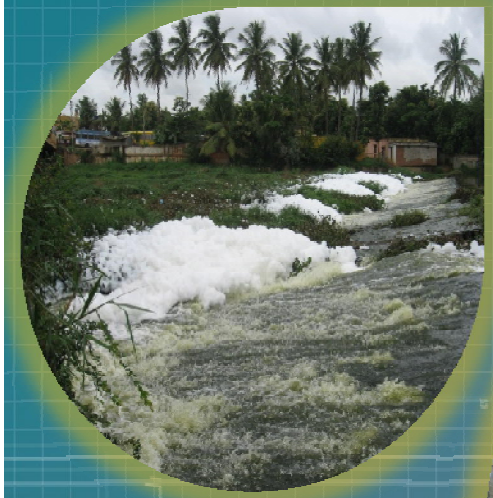
Disturbances in P transformations

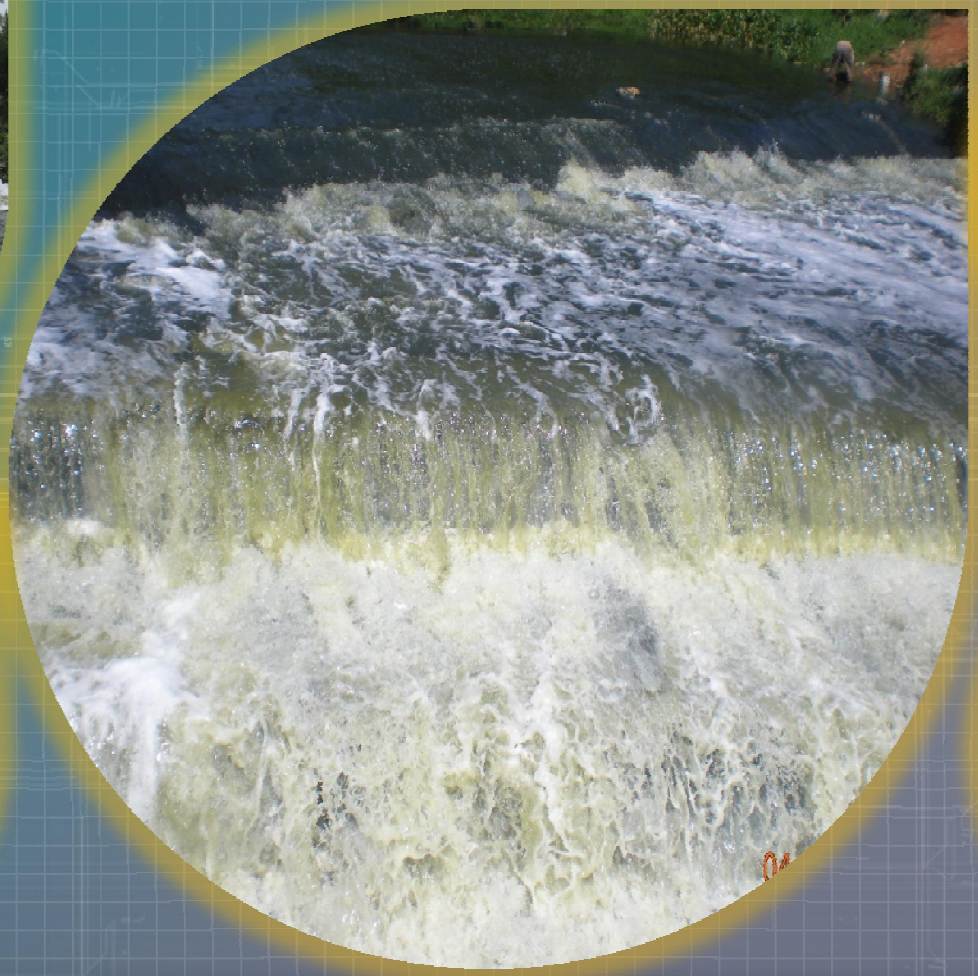
- Phosphates gets into the system from domestic waste (human waste), detergents and also from runoff from agricultural fields.
- A major fraction of the Phosphates are present in soluble orthophosphate forms, which are readily uptaken by the planktons, macrophytes and bacteria's as nutrients.
- Quantum of P increases, it enhances eutrophication, with the increase in particulate organic matter PO_4^{3-} is adsorbed over them; settling of dead algae and macrophytes and settles with increased oxidized conditions and forms huge deposits in the sediments.
- Due to turbulence and reducing conditions again it resuspends back and helps in algal blooms.

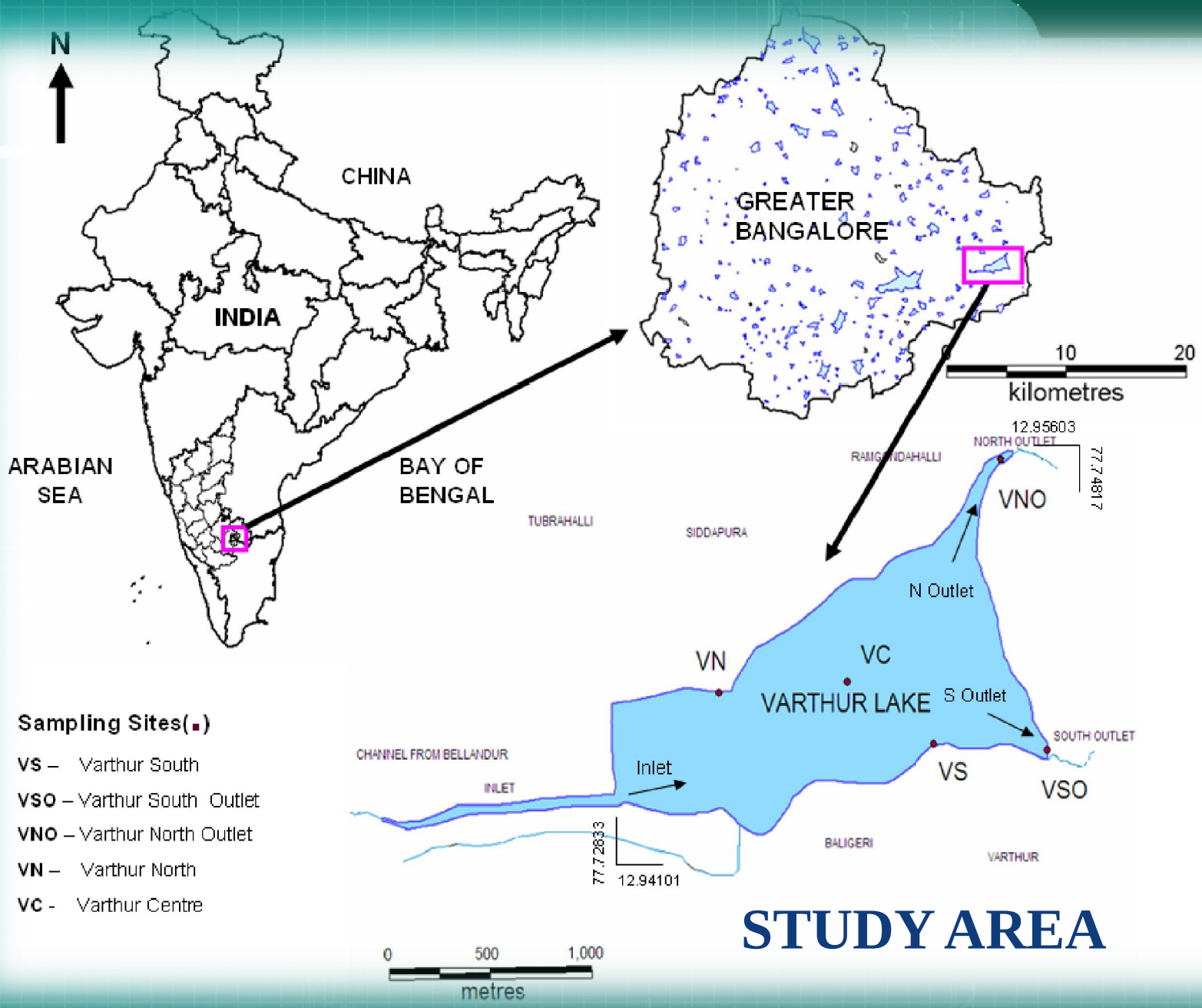
Effects of domestic wastewater (Detergents)

- All detergents destroy the external mucus layers & gills.
- 15 ppm detrimental, 5 ppm fish egg dies.
- Surfactants decrease the breeding ability of aquatic organisms.
- Lowers the surface tension of the water.
  (Pesticides and phenols)
- 2 ppm enables a fish to absorb double the concentration.
- Phosphates in detergents can lead to freshwater algal blooms that releases toxins and deplete oxygen in waterways.
- When the algae decompose, they use up the oxygen available for aquatic life.(Lowers DO)

Case study : Varthur Lake







Sampling Sites(▪)

VS – Varthur South

VSO – Varthur South Outlet

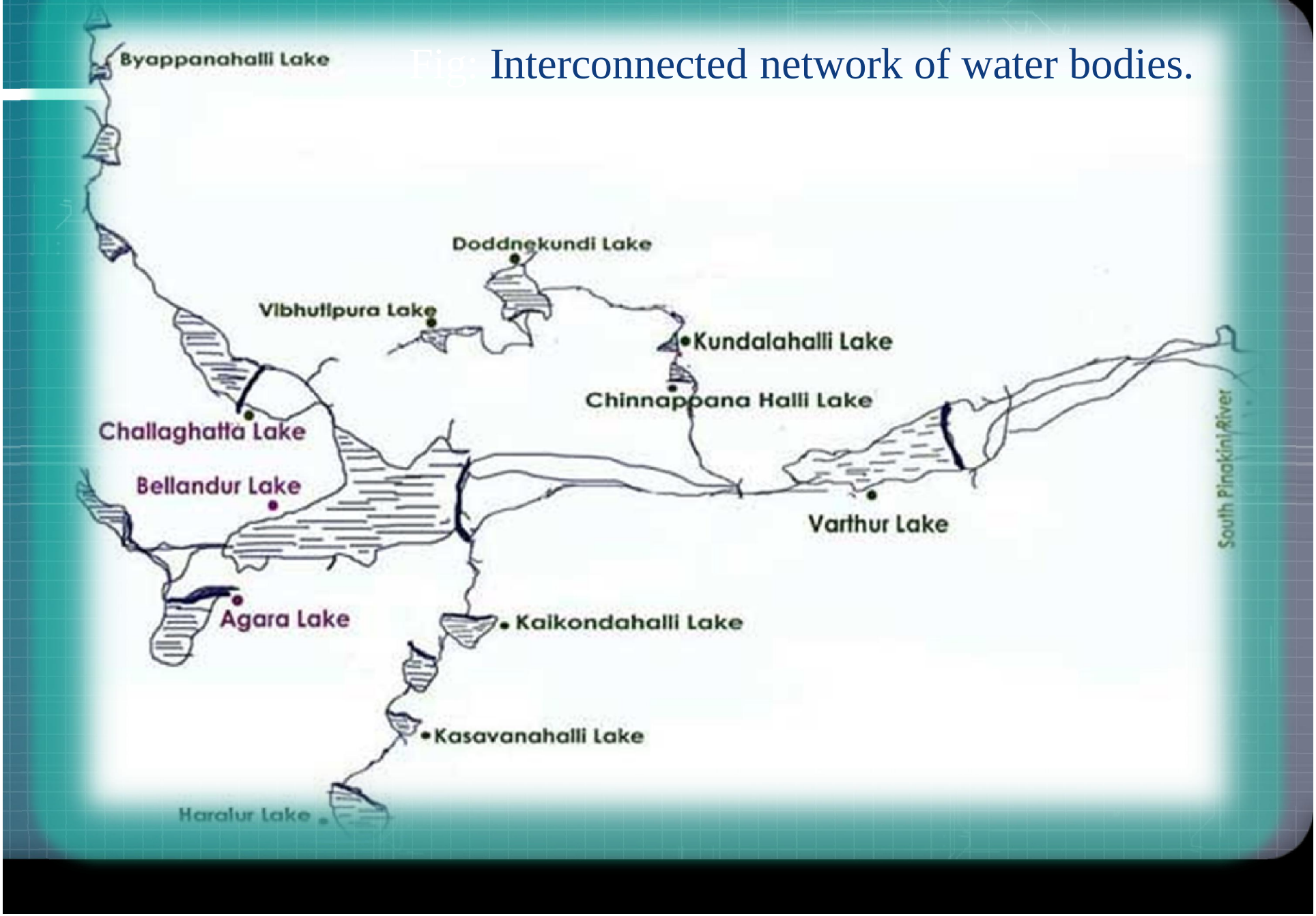
VNO – Varthur North Outlet

VN – Varthur North

VC - Varthur Centre

STUDY AREA

Fig: Interconnected network of water bodies.



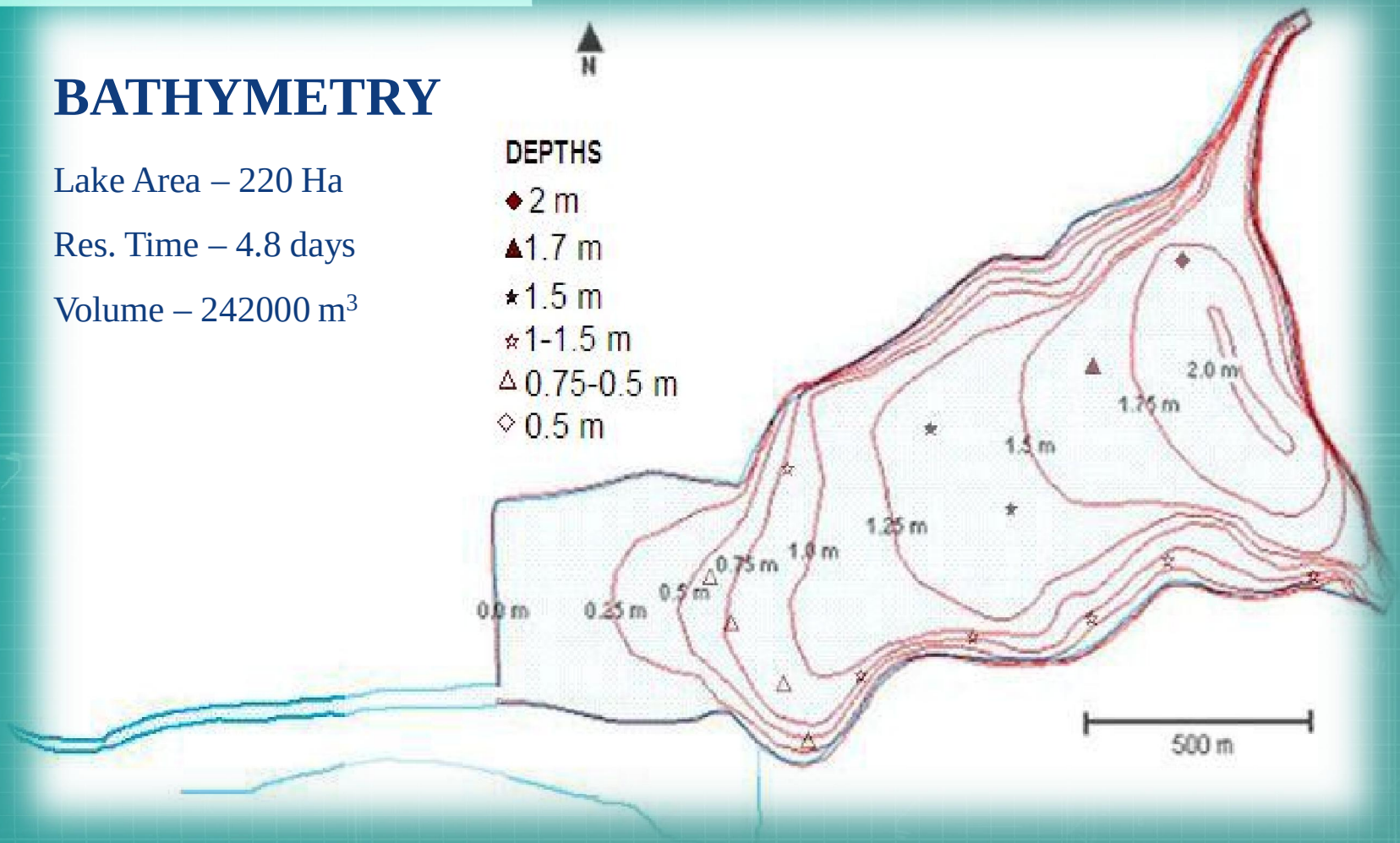

Lake Monitoring :
Physico-chemical
&
Biological
Analysis

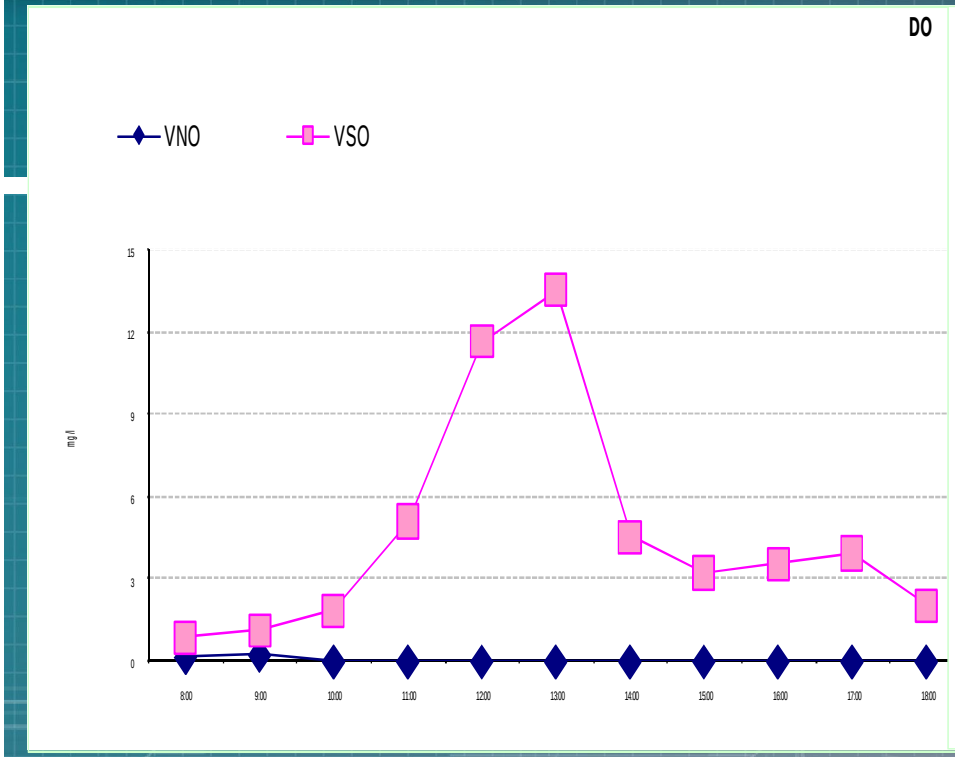
BATHYMETRY

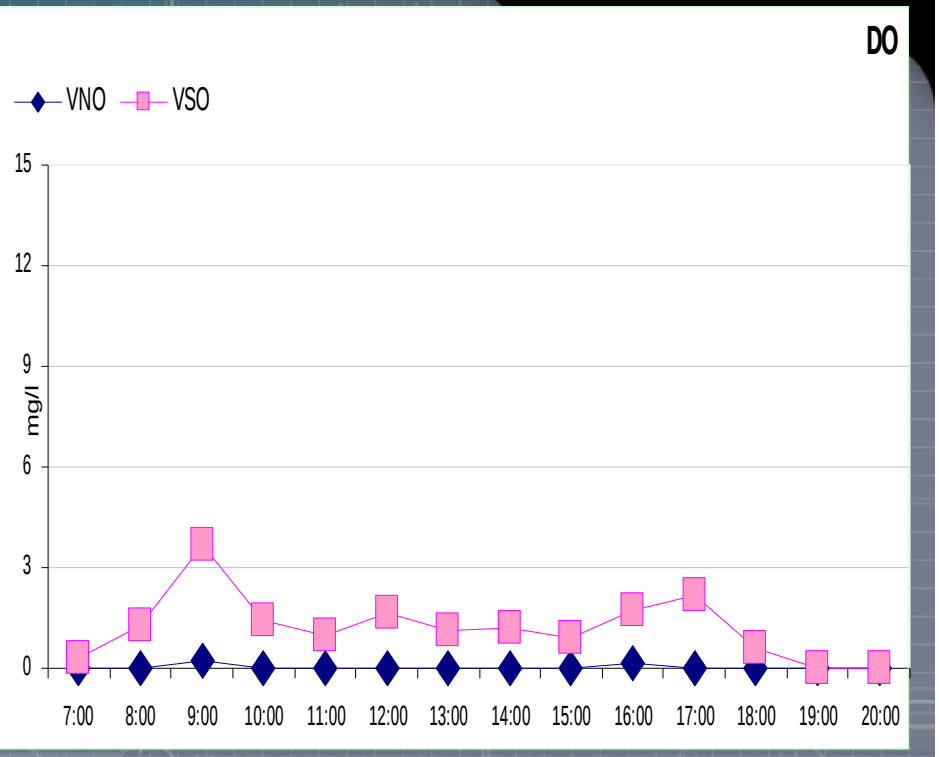
Lake Area – 220 Ha

Res. Time – 4.8 days

Volume – 242000 m^3



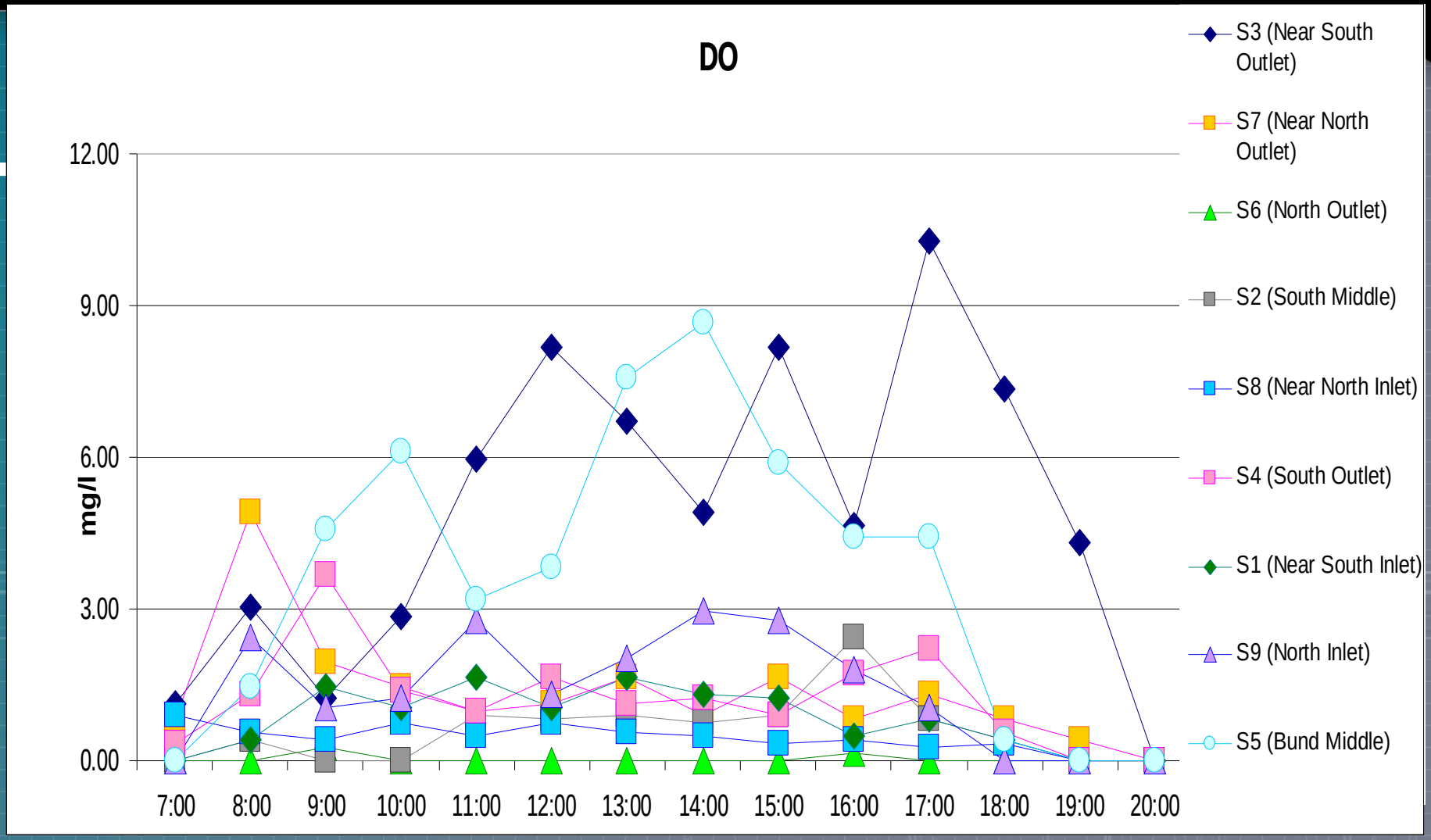




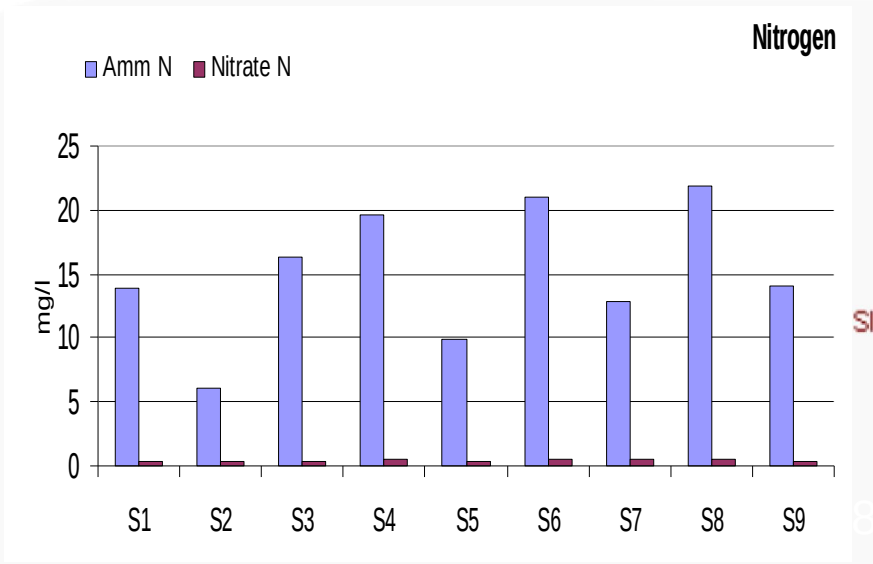
Dissolved Oxygen

DO pattern in Jan 09 (left) when the water flow was uninterrupted and free from macrophytes and in April (right) where there was large cover of Macrophytes

DO level reaching supersaturation due to optimum algal photosysnthesis during the mid-day but presence of macrophytes reduces photosynthesis and air-water interface for gaseous exchange bringing down DO to almost about 1 mg/l.

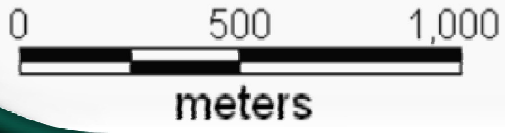


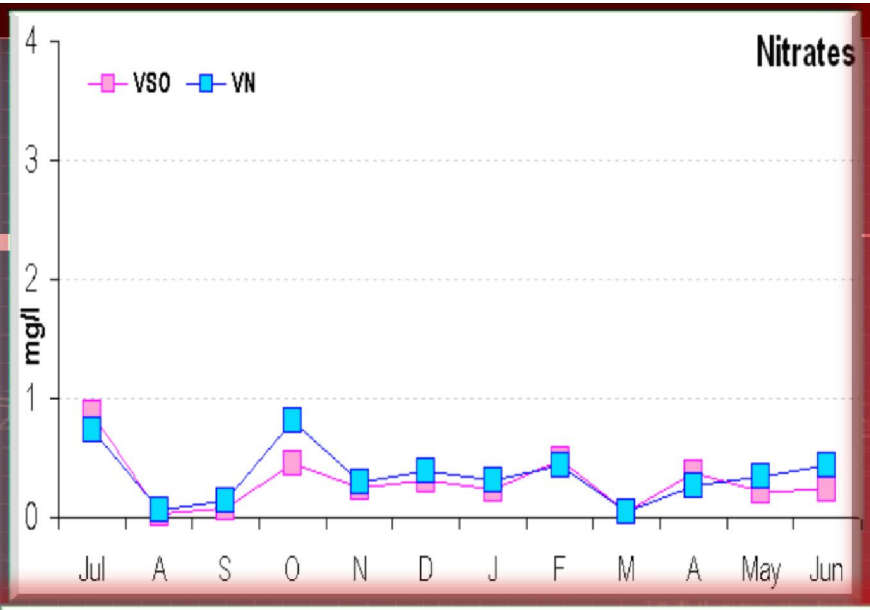
§ Impact of macrophyte cover is evident - implicating critical DO (hypoxic) conditions at the inlet and middle parts but a intermediate amount was observed near the outlets.

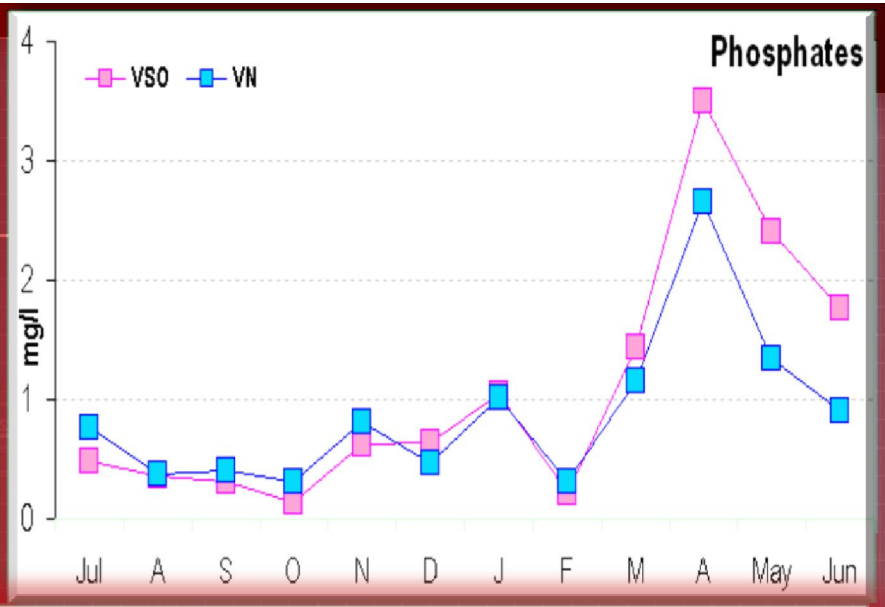


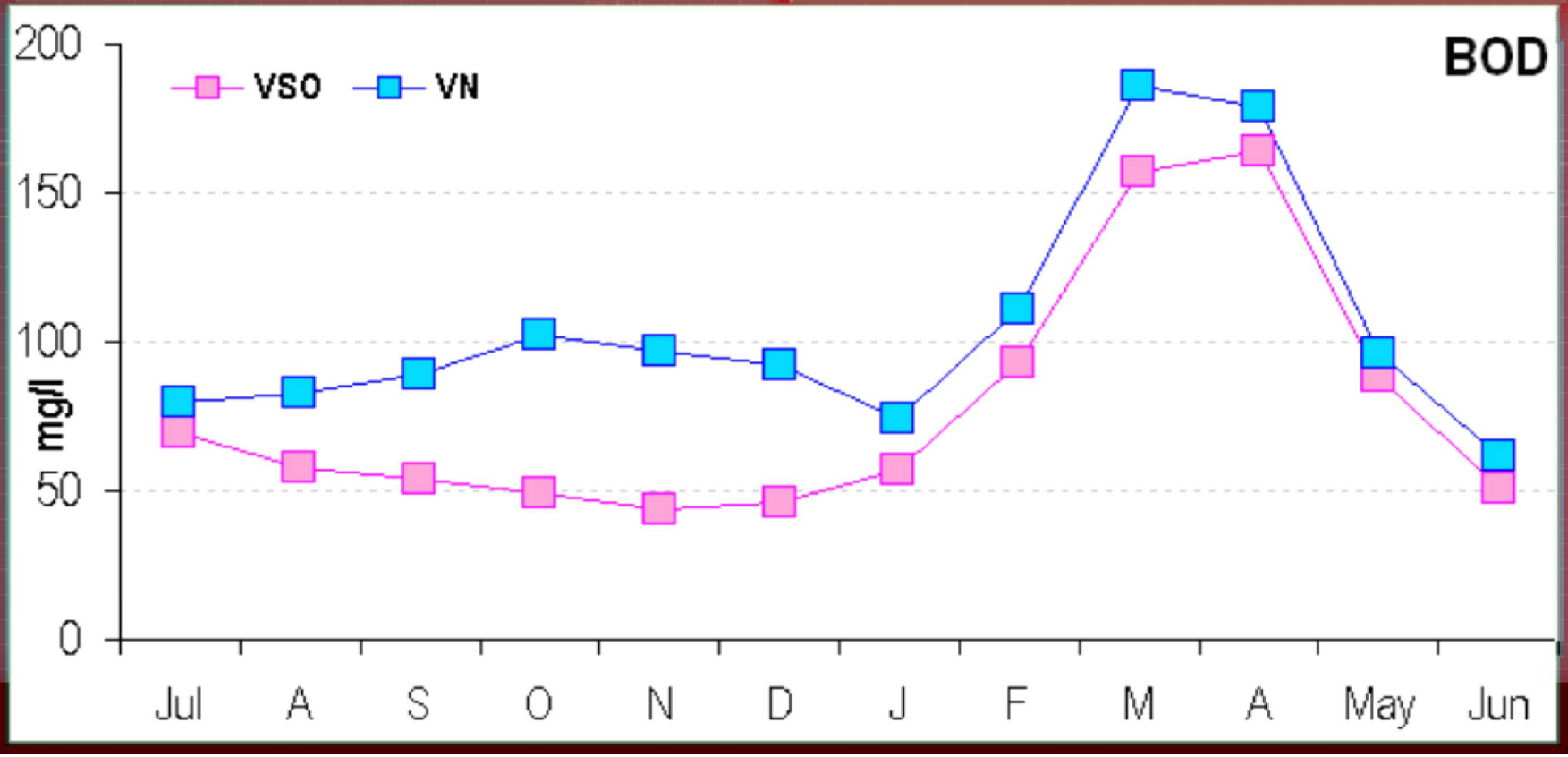
Ammoniacal N much higher in proportion to nitrate N -

- anaerobic conditions , less prevalence of oxidised states of N.




Nitrates
VSO
VN
mg/l
4
3
2
1
0
Jul
A
S
O
N
D
J
F
M
A
May
Jun


Phosphates
VSO
VN
mg/l
4
3
2
1
0
Jul
A
S
O
N
D
J
F
M
A
May
Jun


BOD
VSO
VN
mg/l
200
150
100
50
0
Jul
A
S
O
N
D
J
F
M
A
May
Jun

Microscopic identification of microalgae :

Chlorophyta	Cyanophyta	Bacillariophyta	Euglenophyta
Chlamydomonas Chlorogonium Ankistrodermus	Cylindrospermopsis Arthrospira Microcystis	Gomphonema Melosira Navicula Pinnularia Nitzschia Synendra Cyclotella Hantzschia Sellaphora	Phacus

The species shown belong to the class Bacilariophyceae which are pollution resistant species found to be abundant in Varthur lake.

***Gomphonema*:** They occur in a wide range of freshwater bodies especially those enriched with sewage.

***Navicula*:** They are very common in eutrophic to hypereutrophic fresh waters with high electrolyte content and tolerant to strongly polluted conditions. Known to have a very high lipid content.

***Nitzschia*:** They are common in eutrophic and hypereutrophic waters and tolerant to extremely polluted conditions. Important in lipid point of view

Pinnularia

Navicula

Gomphonema

Nitzschia