# Biotechnology for the decontamination of Metal Wastes

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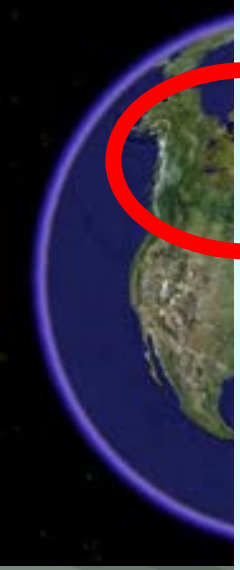

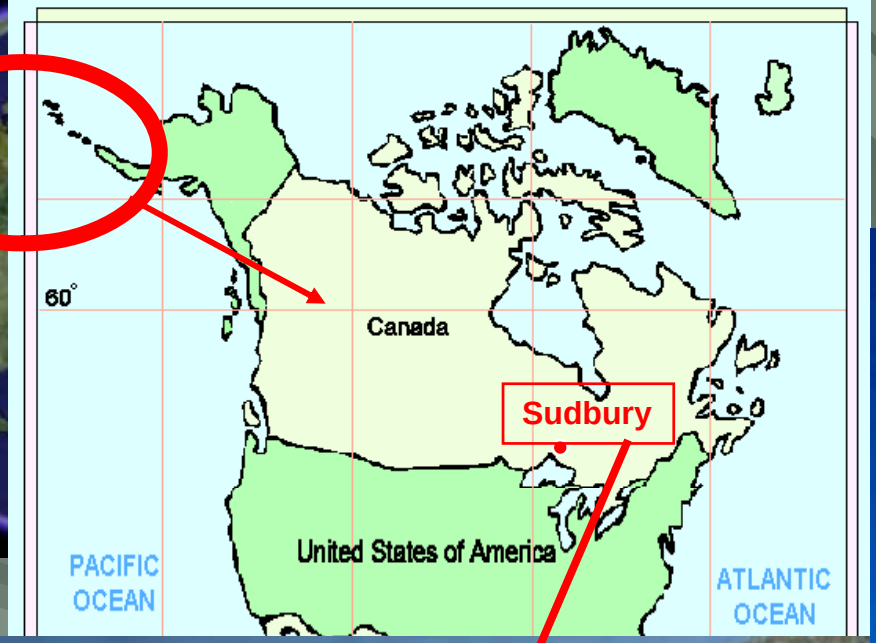


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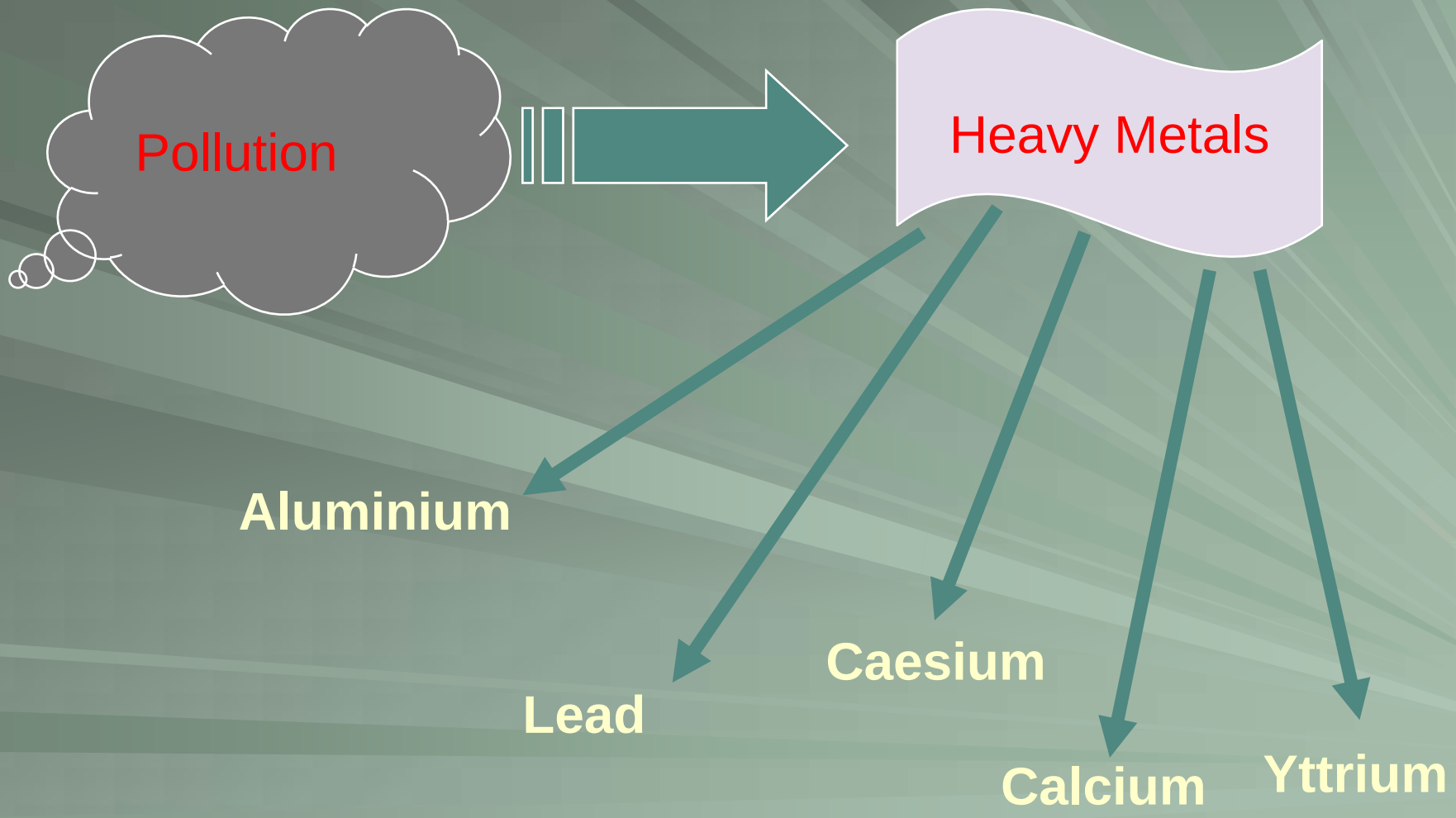
# Problem:


Pollution
Heavy Metals
Aluminium
Lead
Caesium
Calcium
Yttrium

# Accumulation of metals in living systems

## METAL ACCUMULATORS

| | Plants | Animals |
|---|---|---|
| a) Mn | Ferns | Marine crustacea |
| b) Ni | Alyssium sp. | |
| c) Sr | Brown algae | Acantharia |
| d) V | Brown algae | Coelenterates |
| e) Zn | Thlaspi calaminare | Coelenterates |

# Biological Effects

**Mode of toxicity and interaction with cells.**

i) **Membranes ->** **altered membrane fluidity**
**phospholipid constituents**

ii) **$Ca^{2+}$ metabolism and calmodulin**

iii) **Iron metabolism -> transferrin**

iv) **DNA and $Al^{3+}$**

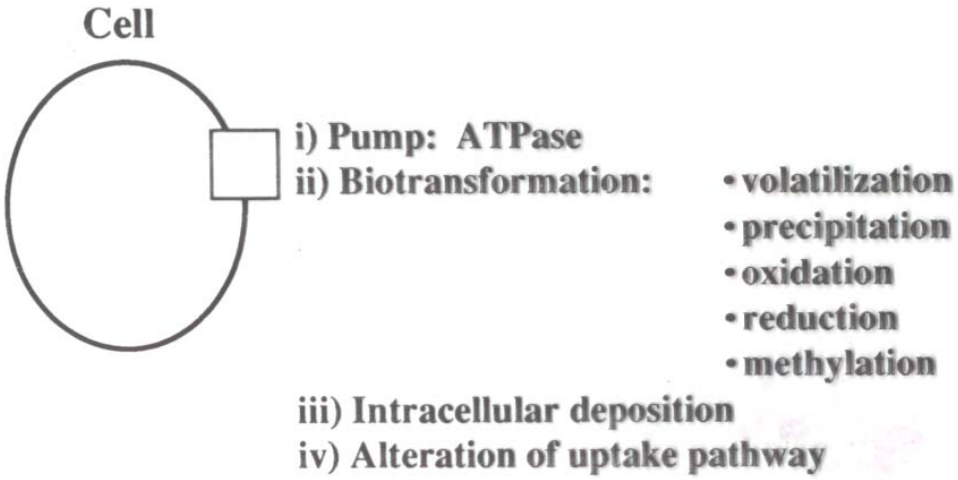
v) **Signal transduction mechanism "phosphoinositide"**

vi) **Tubulin**

vii) **Decrease glucose utilization**

# Adaptation

## GENERAL ADAPTATION MECHANISMS

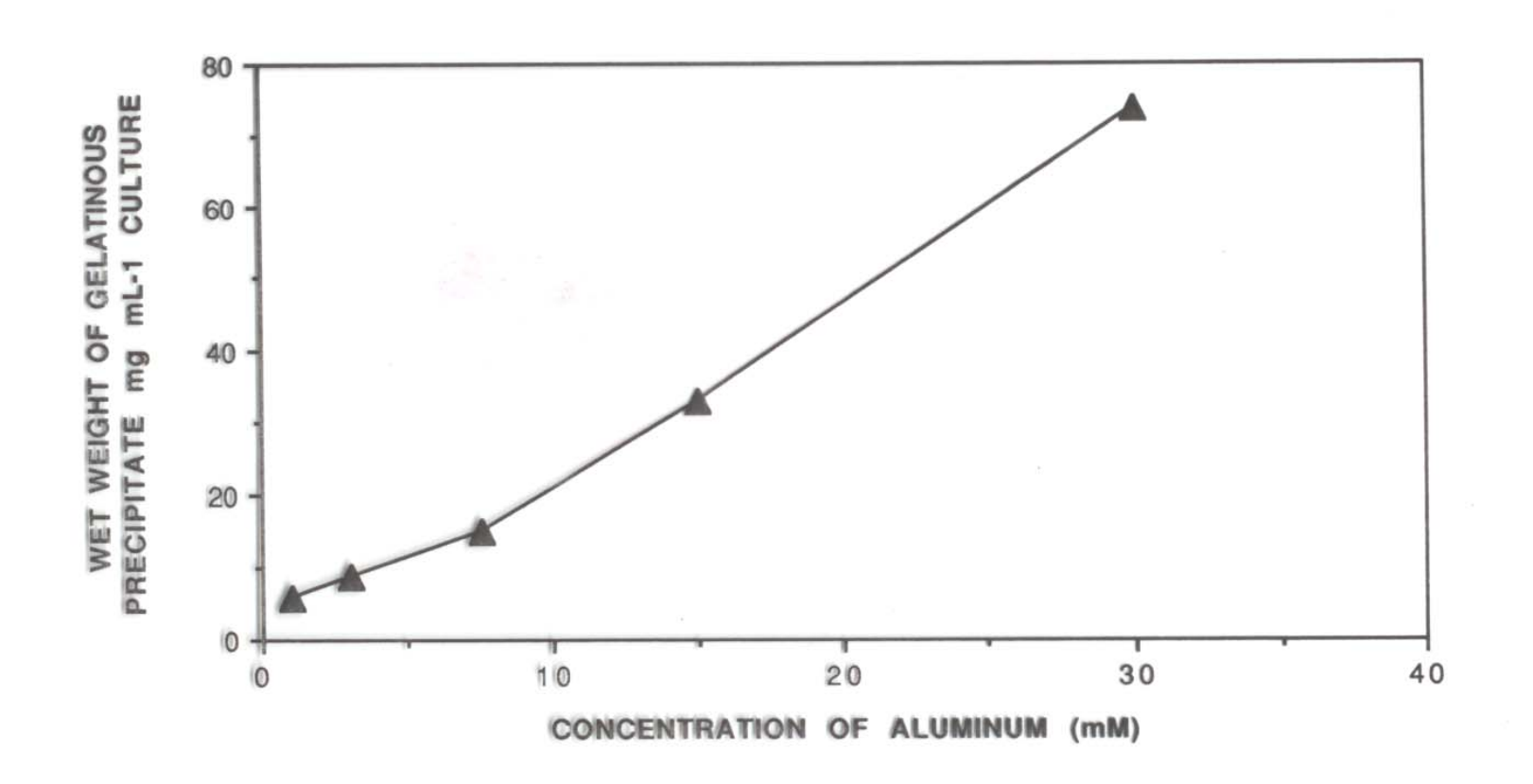


# Aluminium Stress on biological systems

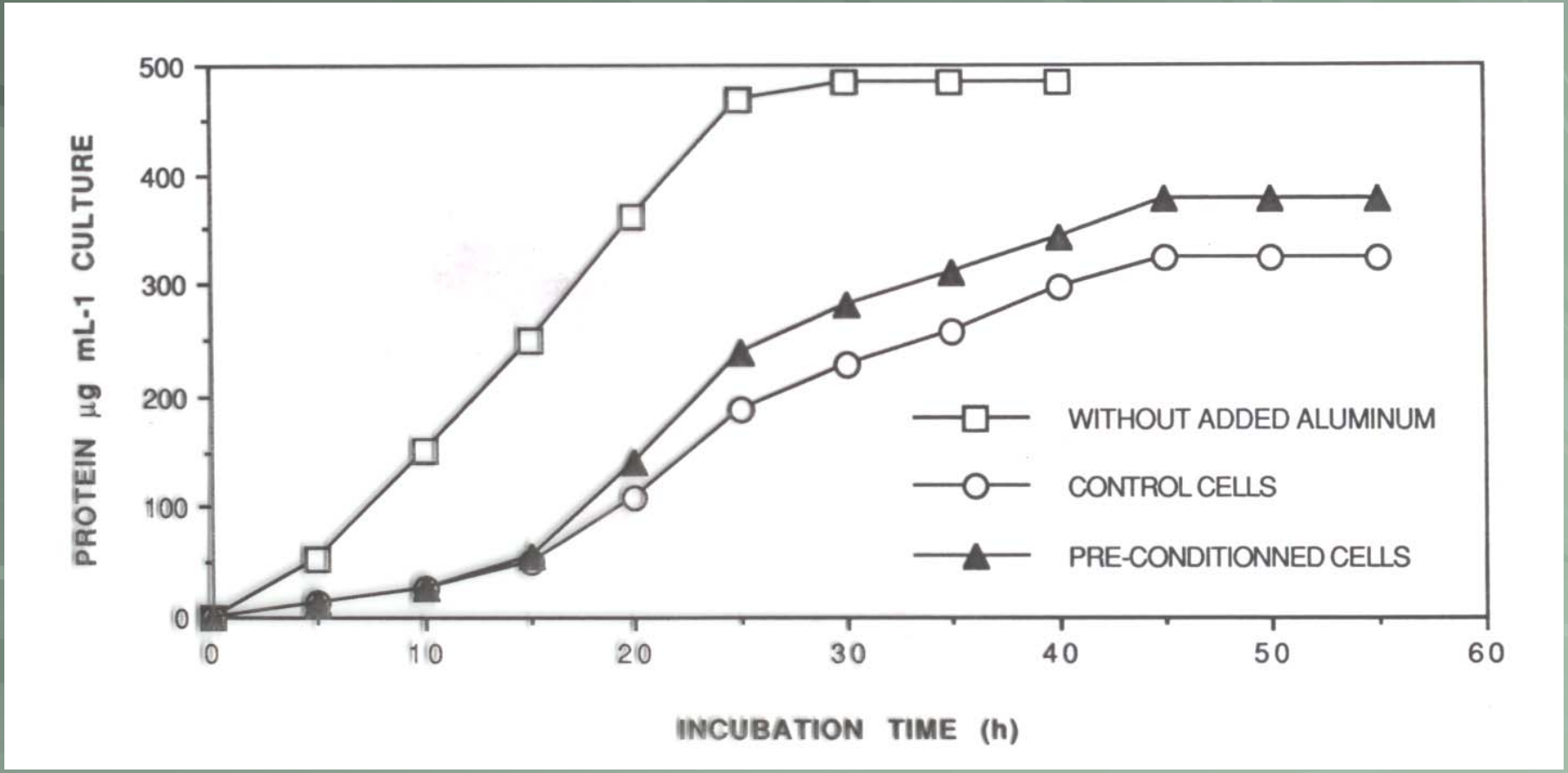
| STRESS | CELL | ADAPTATION |
|---|---|---|
| $Al^{3}$ | ----> | -----> Phospholipide (PE), aluminophore |
| $Fe^{3+}$ | ----> | -----> Hydroxides de fer, PE |
| $Ca^{2+}$,$Sr^{2+}$ | ----> | -----> $CaCo_3$, $SrCO_3$ |
| $Ga^{3+}$, $Zn^{2+}$ | ----> | -----> Peptides et protéines |
| $Y^{3+}$ | ----> | -----> Bioaccumulation |
| $In^{3+}$ | ----> | -----> $InPO_4$ |

Al, Ca, Fe, Zn, Ga ---------> Précipitation, (PE)

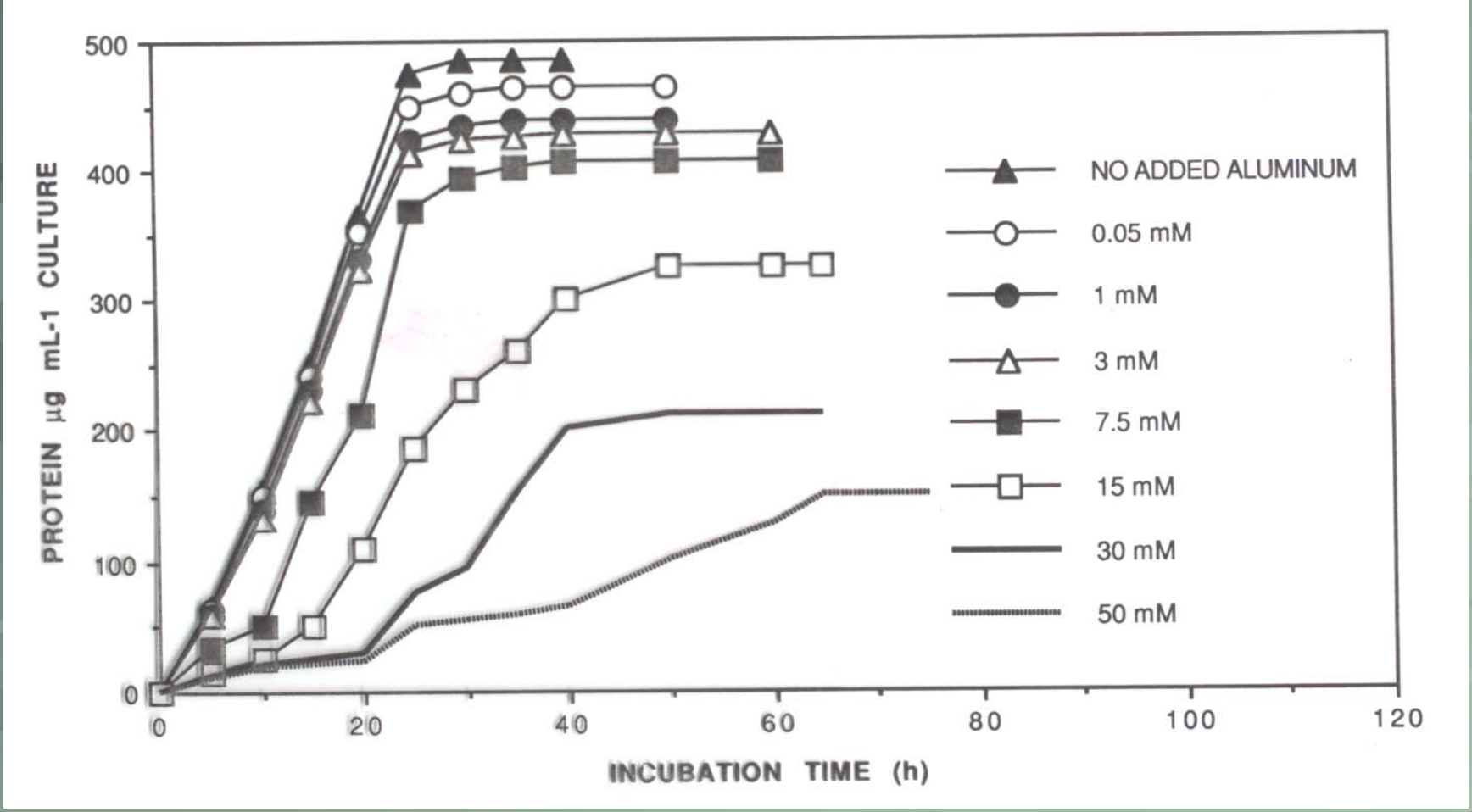
# Influence of Aluminum concentration on the weight of the gelatinous residue



# Preconditioned Cell Growth in 15mM Aluminium



# Growth profile in varying concentrations of Aluminium.



# Insolubilization of Al

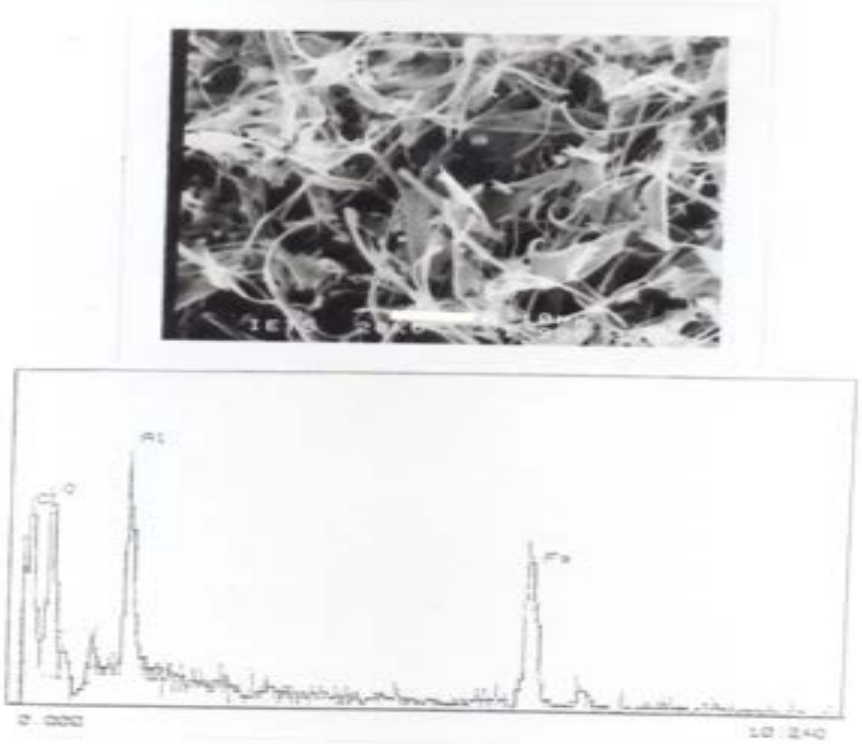
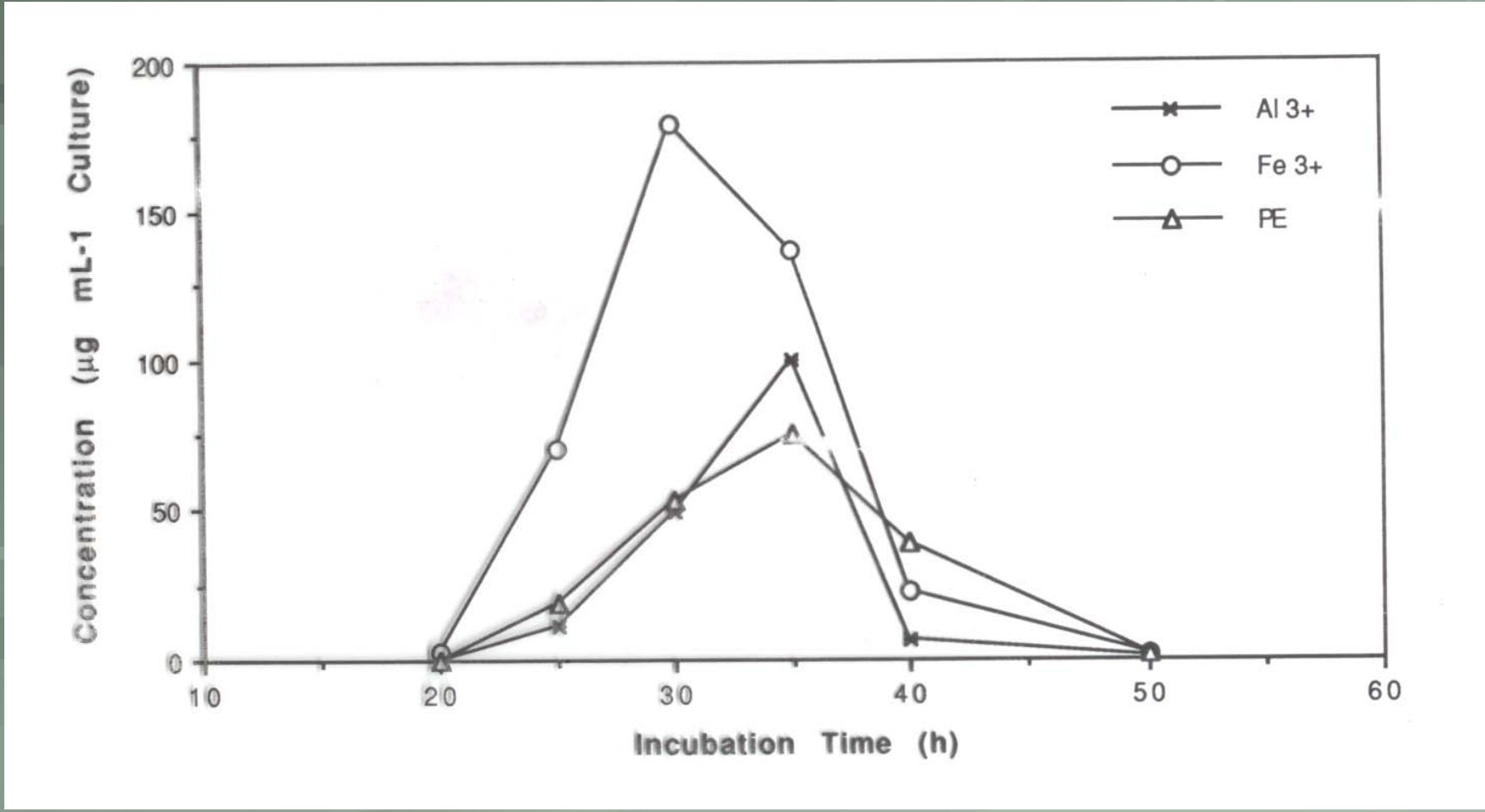
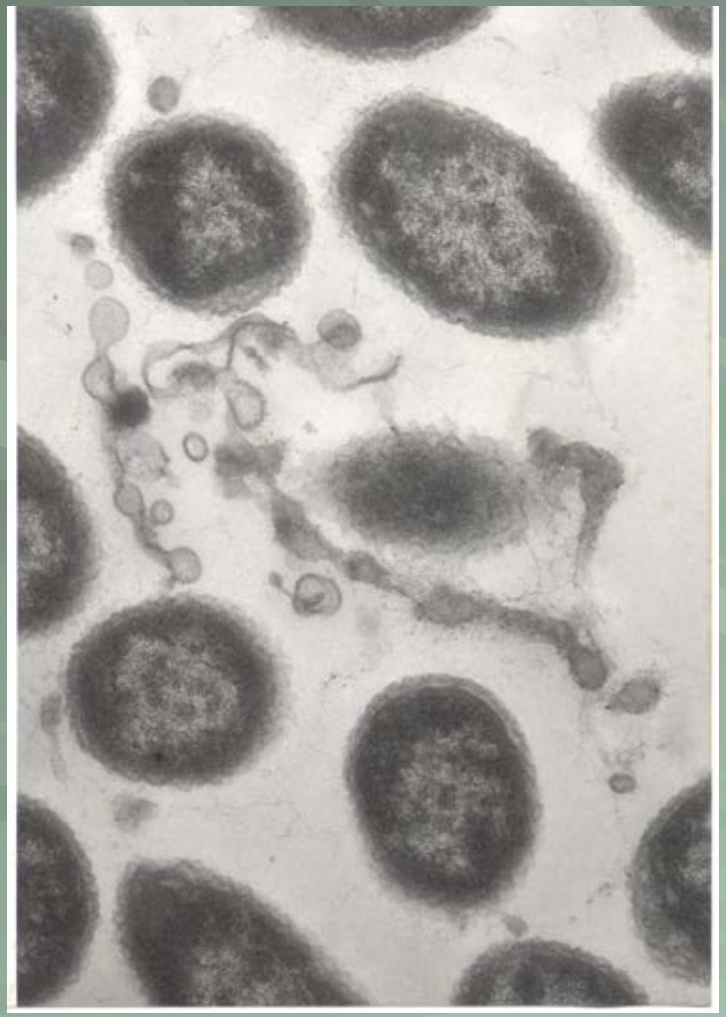


Figure 25 Scanning electron micrograph of the dialysate obtained from the spent fluid at 30 h of growth. Note the nodule-like structures. The bar represents 10 μm.

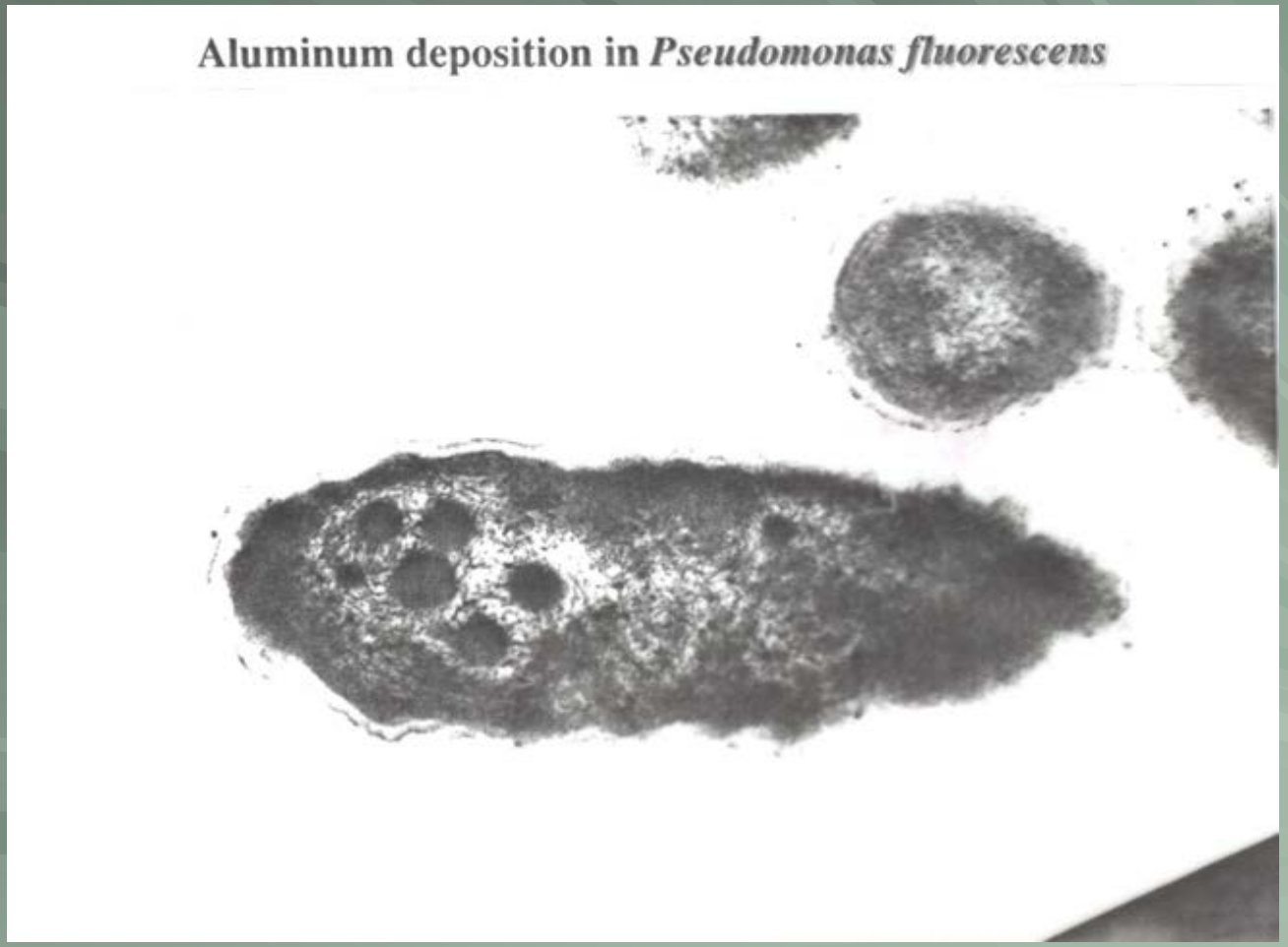
# Aluminum, Iron, and PE Isolated by ultra-centrifugation from multiple-metal culture



# SEM: Deposition of Al



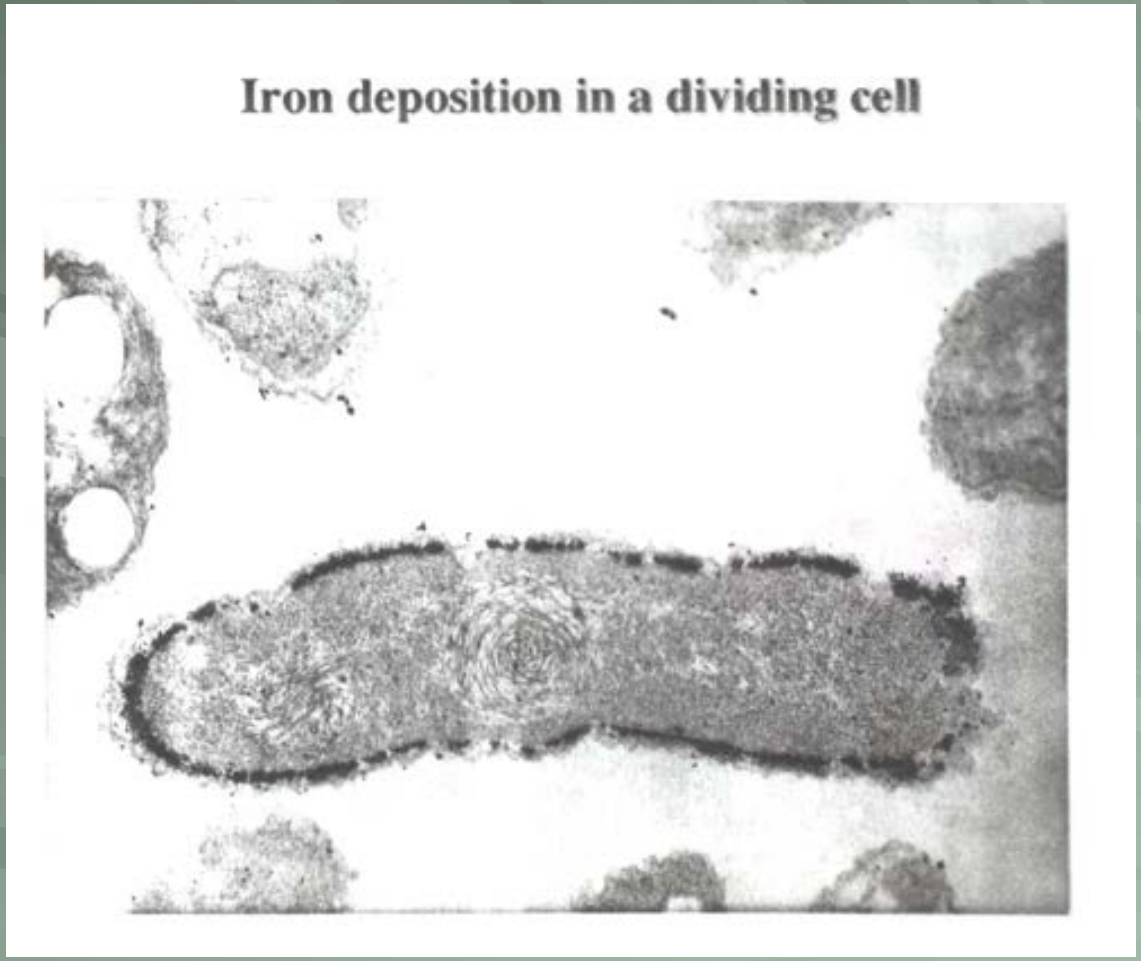
# Intracellular accumulation of Al



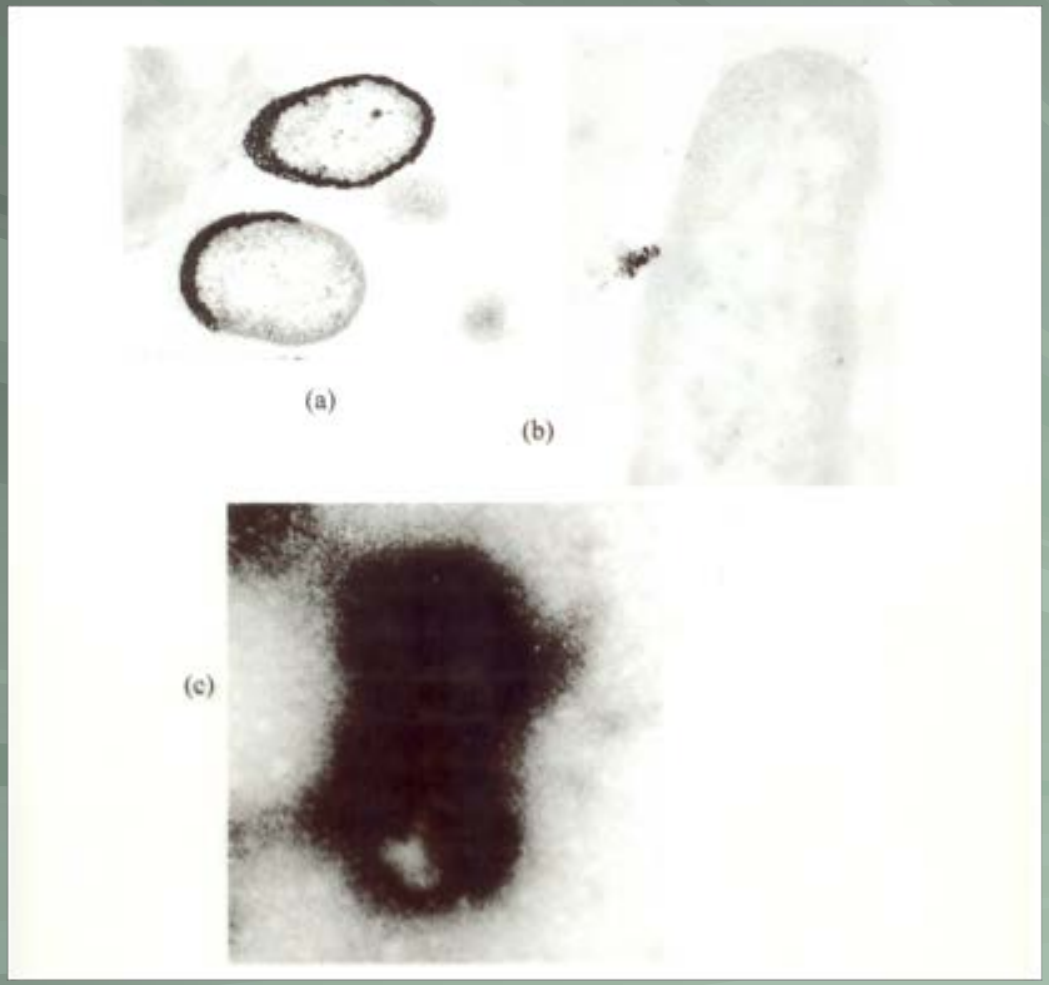
# AI in ***P.fluorescens***

# Gelatinous deposit of Al & Fe

# Fe deposition in P.fluorescens



# Membrane-assisted secretion of Metals in P.fluorescens



# Metabolomic Study

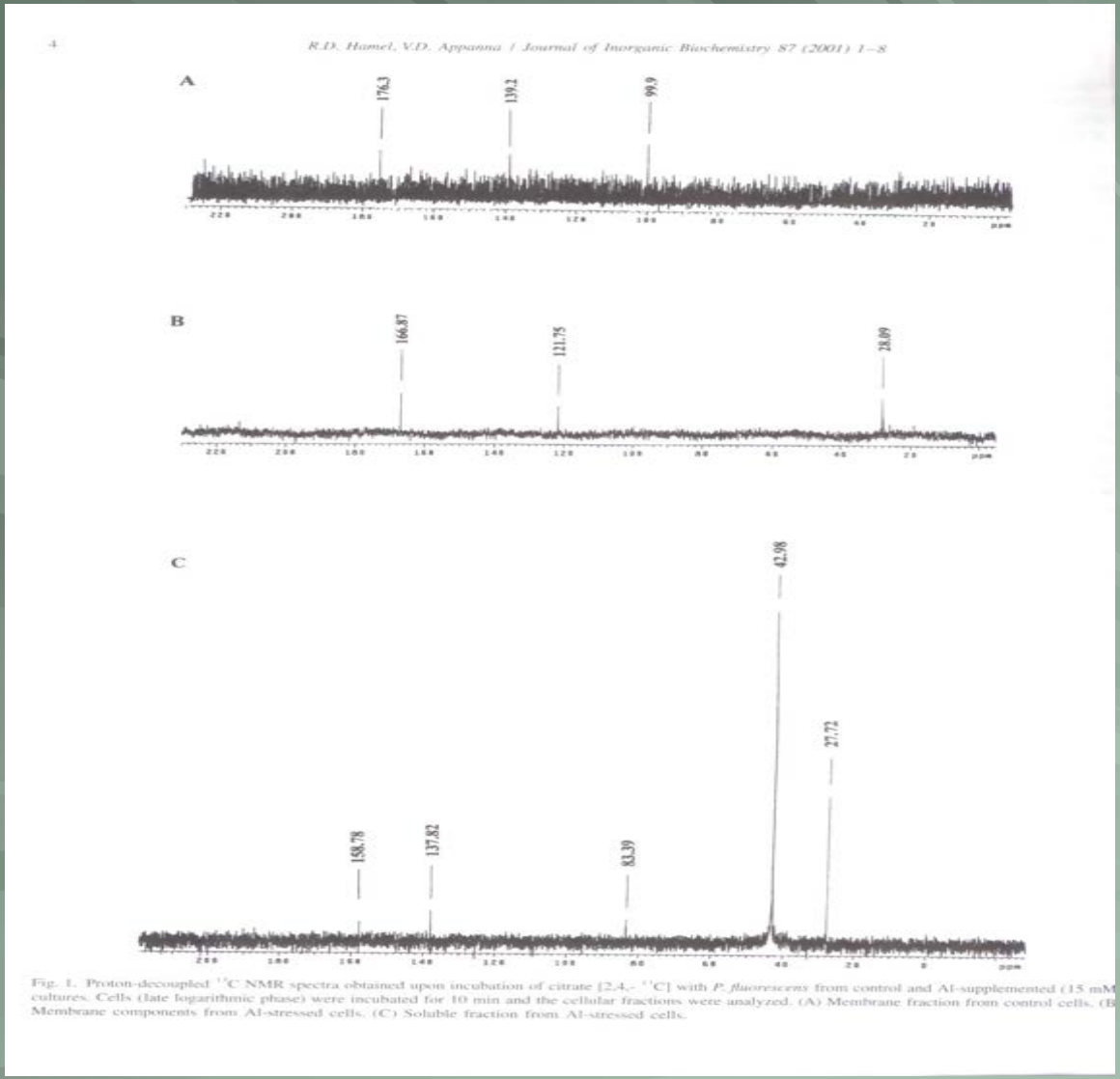
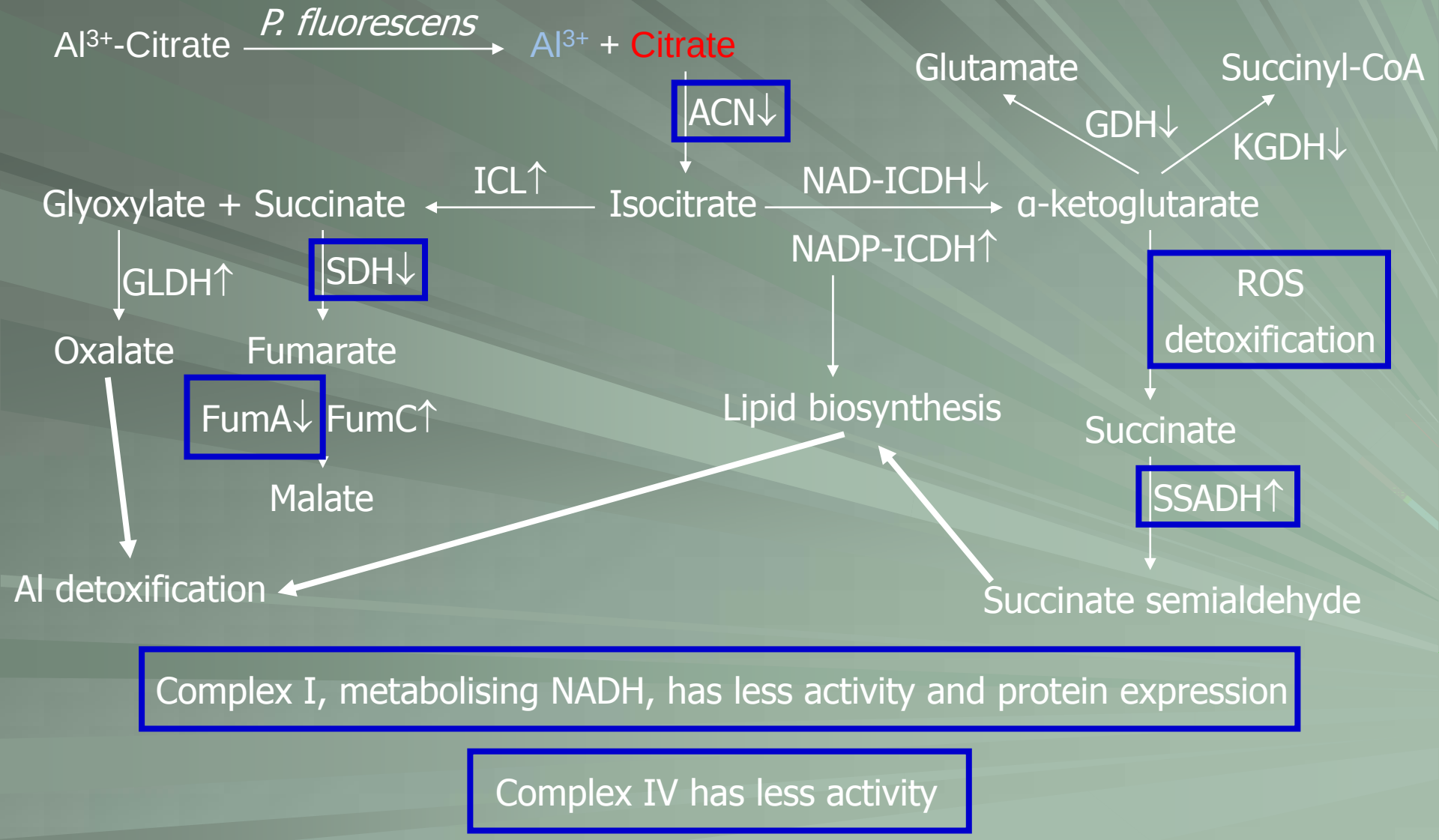



Fig. 1. Proton-decoupled $^{13}C$ NMR spectra obtained upon incubation of citrate [2,4,- $^{13}C$] with *P. fluorescens* from control and Al-supplemented (15 mM
cultures. Cells (late logarithmic phase) were incubated for 10 min and the cellular fractions were analyzed. (A) Membrane fraction from control cells. (B
Membrane components from Al-stressed cells. (C) Soluble fraction from Al-stressed cells.

# Global metabolic network evoked by Al stress




Complex I, metabolising NADH, has less activity and protein expression

Complex IV has less activity