City of Summerside

Prince Edward Island, Canada

Waste Water Treatment Plant Overview and Tour

Outline

- Definitions
- Chronology
- BNR Process Description
- Plant Performance
- Site Photos

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Definitions

- SWPCC: Summerside Water Pollution Control Centre

- Activated Sludge: Suspended growth treatment process utilizing micro-organisms to treat waste in a series of process reactors and settling tanks. Settled sludge or activated sludge is then recycled to the start of the process.

- BNR : Biological Nutrient Removal. Activated sludge process incorporating the use of aerated zones, un-aerated zones and internal recycles.

Definitions

- PAO: Phosphorus Accumulating Organism are microorganisms (bacteria) that uptake and store orthophosphate in excess of their biological requirements.

- BOD: Biochemical Oxygen Demand is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period.

- TSS : Total Suspended Solids is the amount of insoluble solids floating and in suspension in the wastewater

Chronology

Primary Treatment > Tertiary Treatment

- 1972 SWPCC constructed as a primary treatment plant
- 2003 Design team of Delcom & CBCL
- 2005 Pre-design study; BNR is chosen.
- 2006 Design complete, project goes to Tender
- 2006 June construction start-up
- 2007 December substantial completion
- 2008 December plant in full operation

SWPCC – Key Facts

- Capacity for approximately 18,175 people
- Construction Cost = 19 Million
- Average Daily Flow = 11,675 m^3/day (3 mgd)
- Potential High Flow = 39,000 m^3/day (7,150 gpm)
- BOD = 260 mg/L & TSS = 180 mg/L

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What is a BNR?

(Biological Nutrient Removal)

...wastewater treatment methods that utilize biological mechanisms, instead of chemical mechanisms, to remove phosphorus and nitrogen from wastewaters.... (Randall et. al.)

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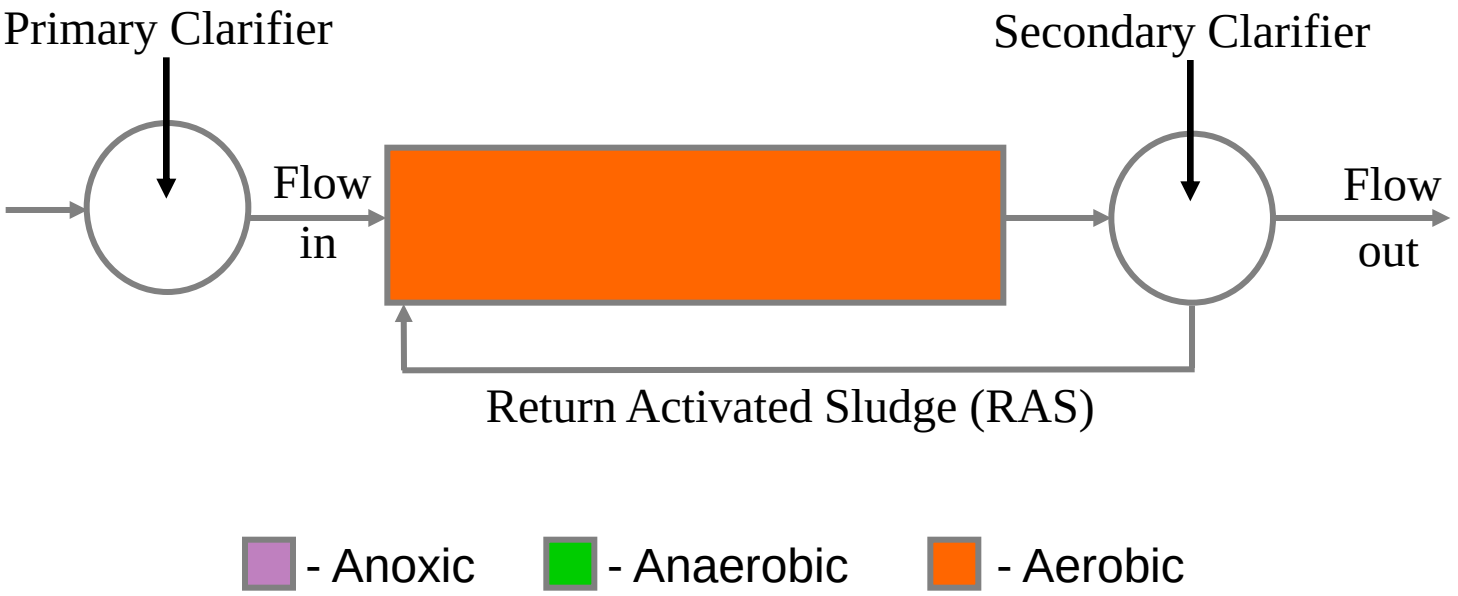
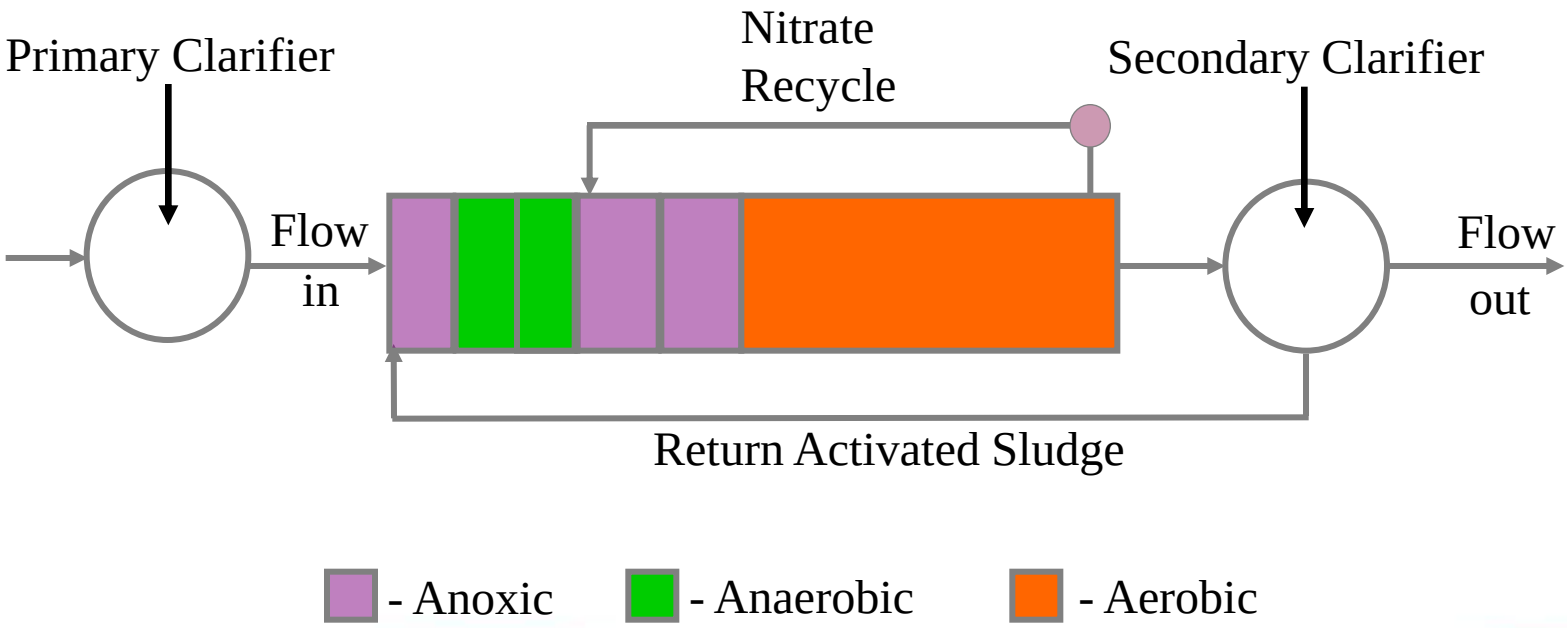
Conventional Activated Sludge Process



BNR - Modified Johannesburg Process

Process used at SWPCC



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Process Reactor Zones

- Anoxic Zone: No dissolved oxygen added; microorganisms utilize nitrate and organic carbon. Majority of denitrification occurs.

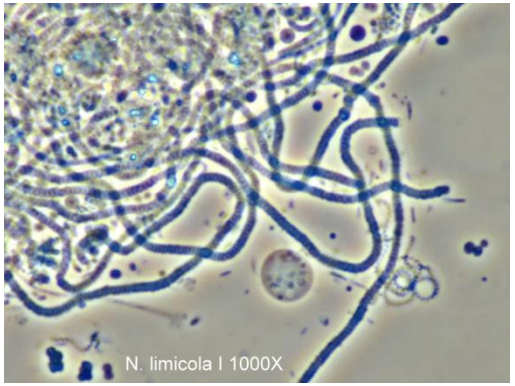
- Anaerobic Zone: Recycled PAOs are subject to an environment high in organic carbon with no dissolved oxygen (DO). Storage of carbon as polyhydroxybutyrate (PHB) and subsequent phosphorus release occurs.

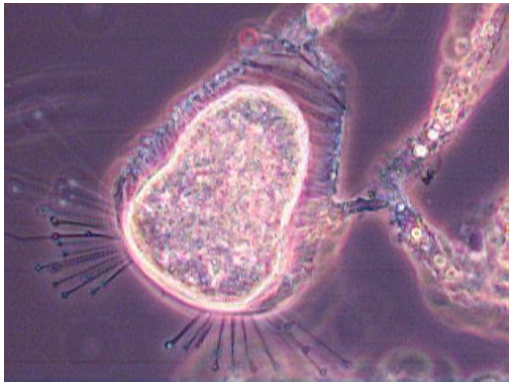
Process Reactor Zones

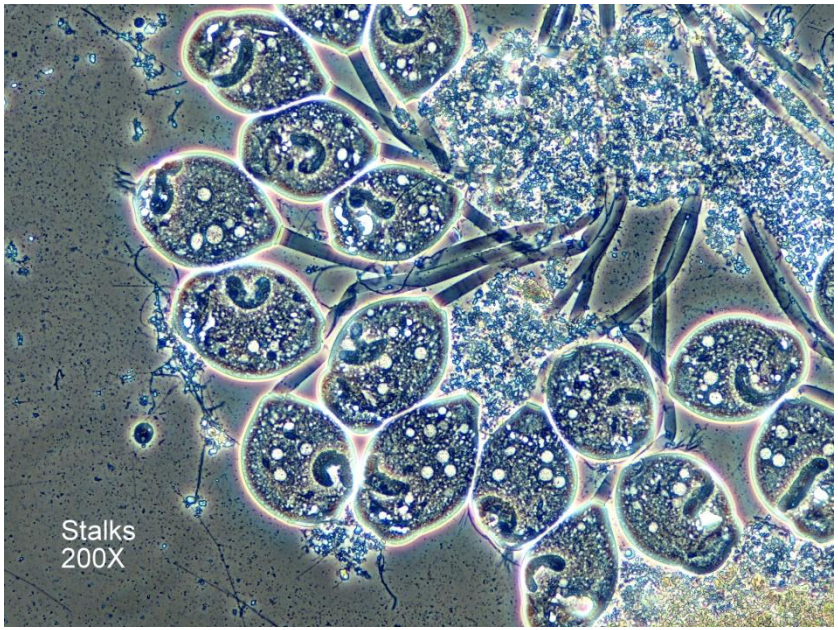
- Aerobic Zone: Three major processes occur in this zone:
  - removal of BOD not previously taken up in anaerobic and anoxic zones
  - nitrification of ammonia by autotrophic organisms
  - phosphorous uptake. Metabolization of PHB previously stored by P-accumulating organisms in the anaerobic zone

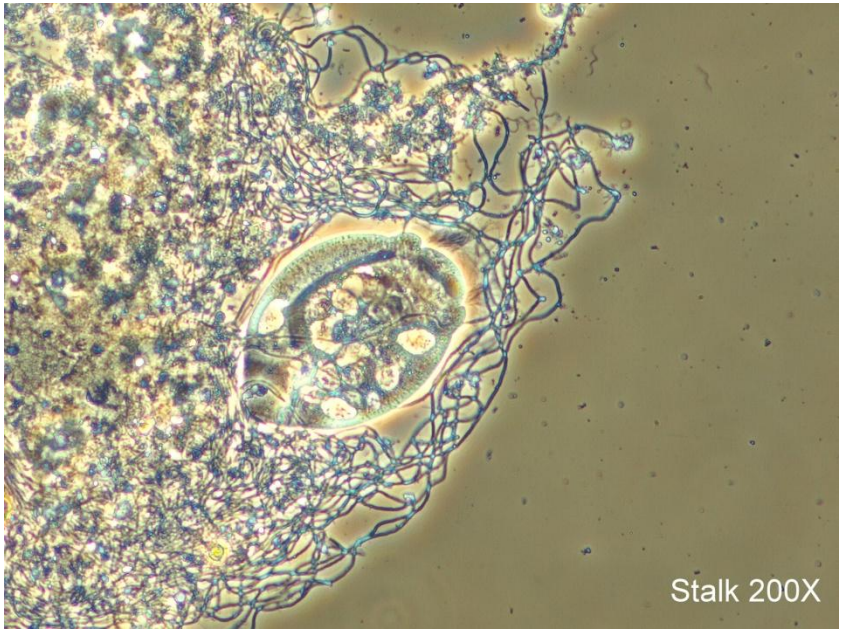
What does all of the work

The biological mechanisms that allow a BNR to operate consists of different types of bacteria, protozoa and metazoan.

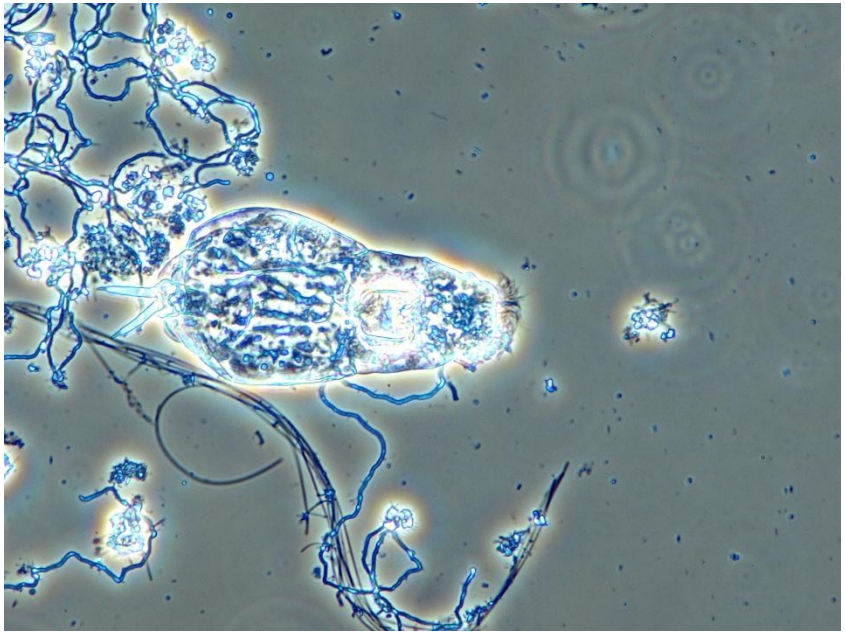


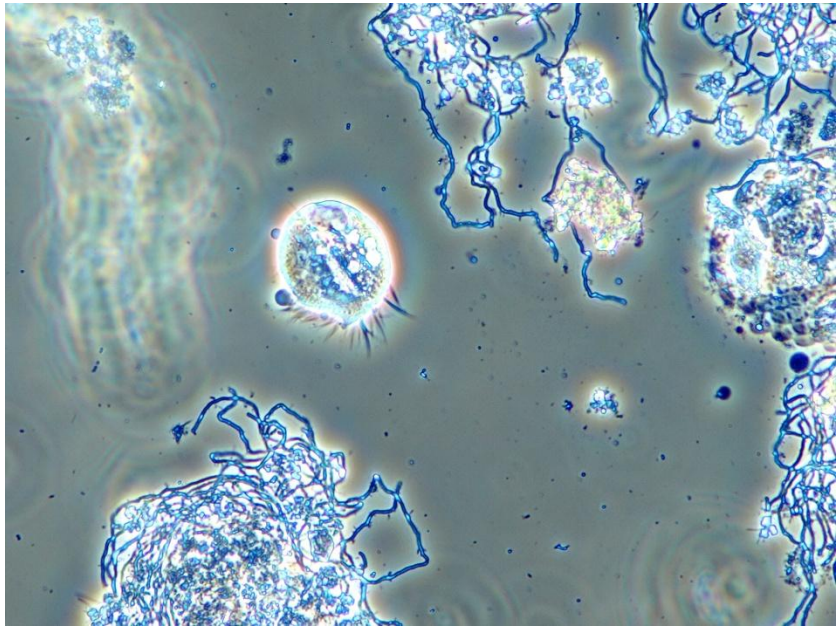


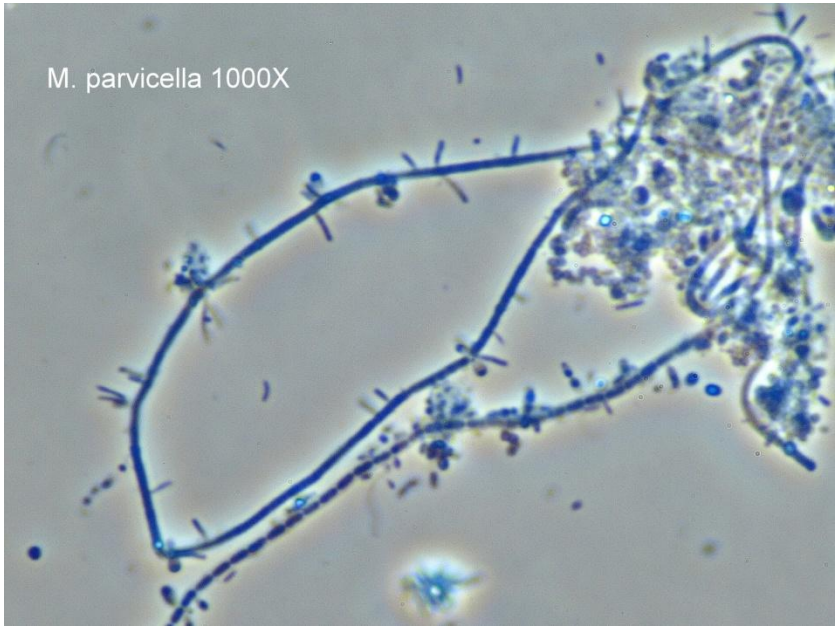

Stalks
200X

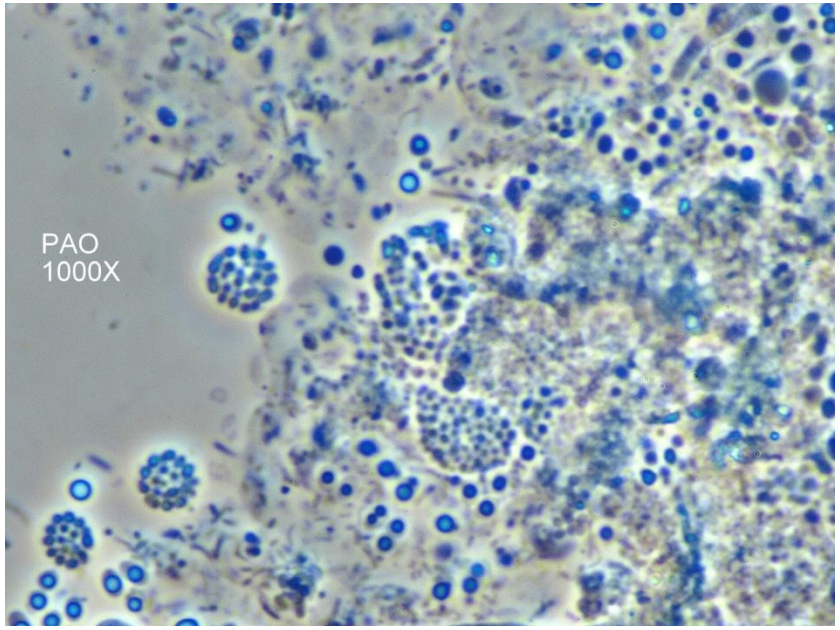

Stalk 200X

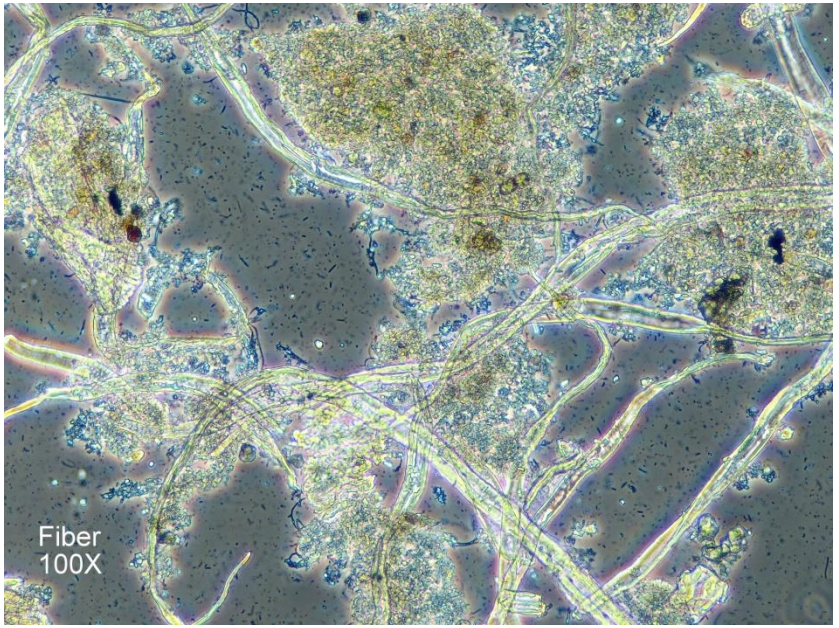

Type 1863 1000X

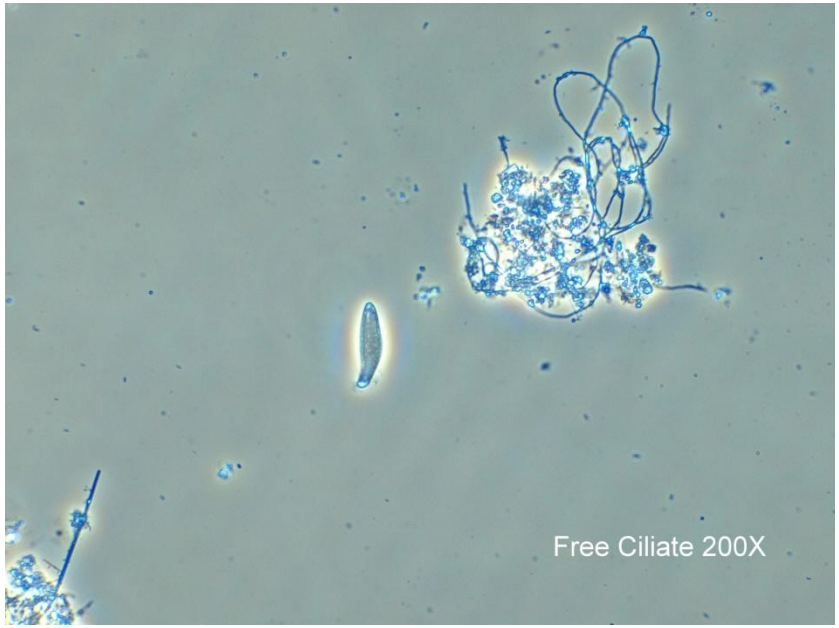


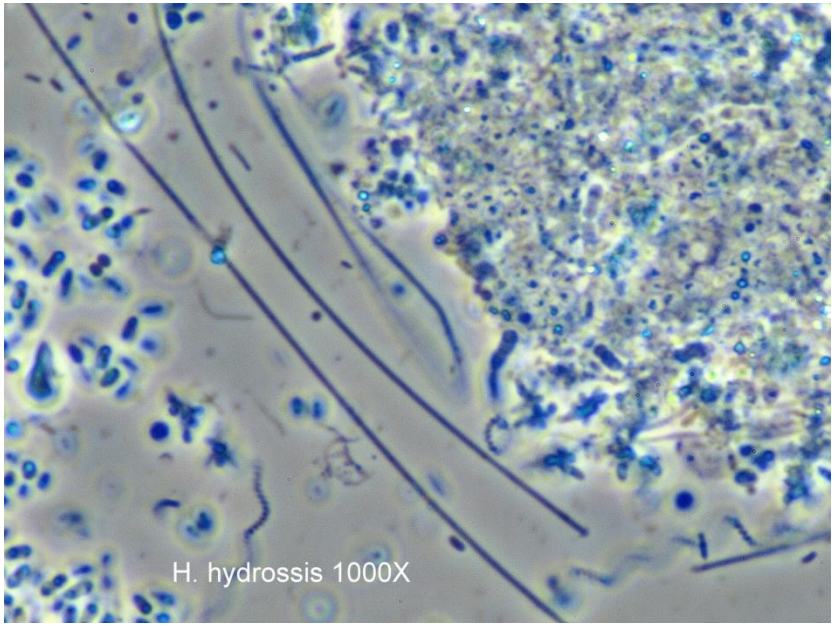


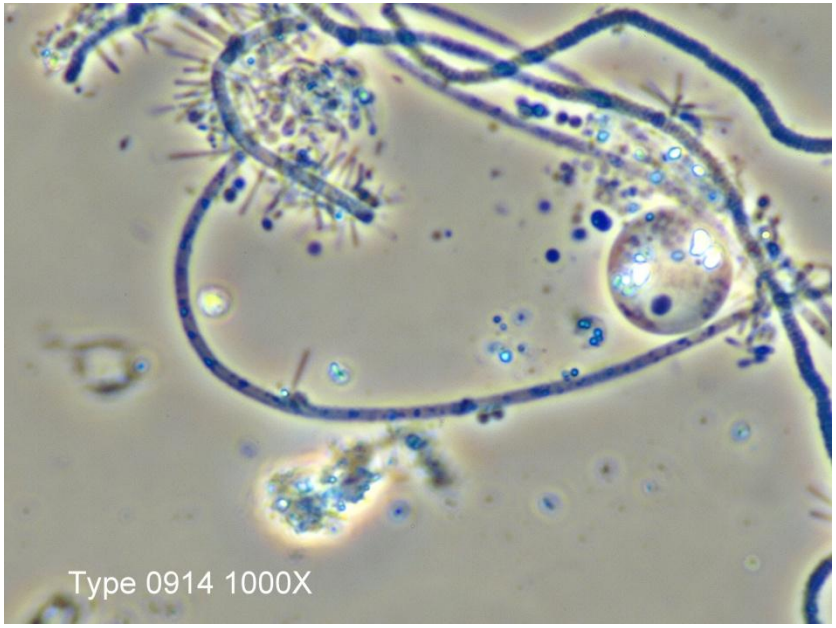

M. parvicella 1000X


PAO
1000X


Fiber
100X


Free Ciliate 200X


H. hydrossis 1000X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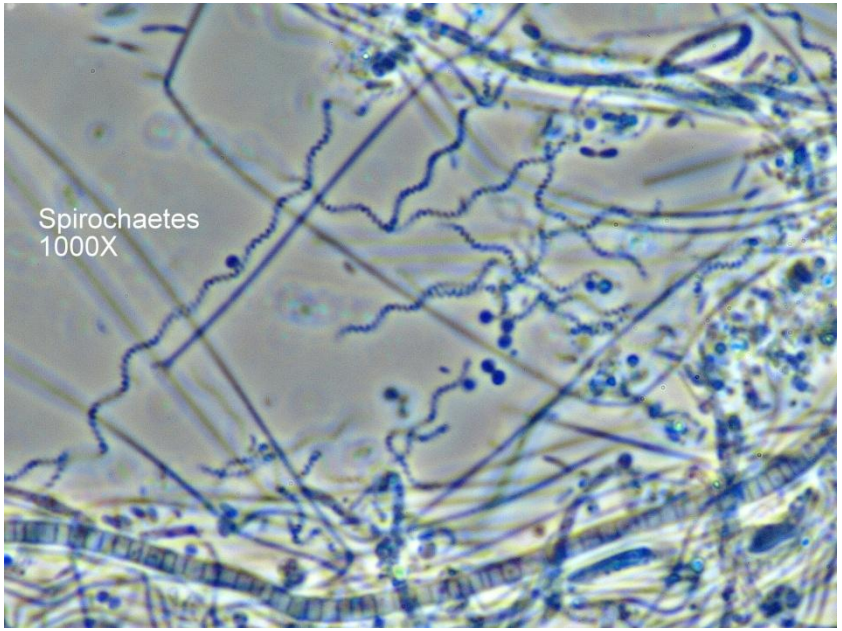
Spirochaetes
1000X

Biological Nutrient Removal

How does it work?

1. Nitrification
2. Denitrification
3. Phosphorus Removal

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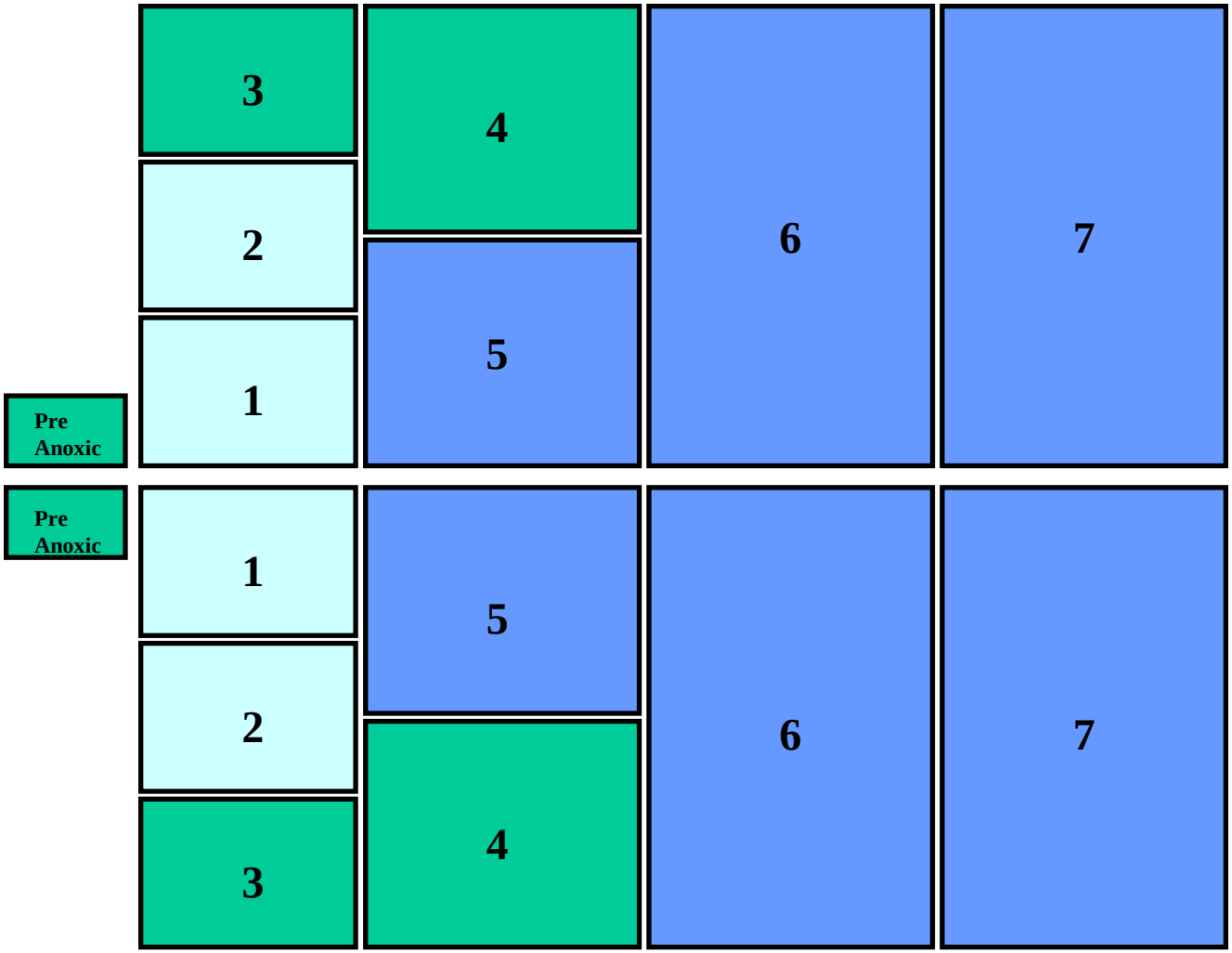
Nitrification

The Biological Conversion of Ammonia to Nitrate

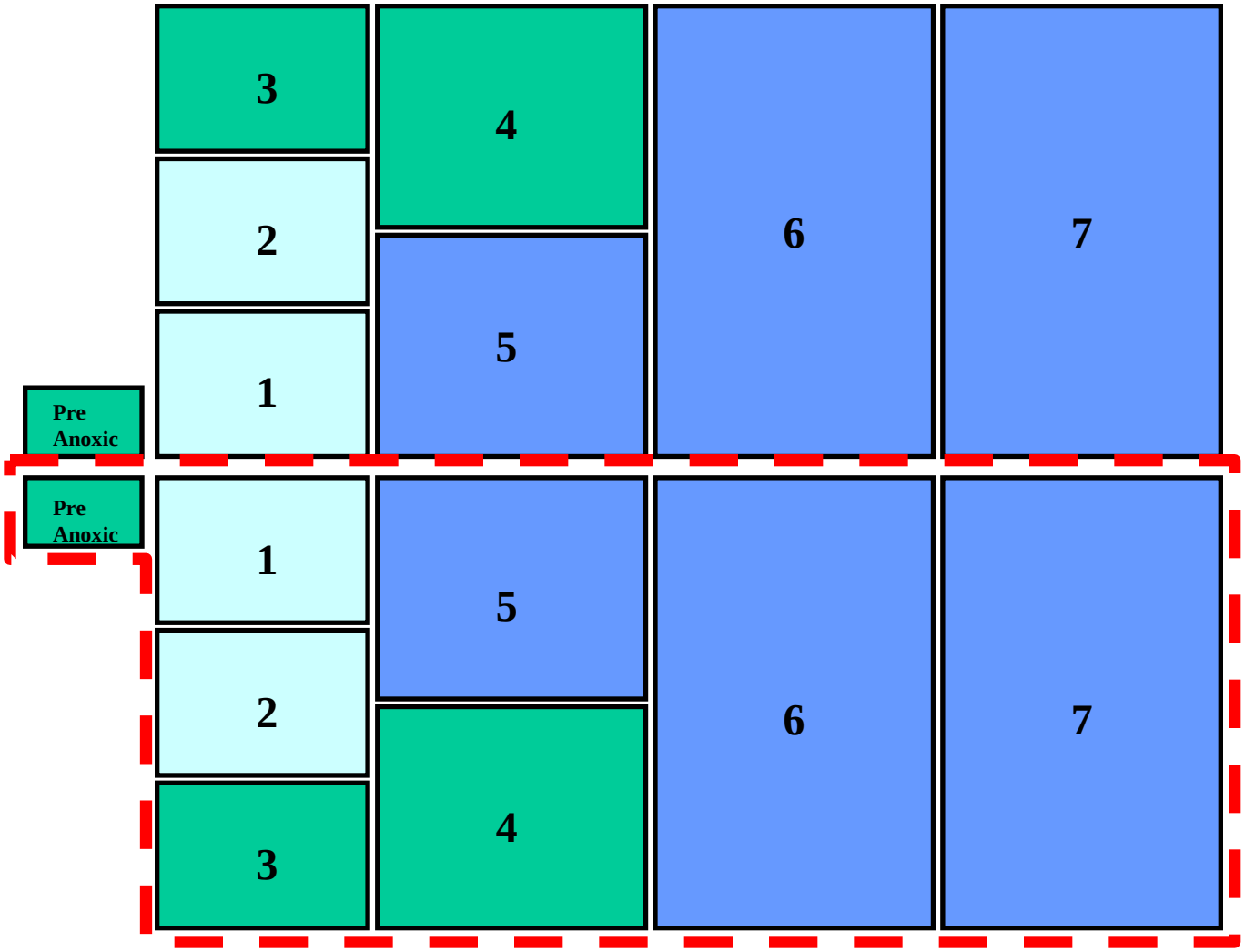
Nitrification

Overview of SWPCC two 7 cell reactors



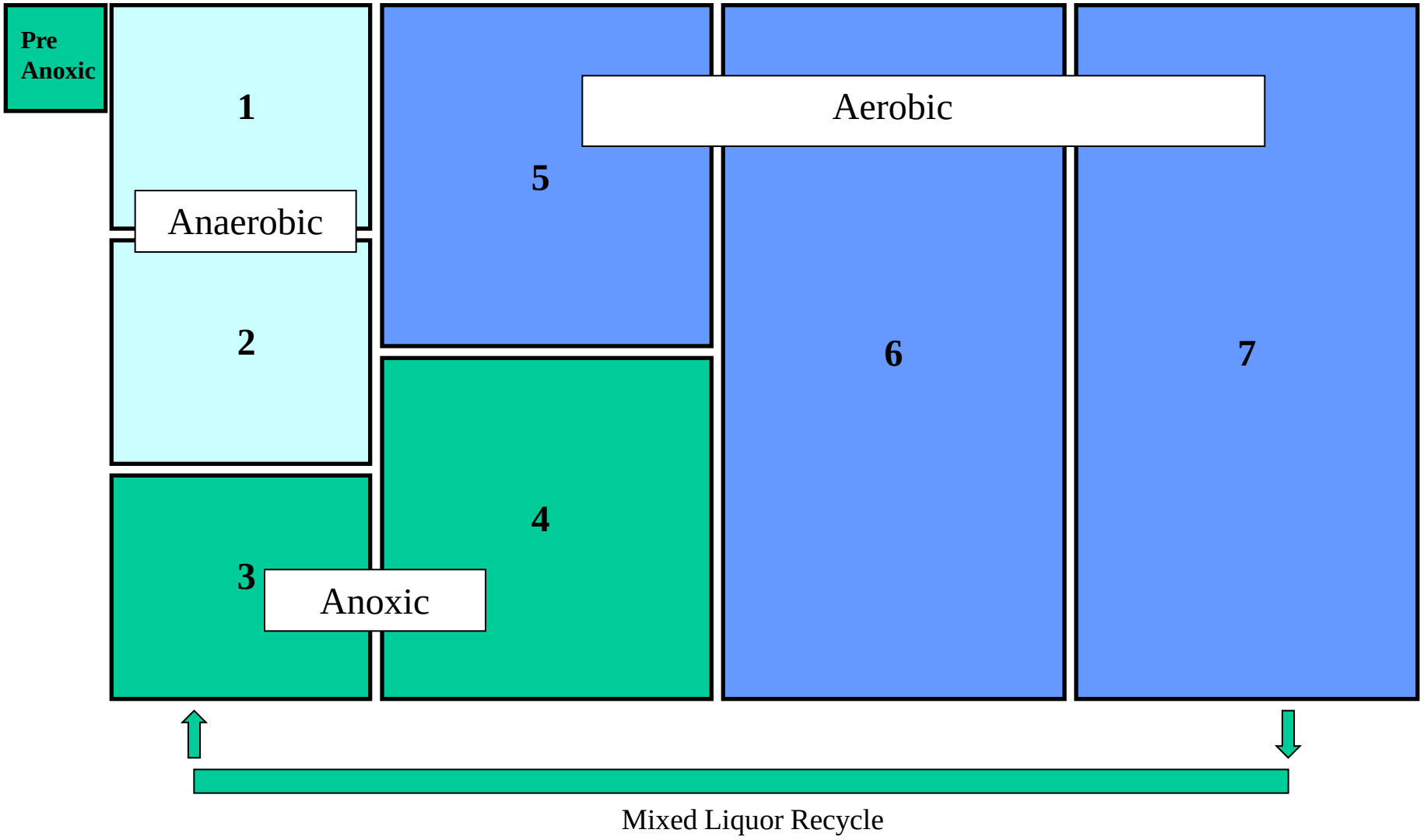
Nitrification

We'll look at just one of the reactors



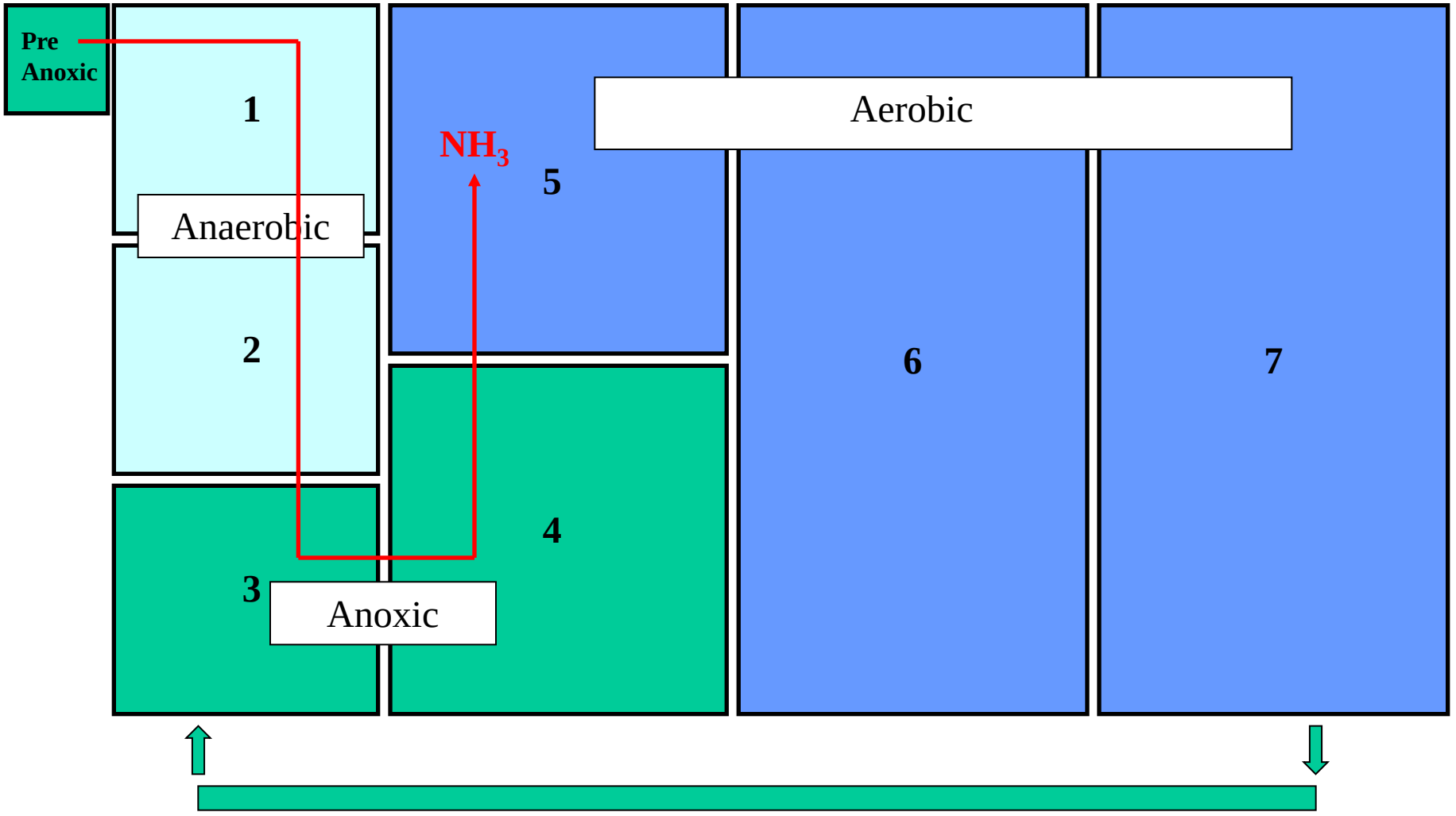
Nitrification

Reactor is broken into 3 types of cells



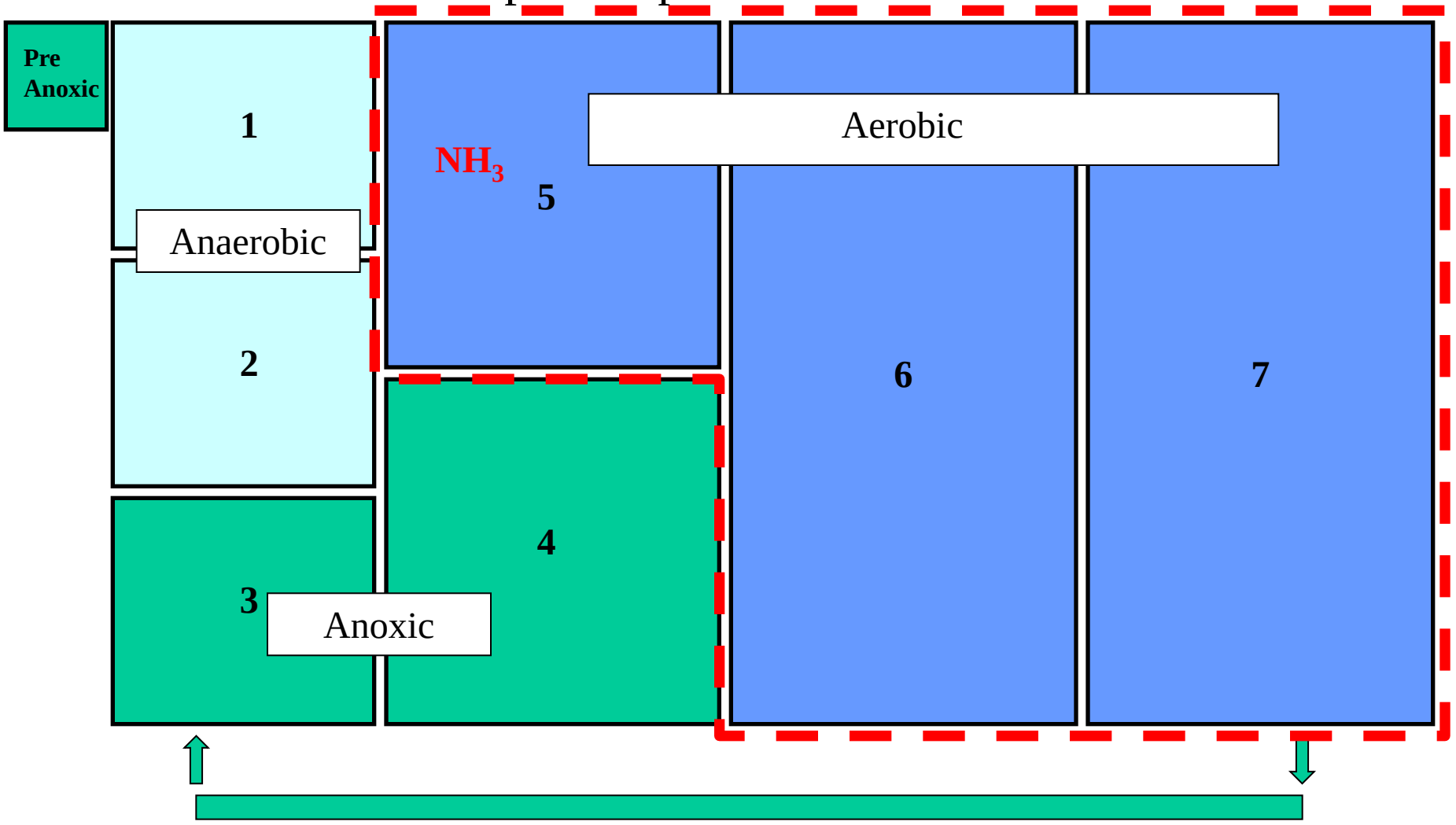
Nitrification

Ammonia (from Primary Effluent) travels from Pre Anoxic Zone to Aerobic Zone

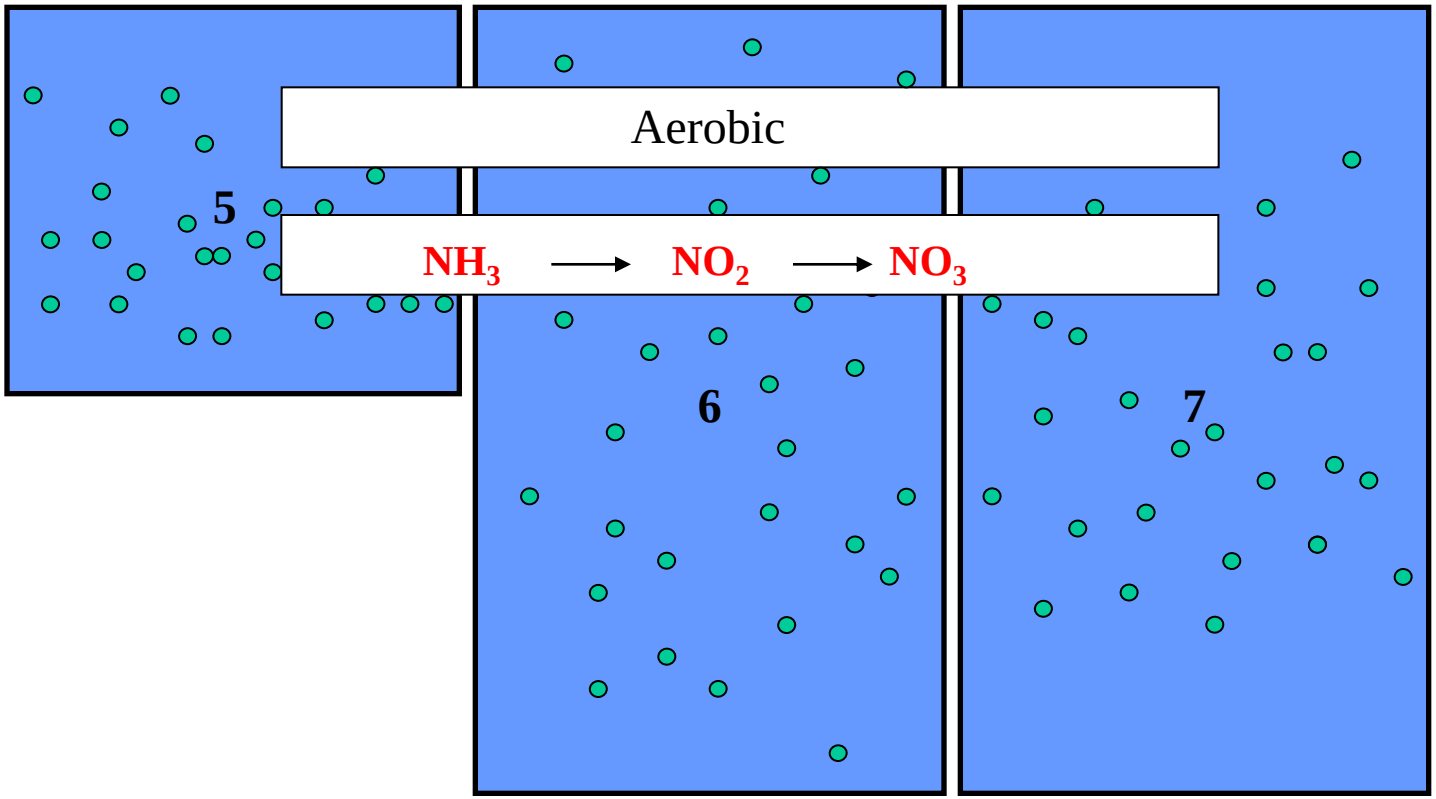


Nitrification

Next step takes place in the aerobic cell



Nitrification



1. Autotrophic Bacteria oxidize the inorganics to provide energy for growth and maintenance
2. Nitrosomonas convert Ammonia to Nitrite
3. Nitrobacter convert Nitrite to Nitrate

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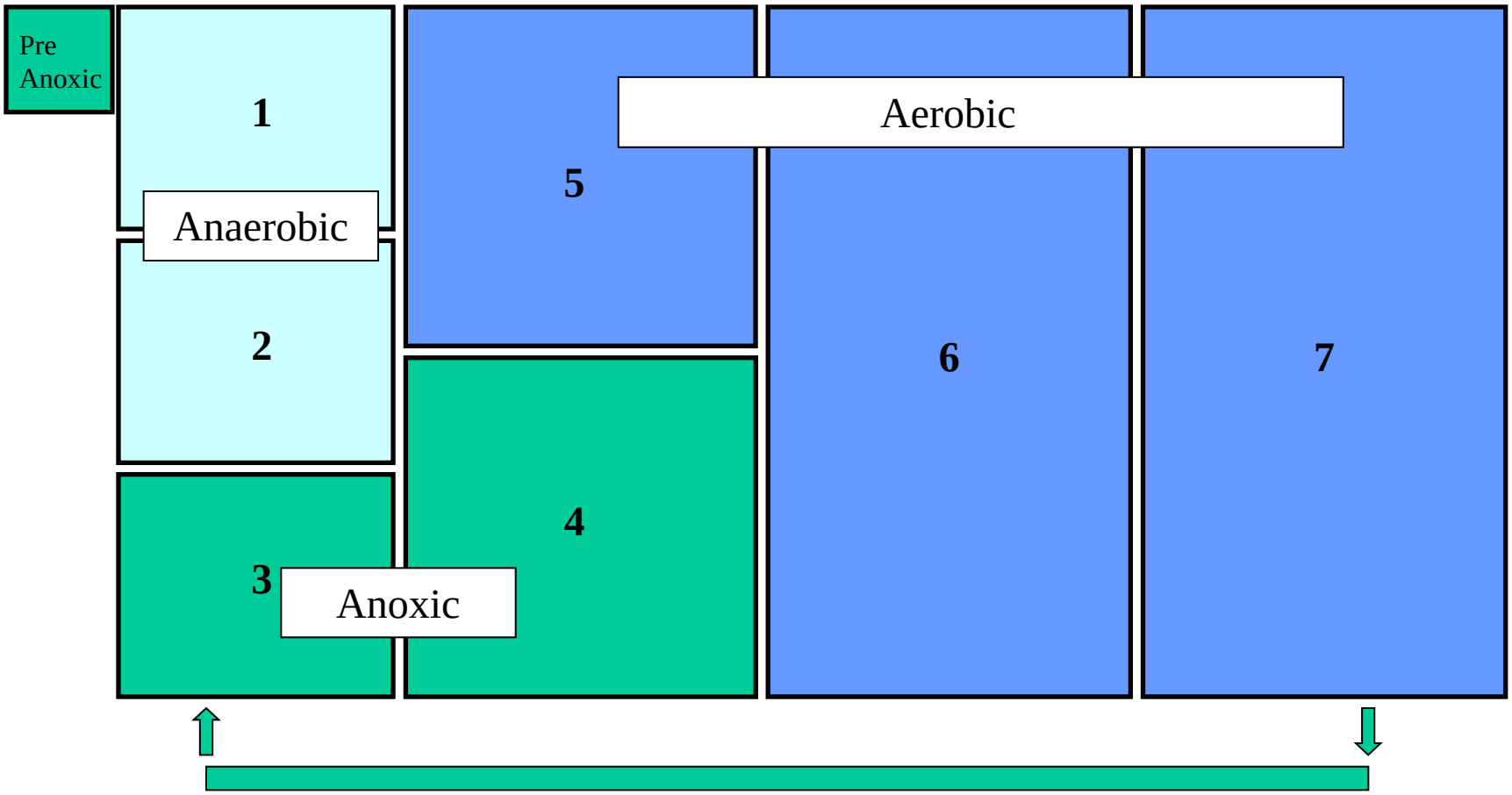
Denitrification

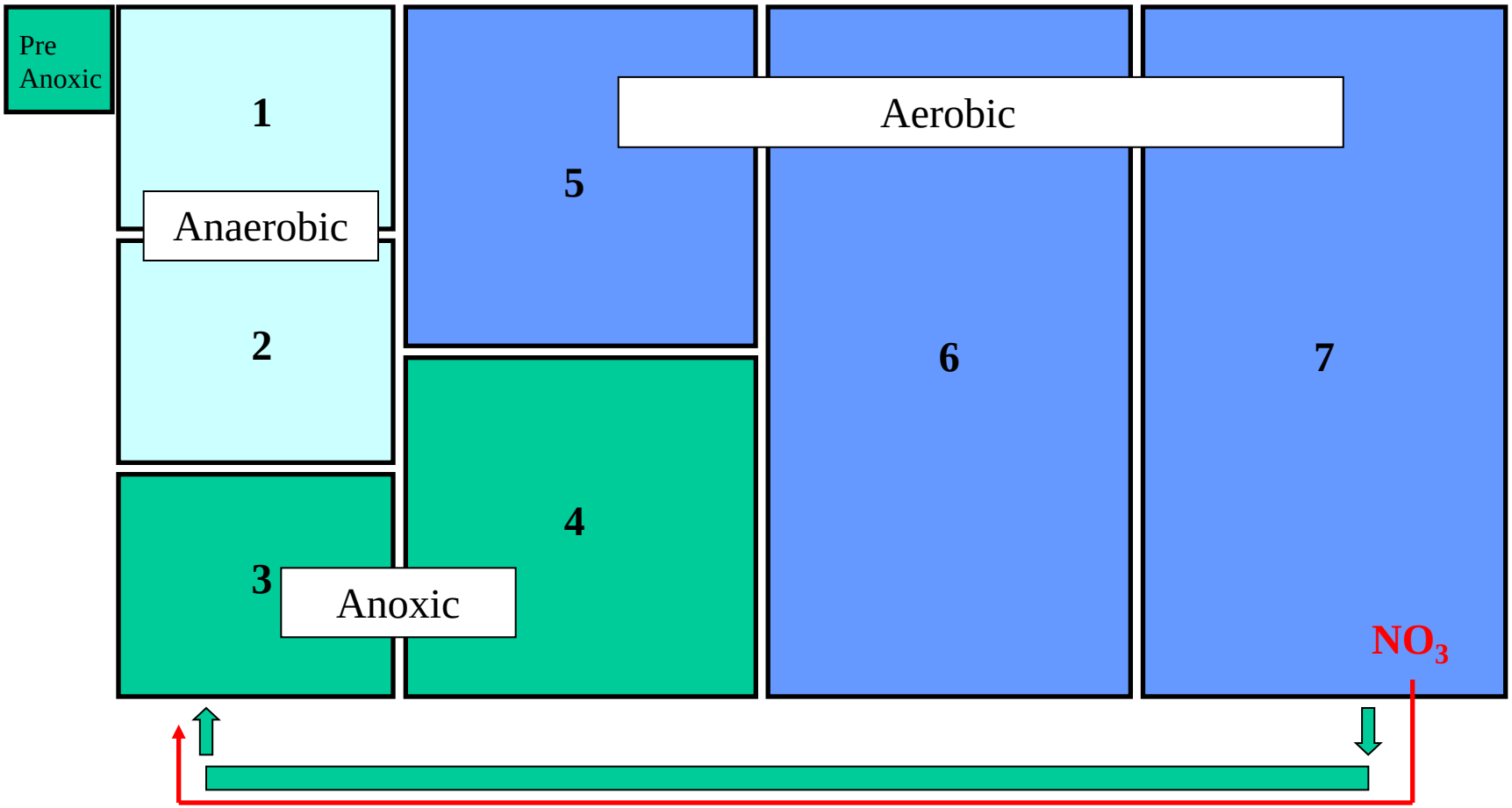
The Biological Reduction of Nitrate to Nitrogen Gas

Denitrification



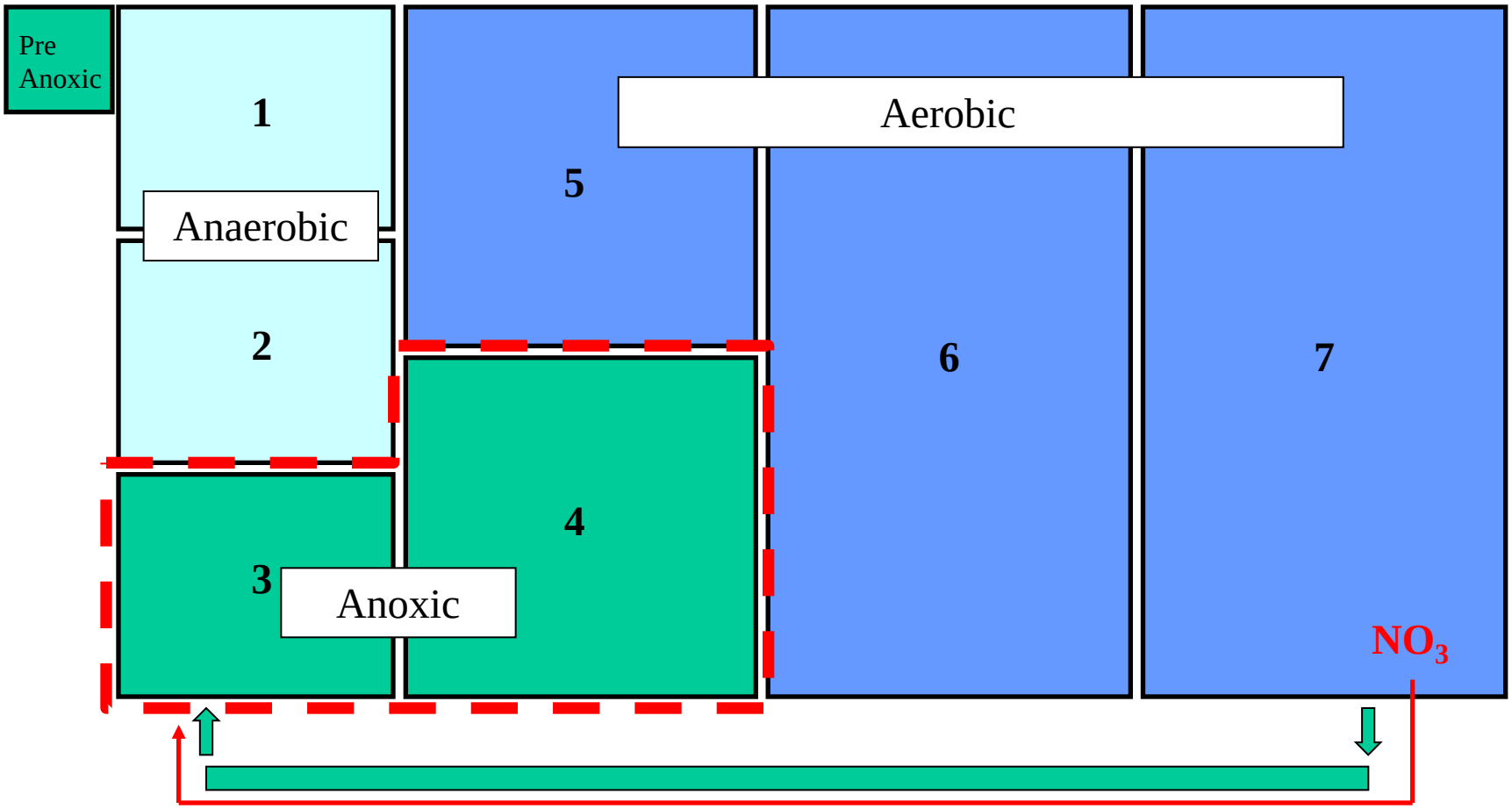
Now that the Ammonia has been converted into Nitrate, it must be converted to harmless Nitrogen gas.

Denitrification



Nitrates are recycled, via the mixed liquor, from the aeration basin back to the Anoxic Zone for Denitrification to take place

Denitrification



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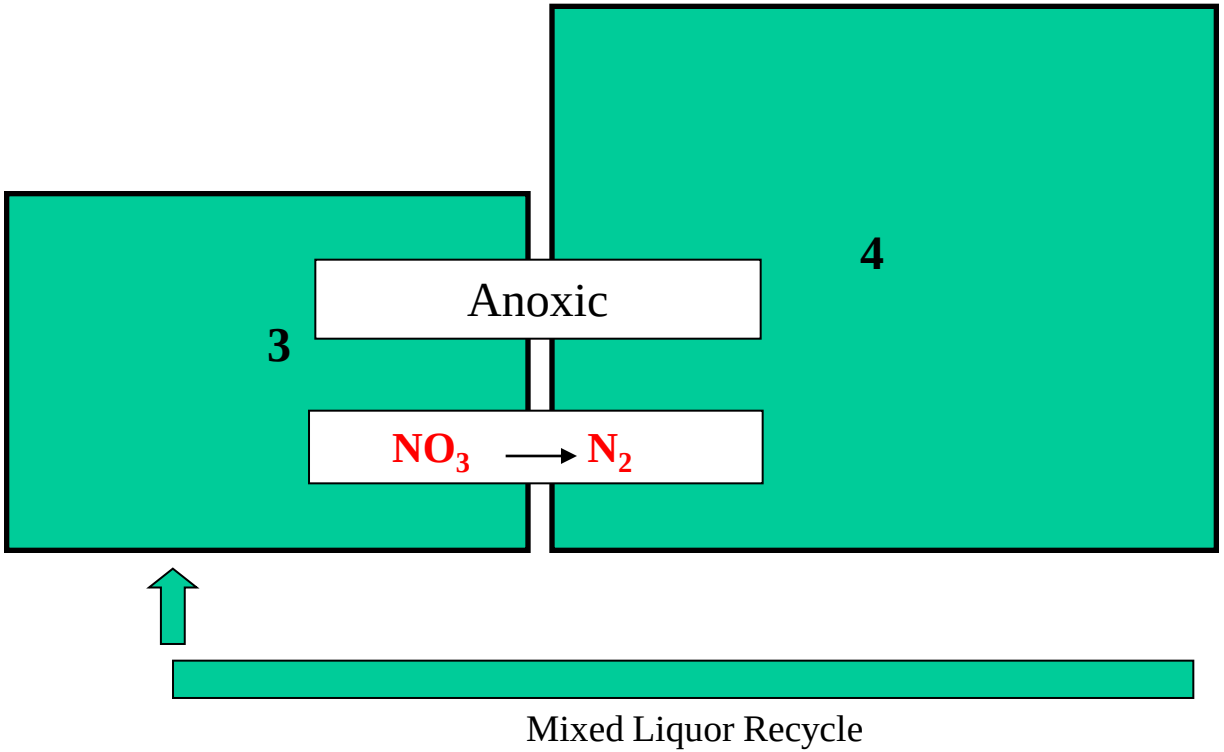
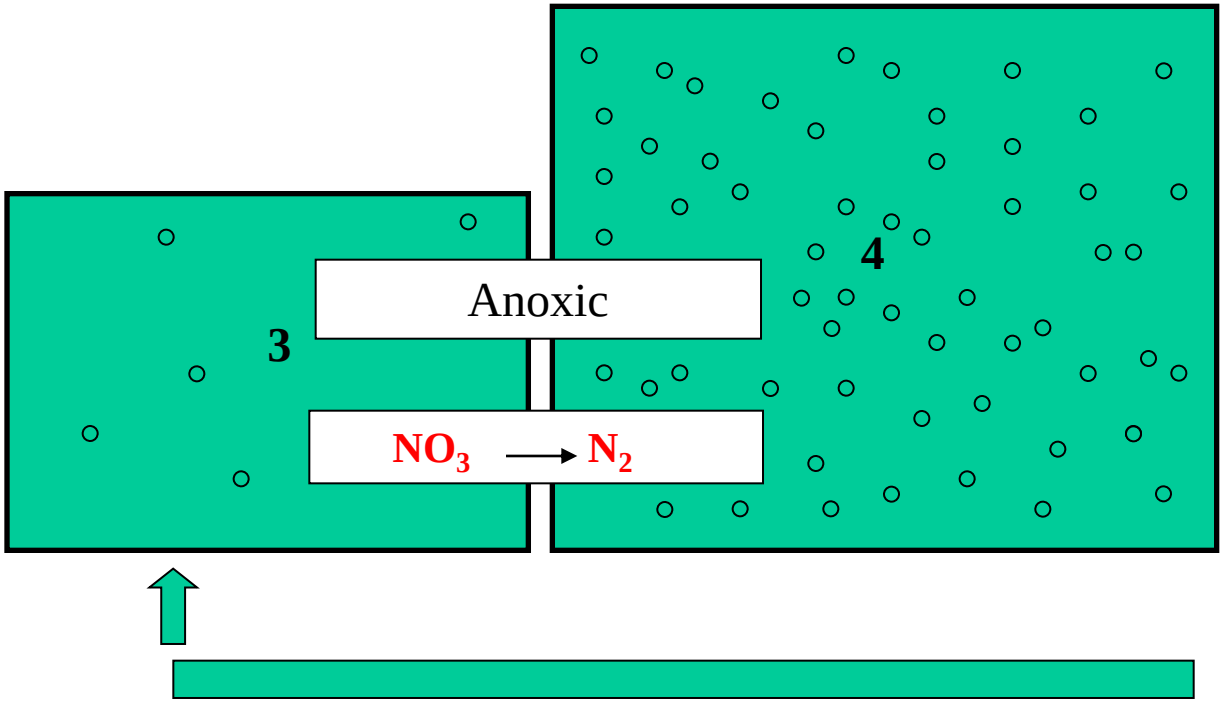
Denitrification



Heterotrophic bacteria use the Nitrates as the terminal electron acceptor (oxygen source) so that they can utilize carbonaceous organic material

Denitrification



When the heterotrophic bacteria strip the Nitrate of it's oxygen, Nitrogen Gas is liberated into the atmosphere

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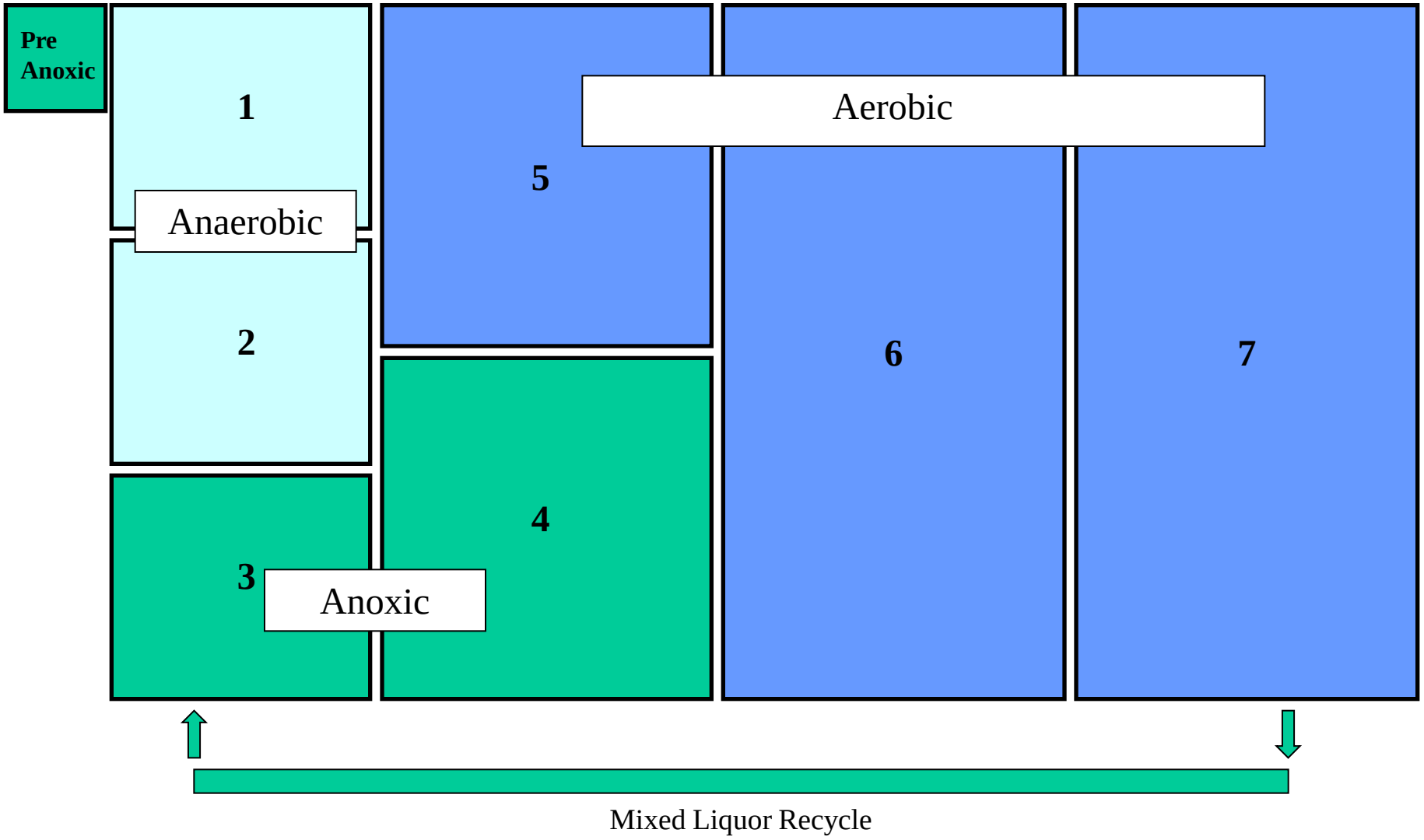
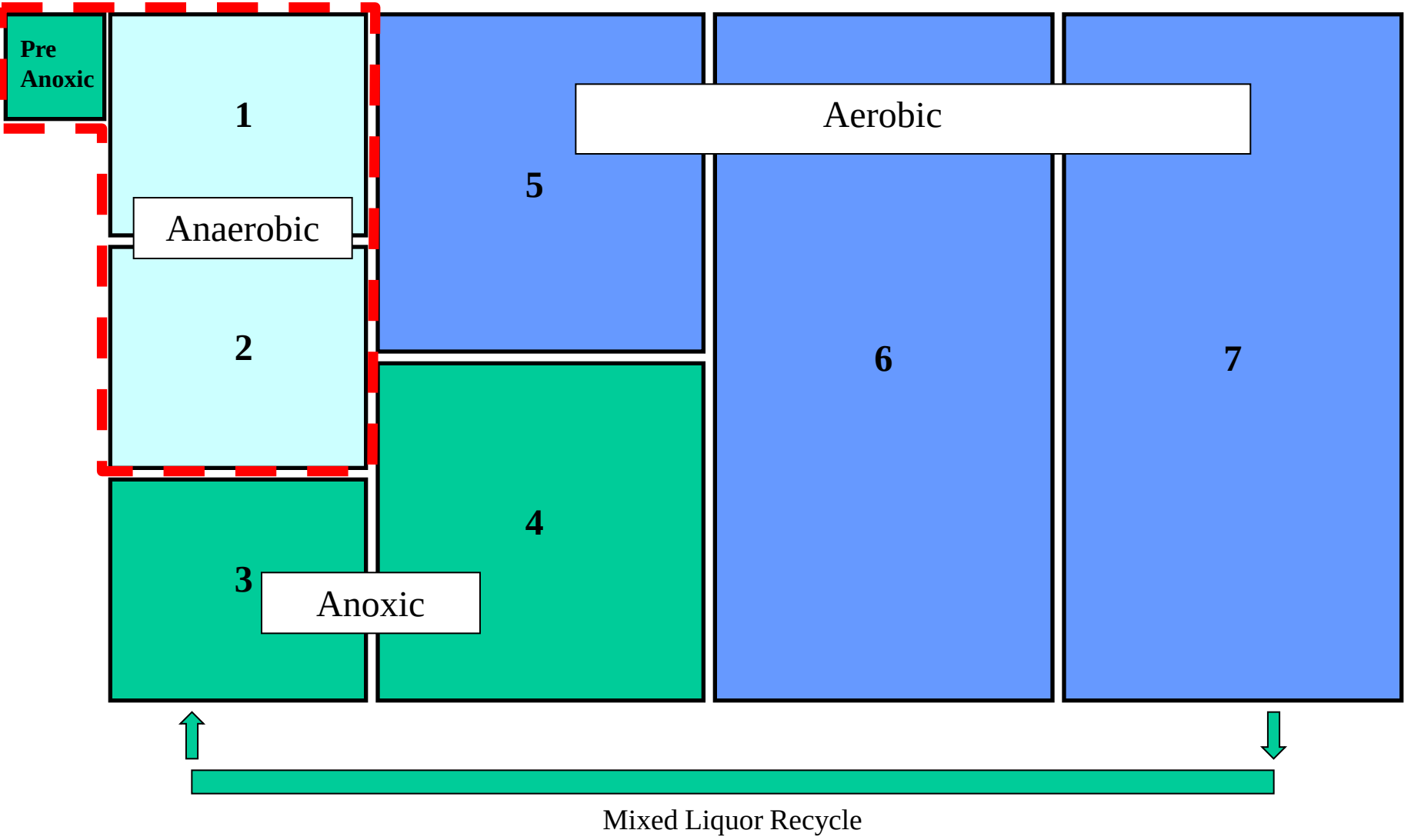
Phosphorus Removal

The Biological Removal of Phosphorus

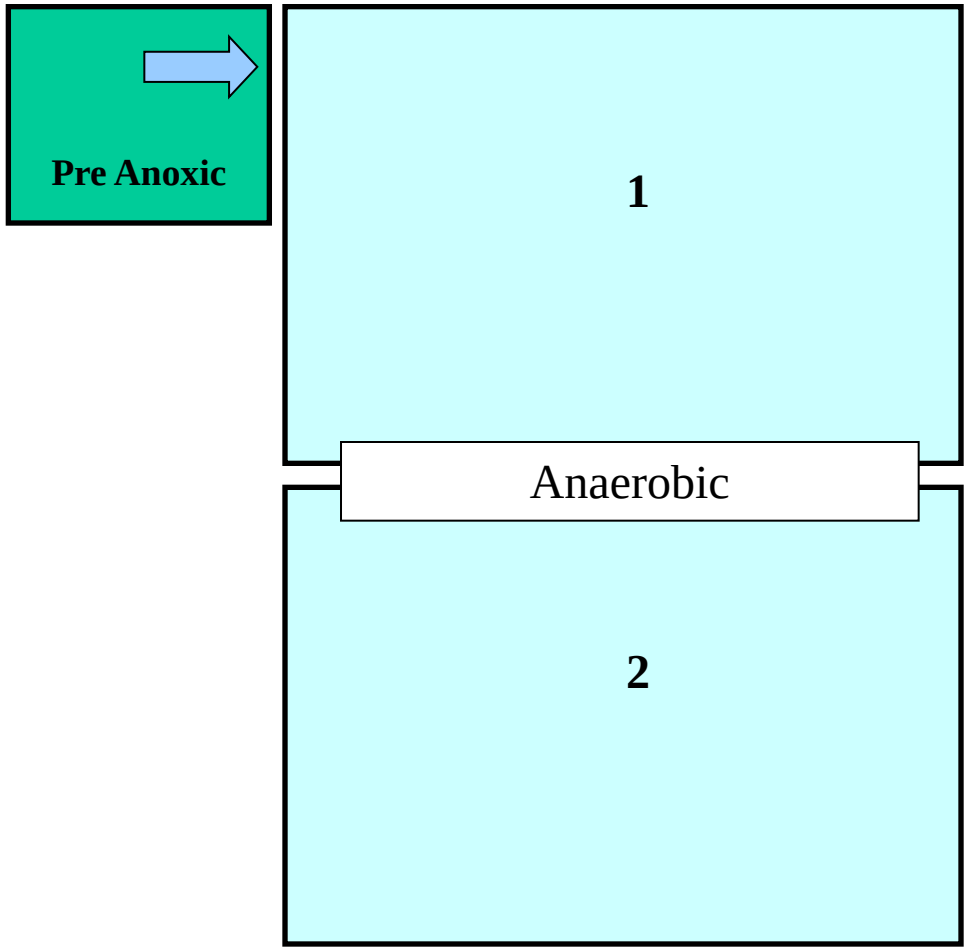
Phosphorus Removal



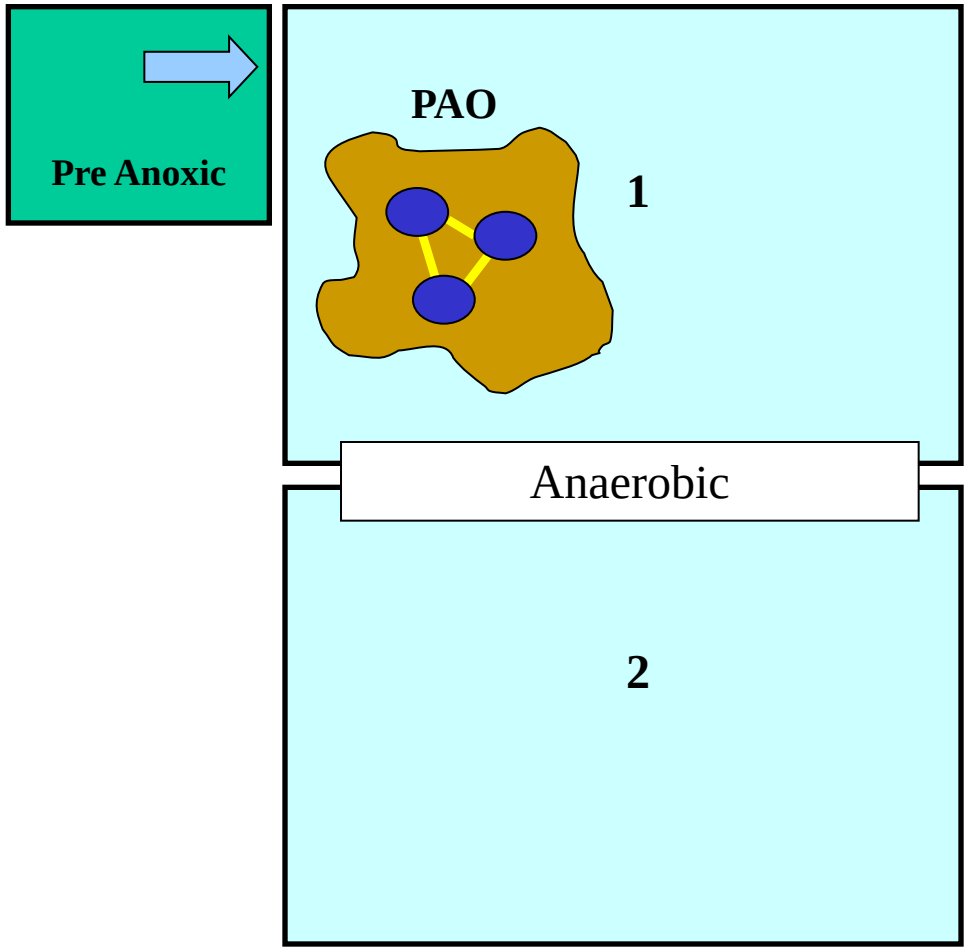
Phosphorus Removal



Phosphorus Removal

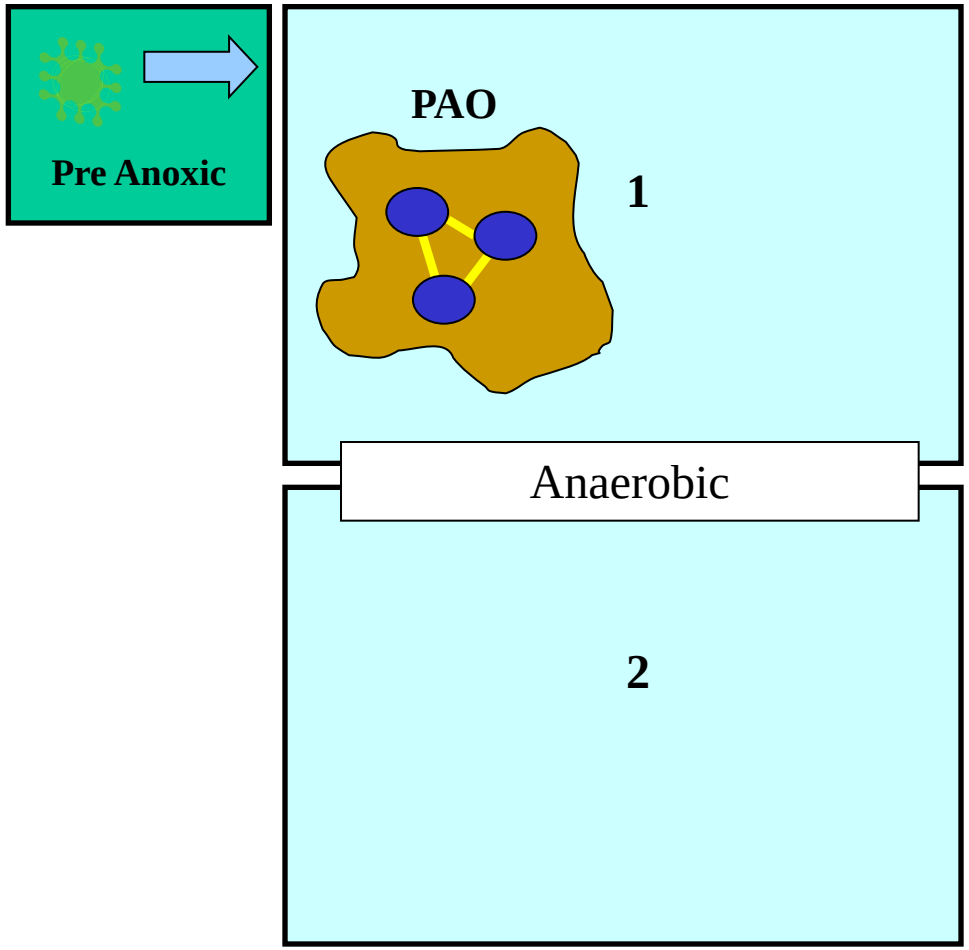


Phosphorus Removal



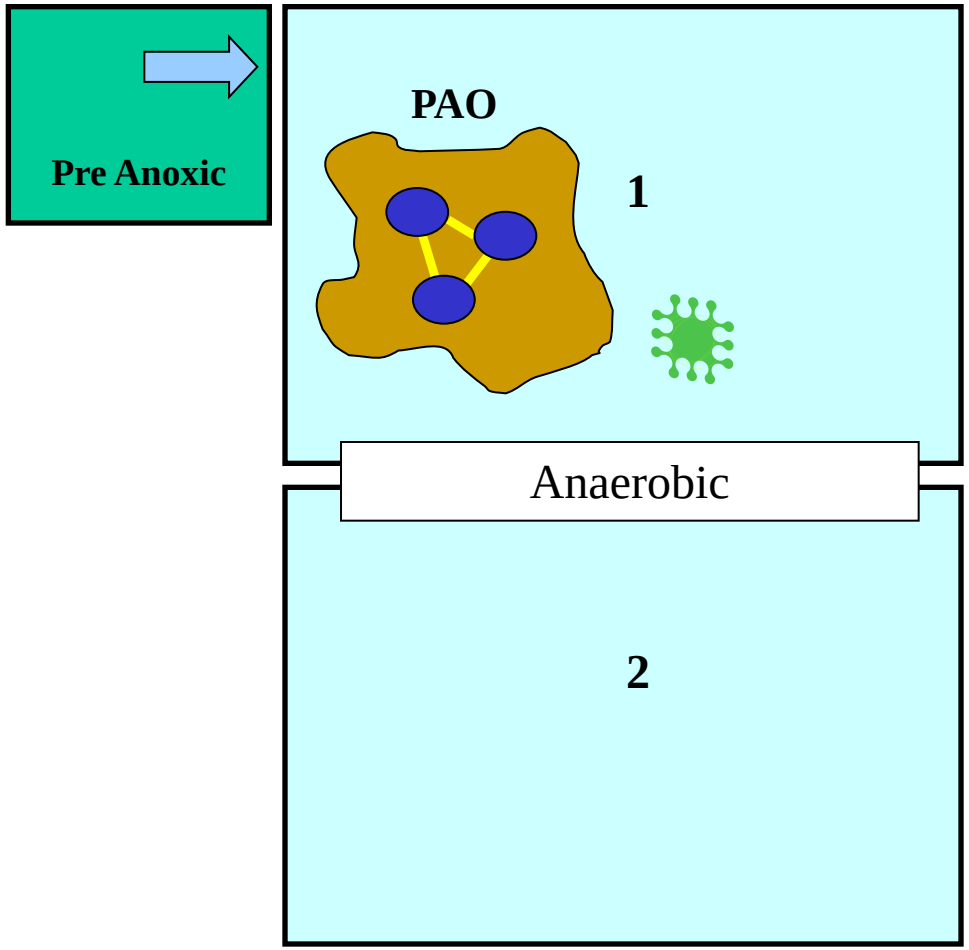
Phosphorus Accumulating Organism (PAO) present in Anaerobic Cells via RAS

Phosphorus Removal



Organic Material (via Primary Effluent) is introduced from Pre Anoxic Zone

Phosphorus Removal



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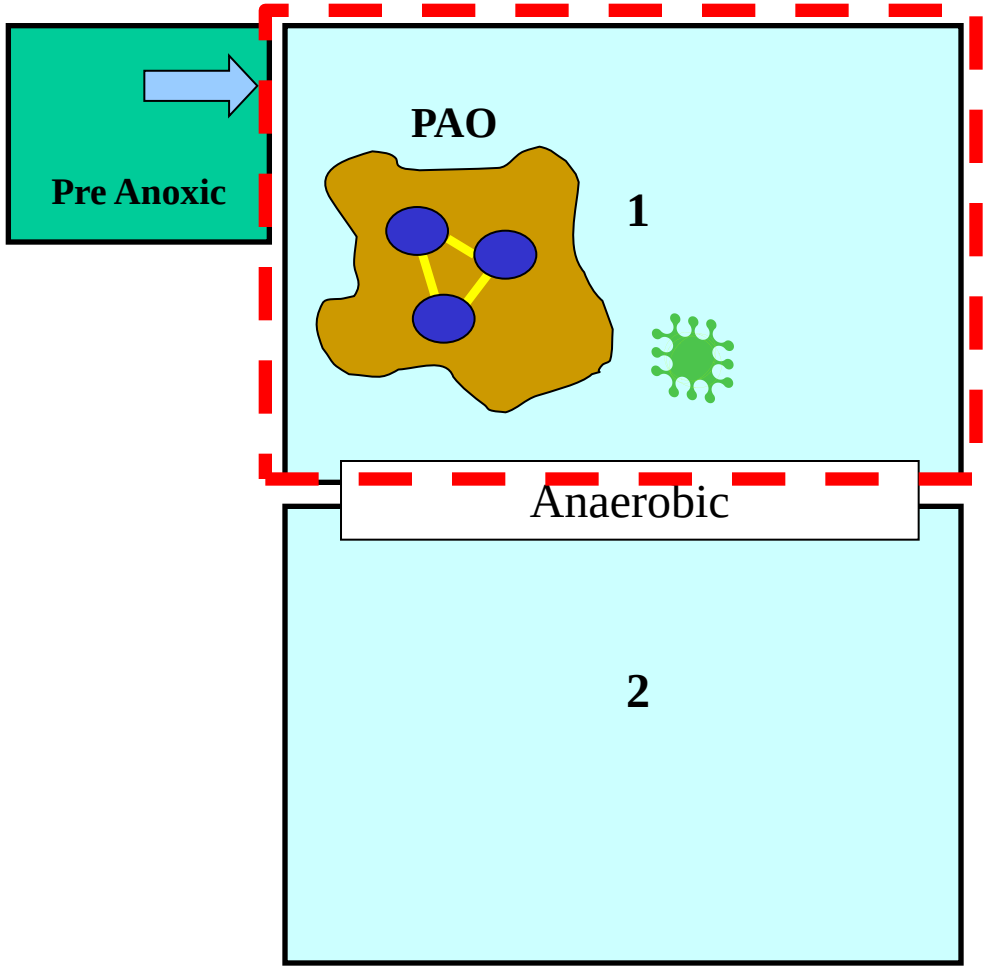
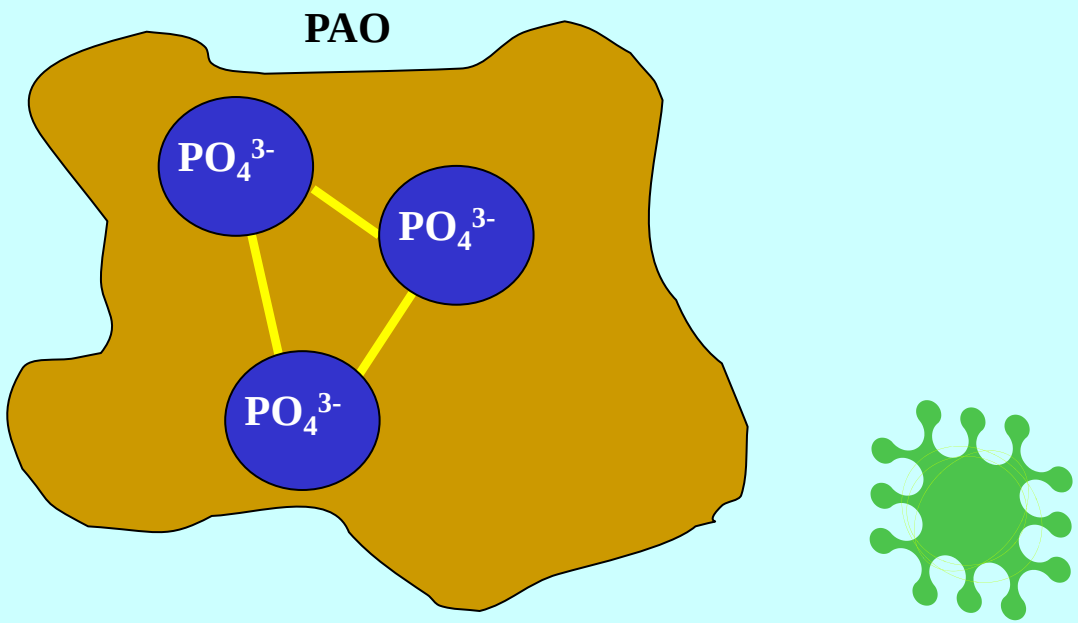


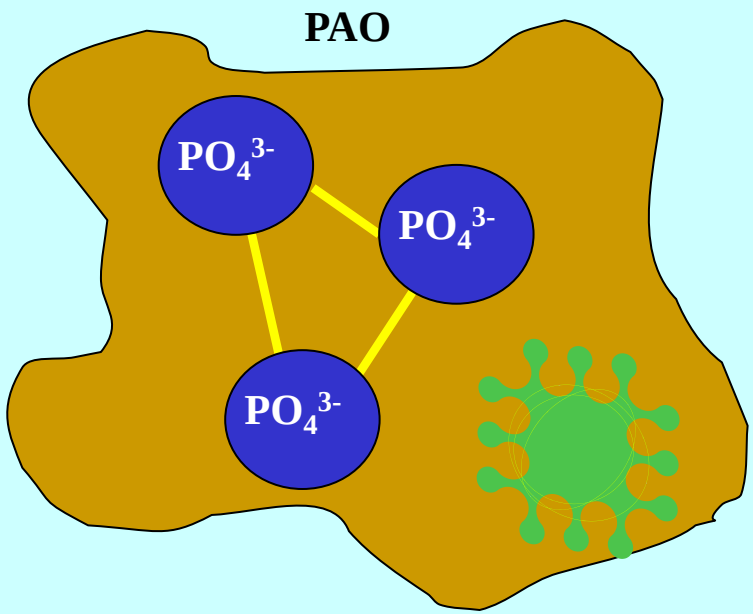
Phosphorus Removal

Anaerobic Cell 1



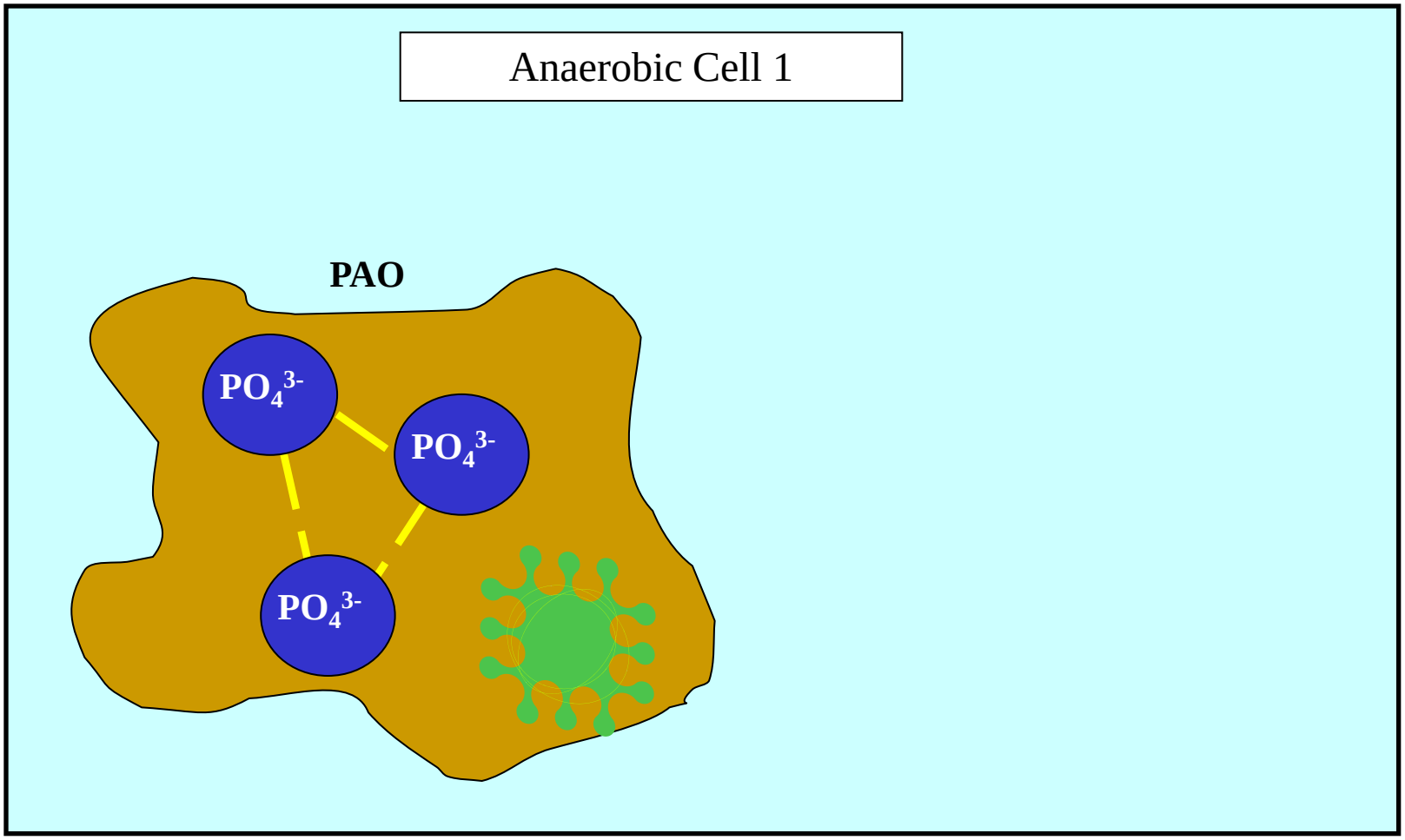
Phosphorus Removal

Anaerobic Cell 1



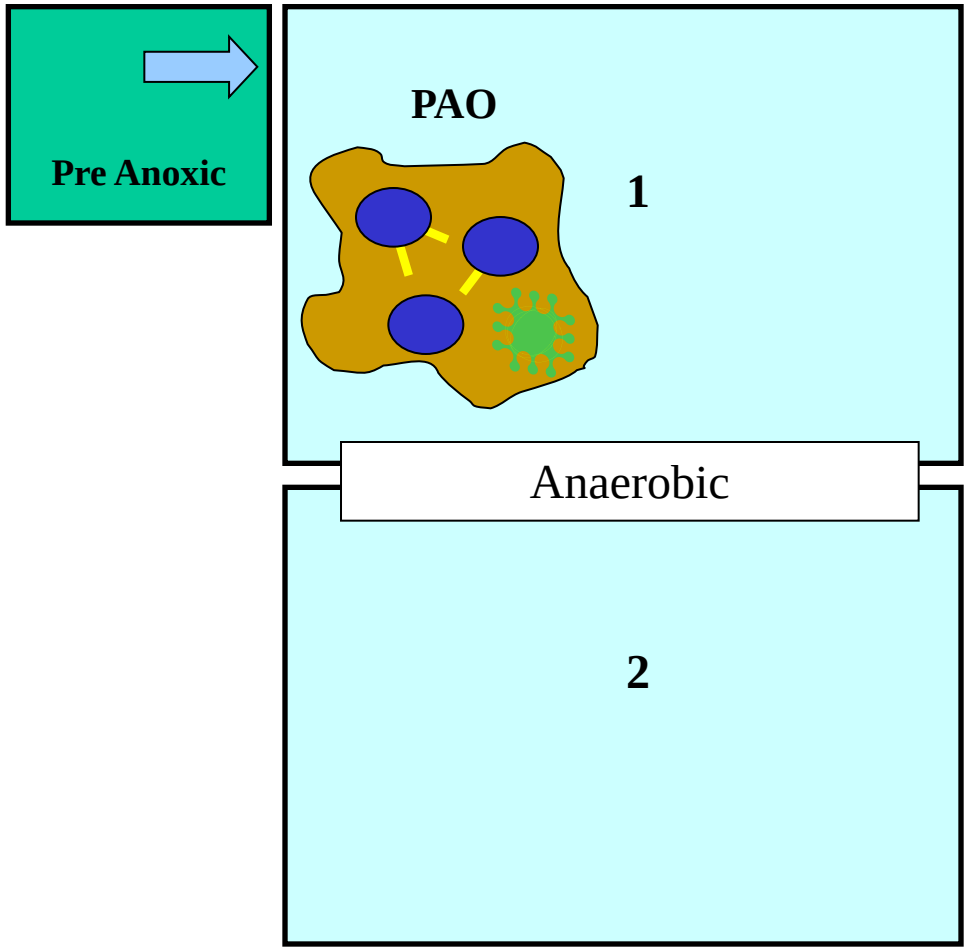
PAO Takes up Organic Matter

Phosphorus Removal



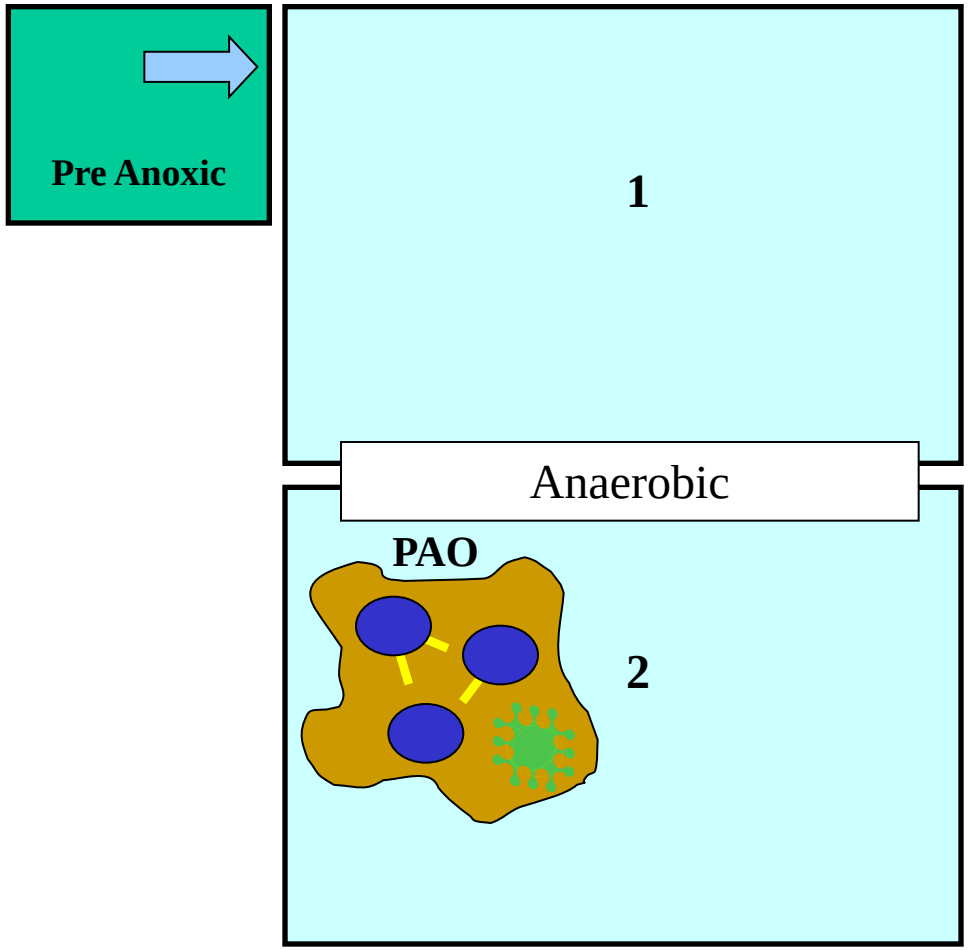
To store the organic material, the PAO requires the energy from the phosphate to phosphate bonds

Phosphorus Removal



PAOs travel through Cell 1 and into Cell 2

Phosphorus Removal



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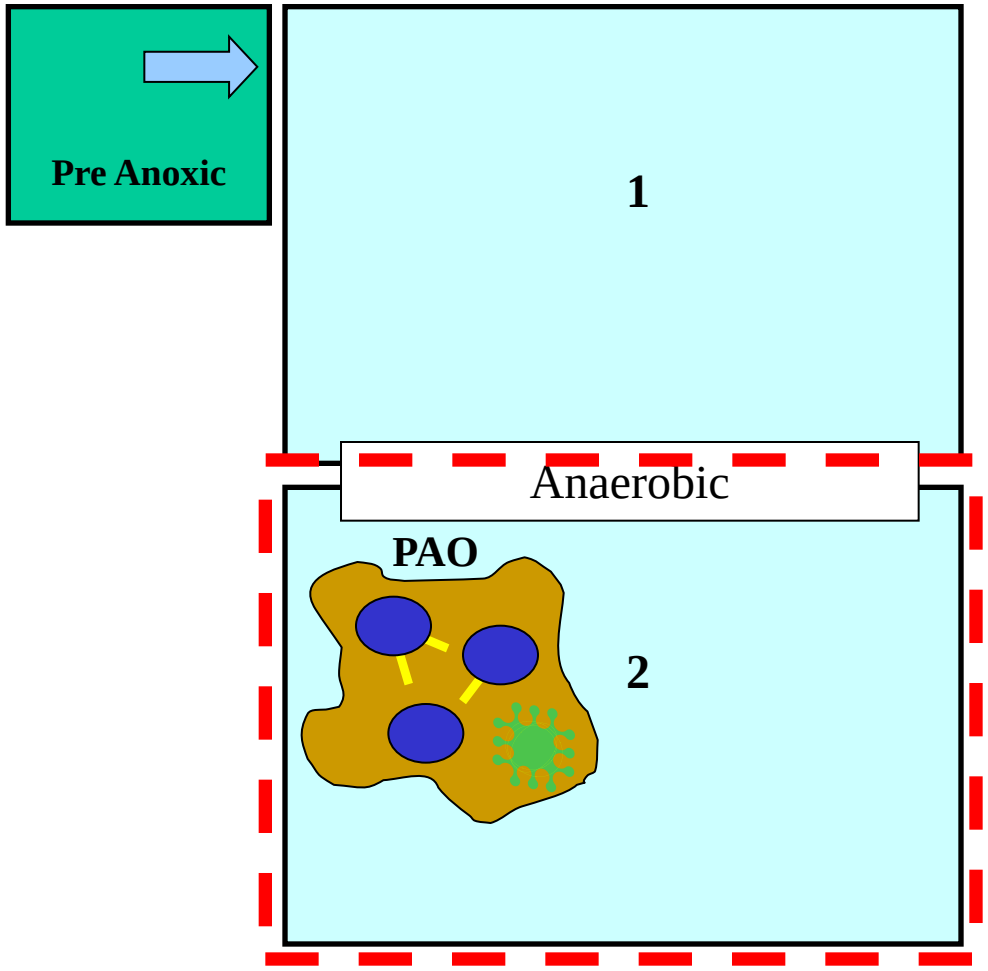
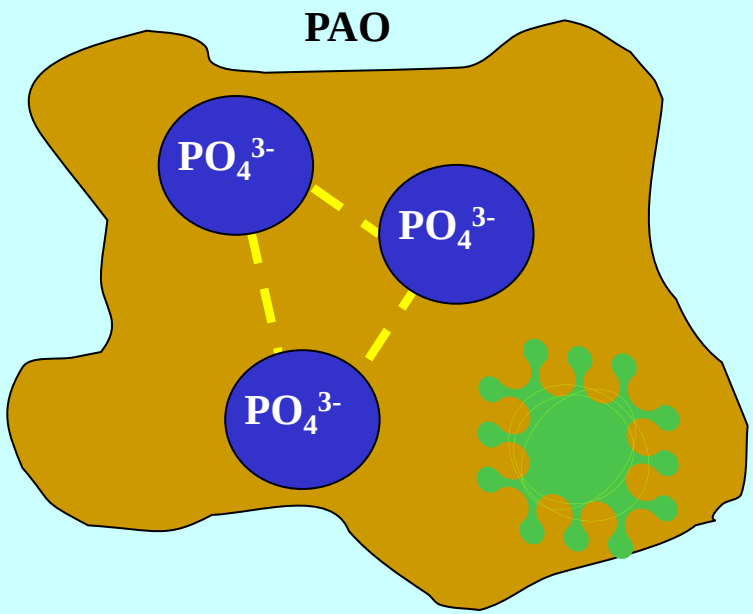
Phosphorus Removal



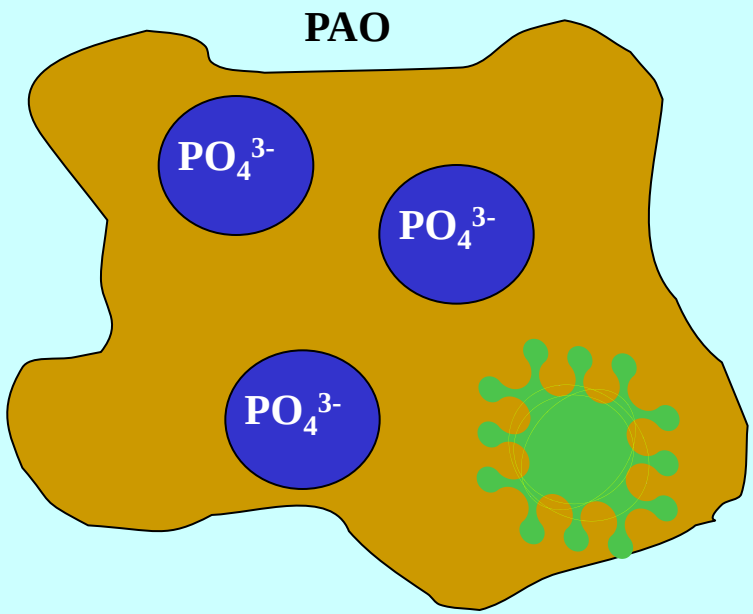
Phosphorus Removal

Anaerobic Cell 2



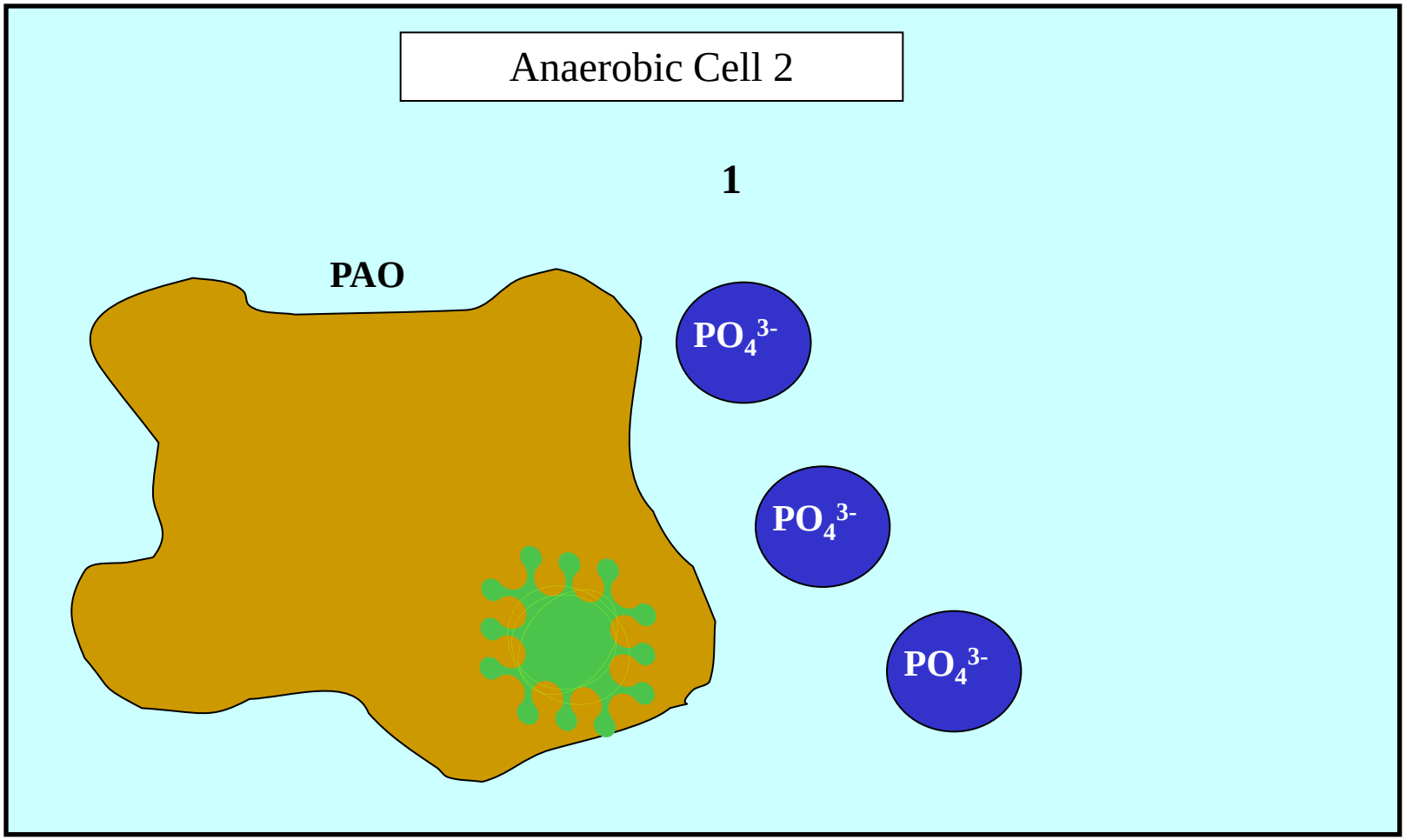
Phosphorus Removal

Anaerobic Cell 2



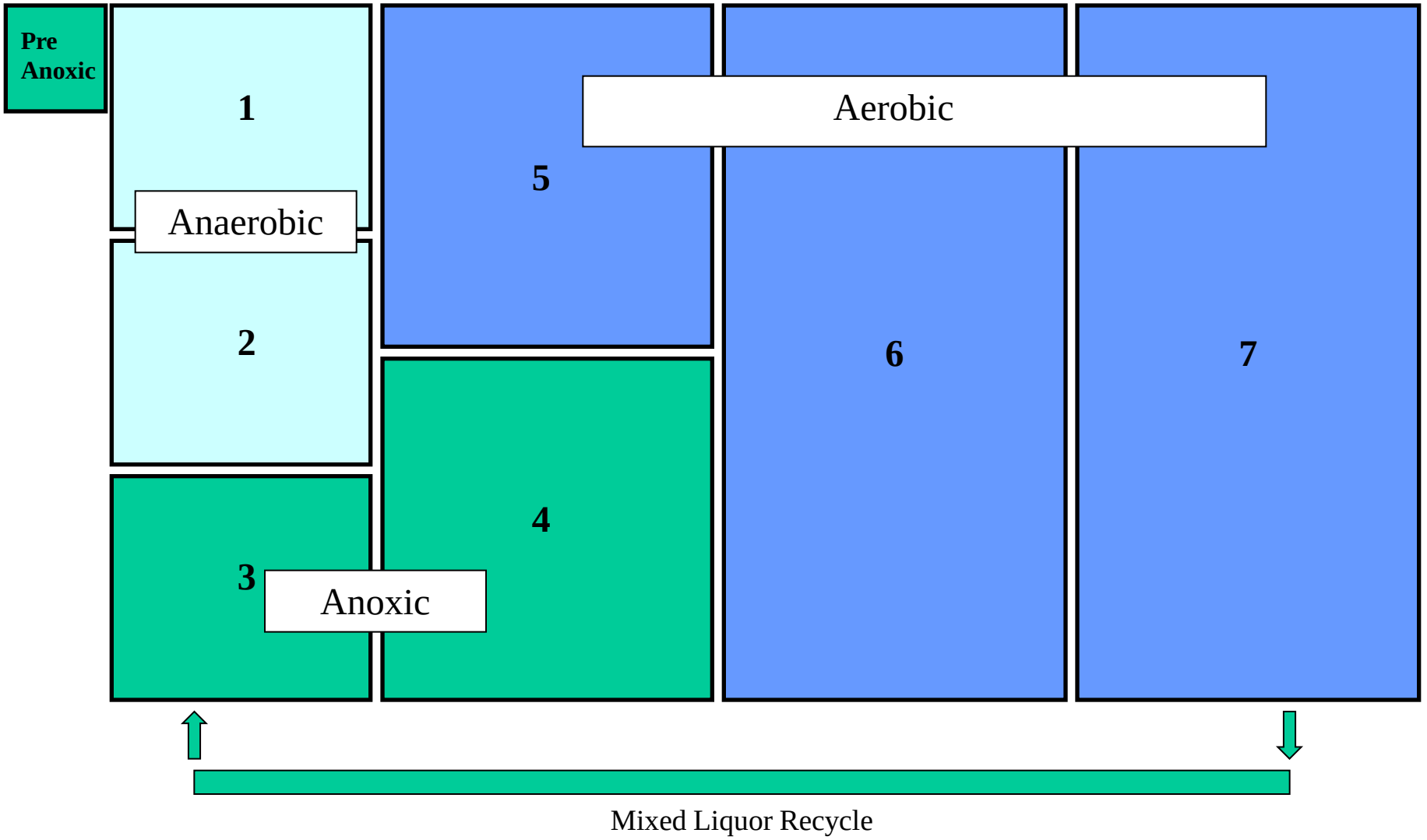
The phosphate to phosphate bonds are broken

Phosphorus Removal

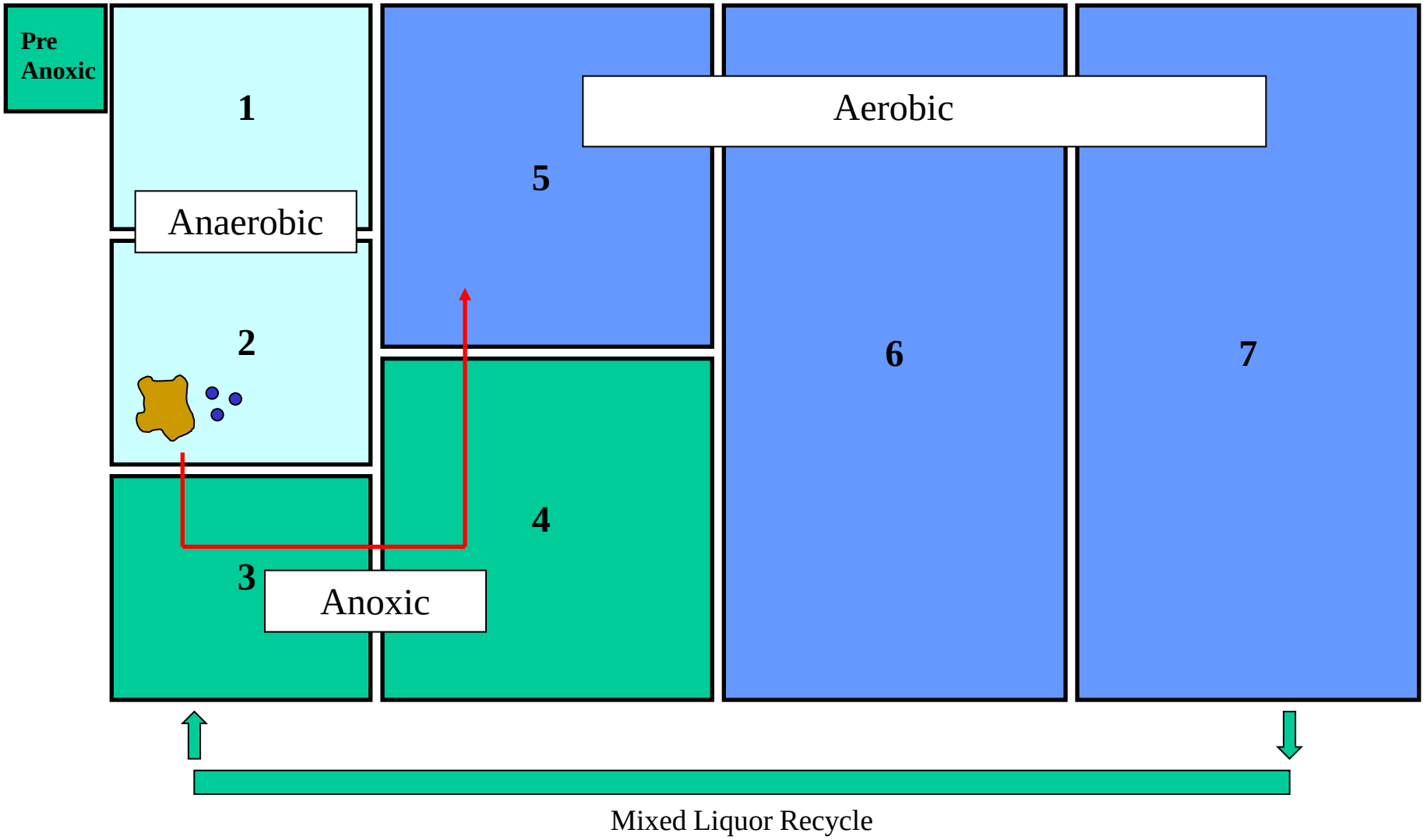


Resulting in increased PO_4^{3-} in anaerobic cells

Phosphorus Removal

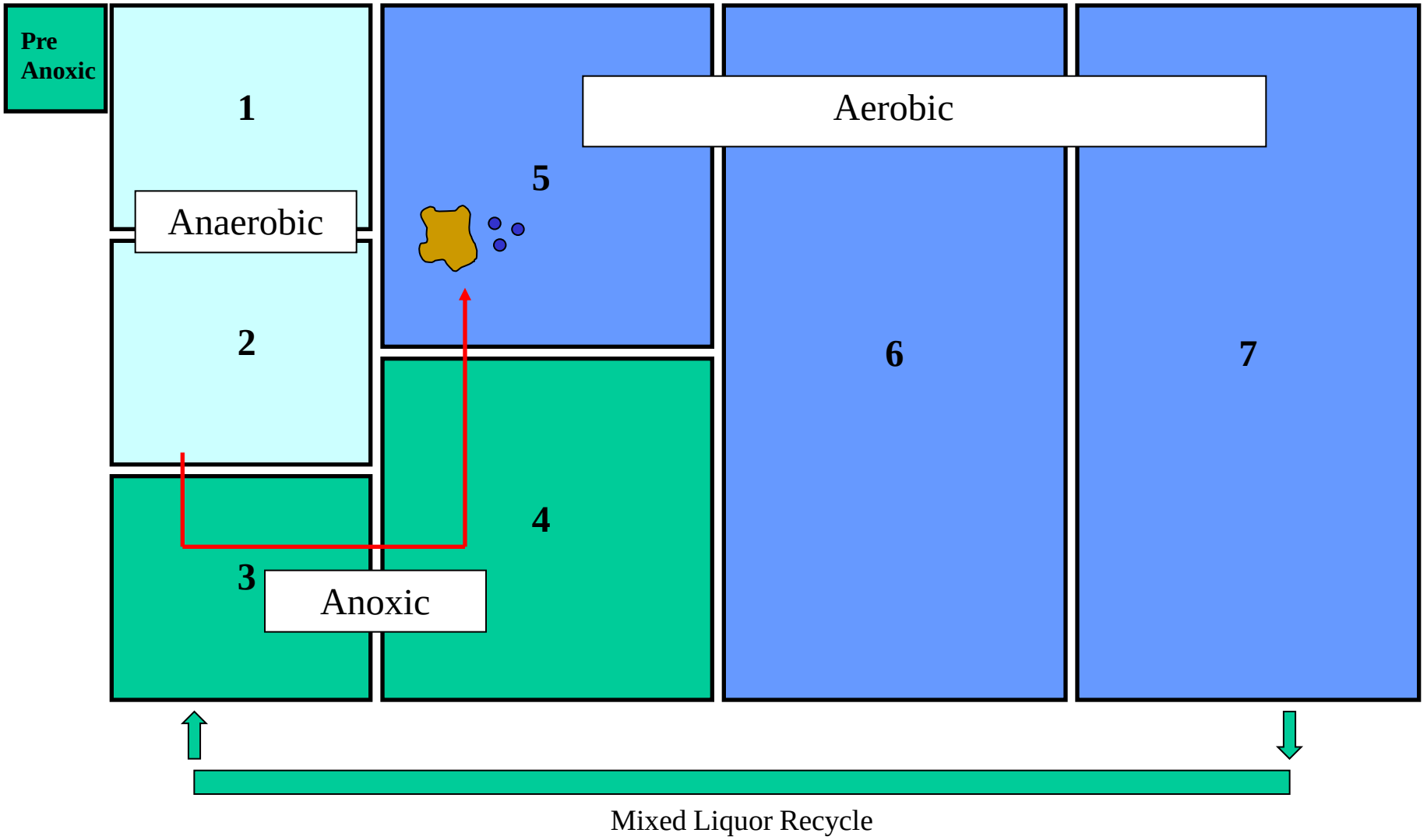


Phosphorus Removal



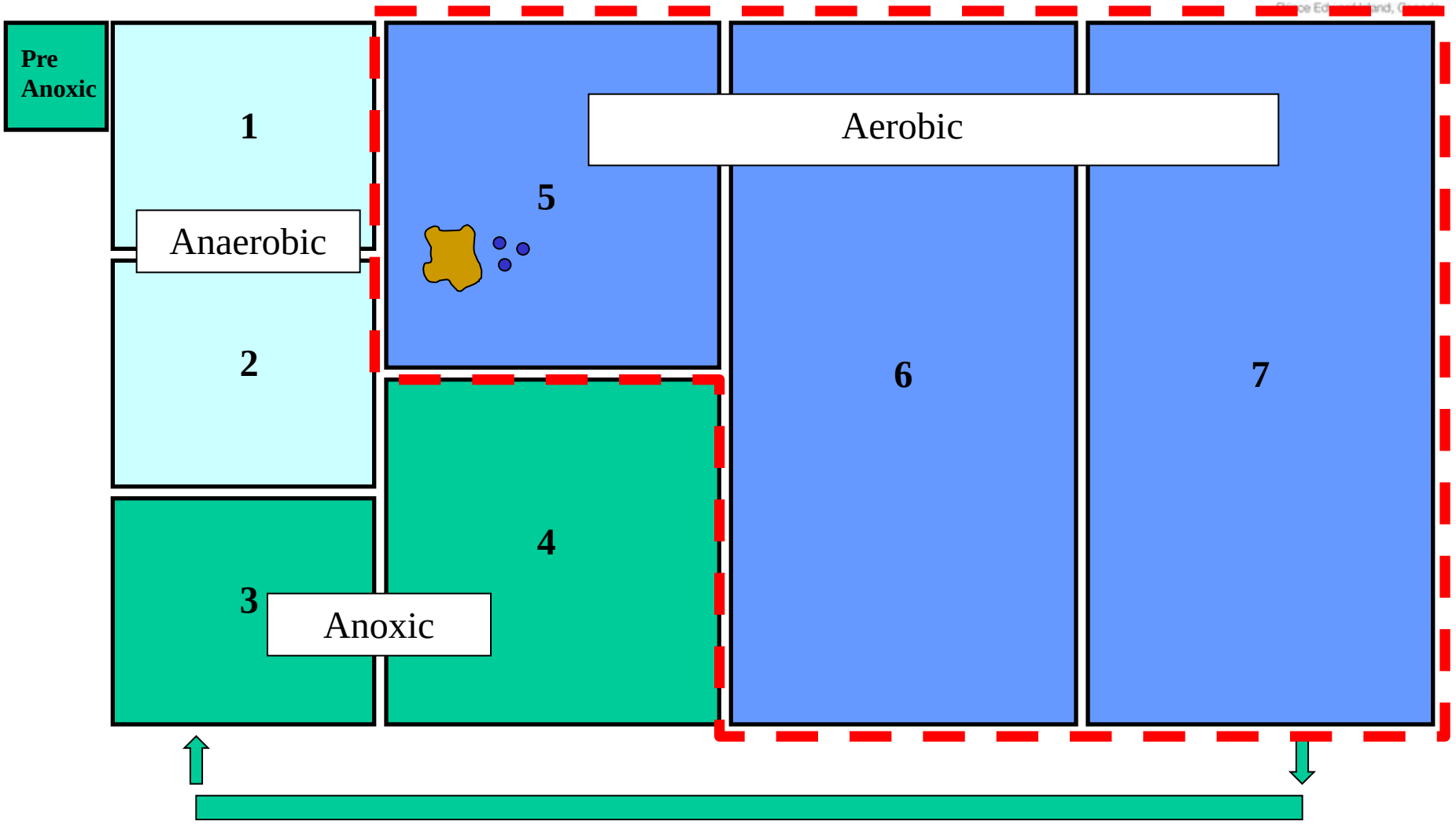
PAOs and free phosphates travel through Anoxic Zone to the aeration basin

Phosphorus Removal

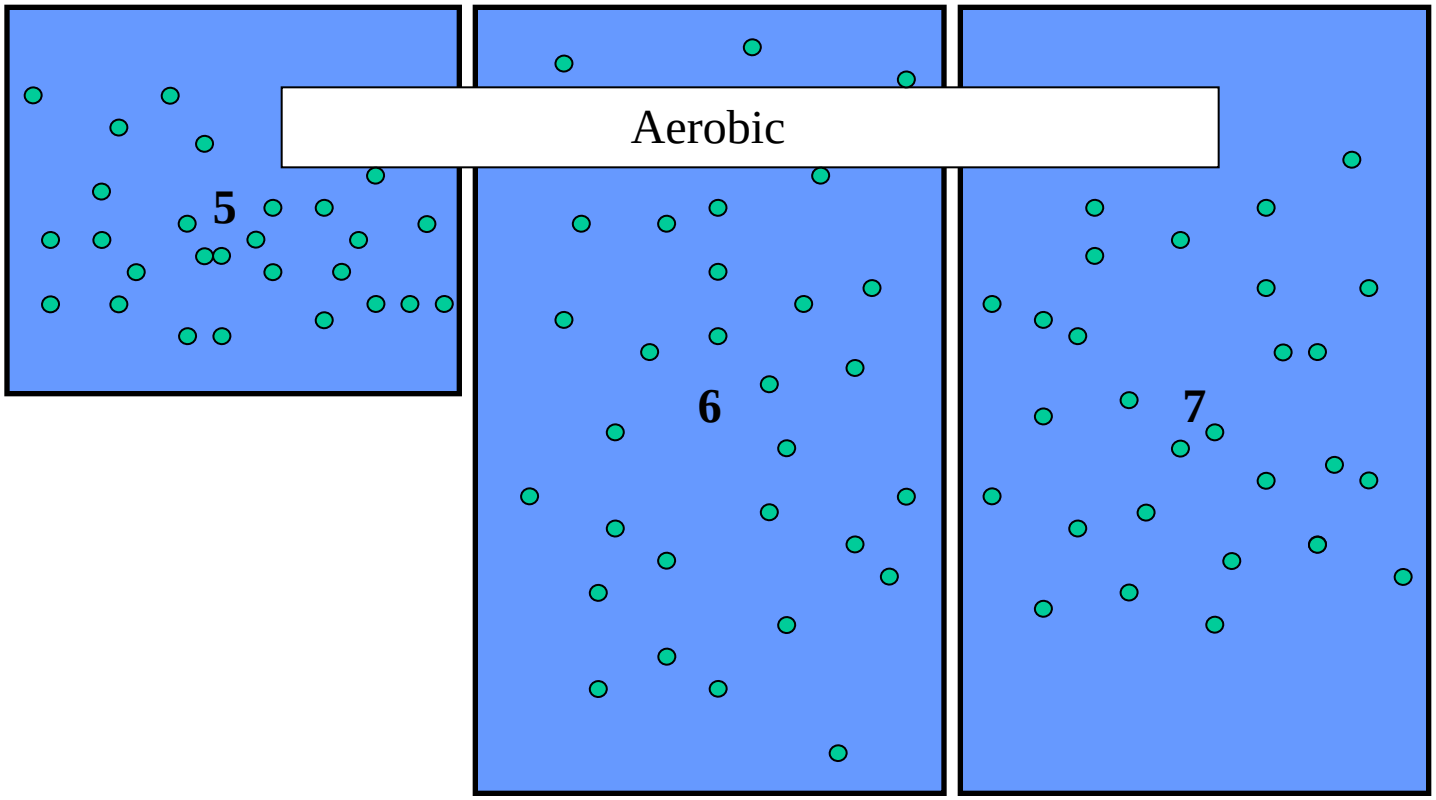


PAOs and free phosphates travel through Anoxic Zone to the aeration basin

Phosphorus Removal



Phosphorus Removal



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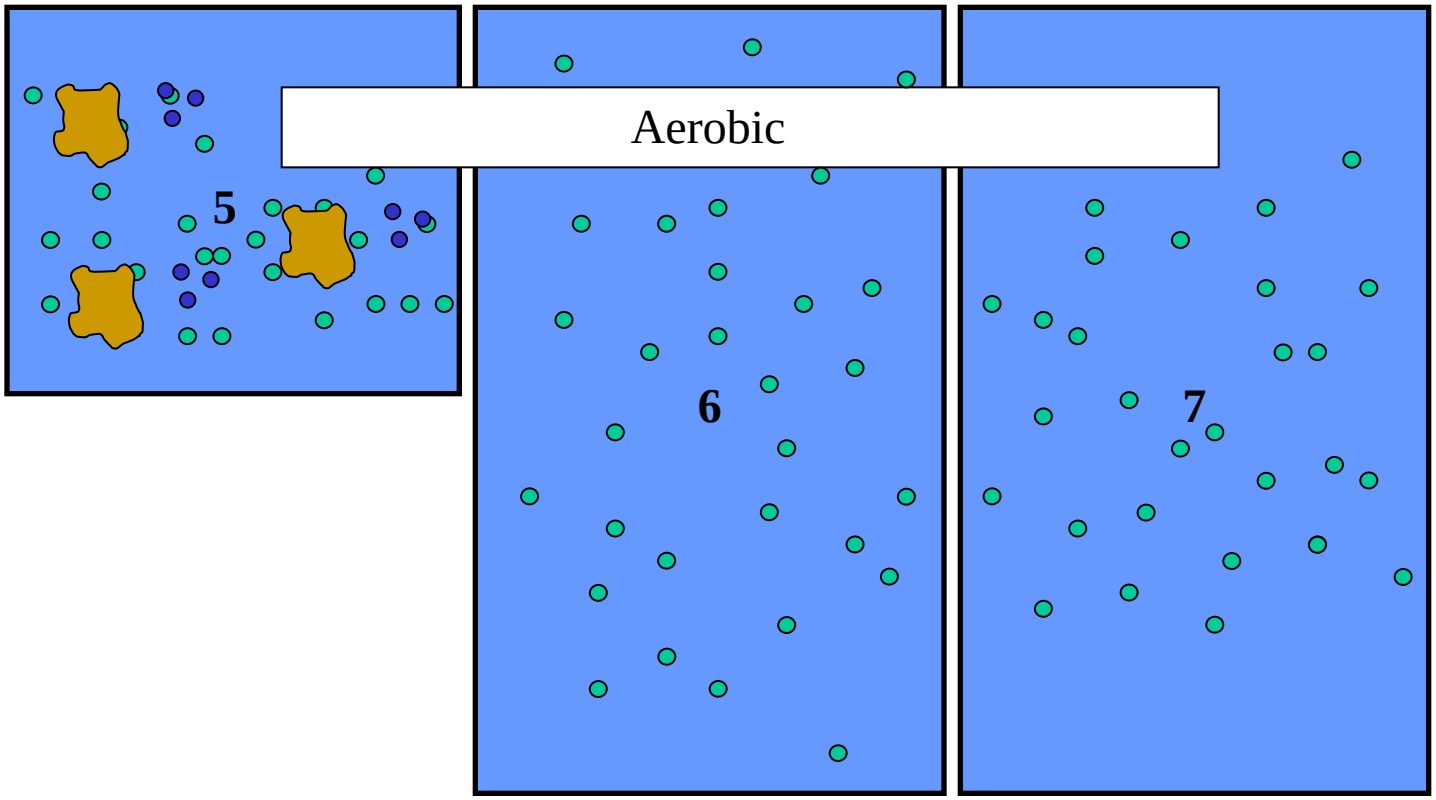

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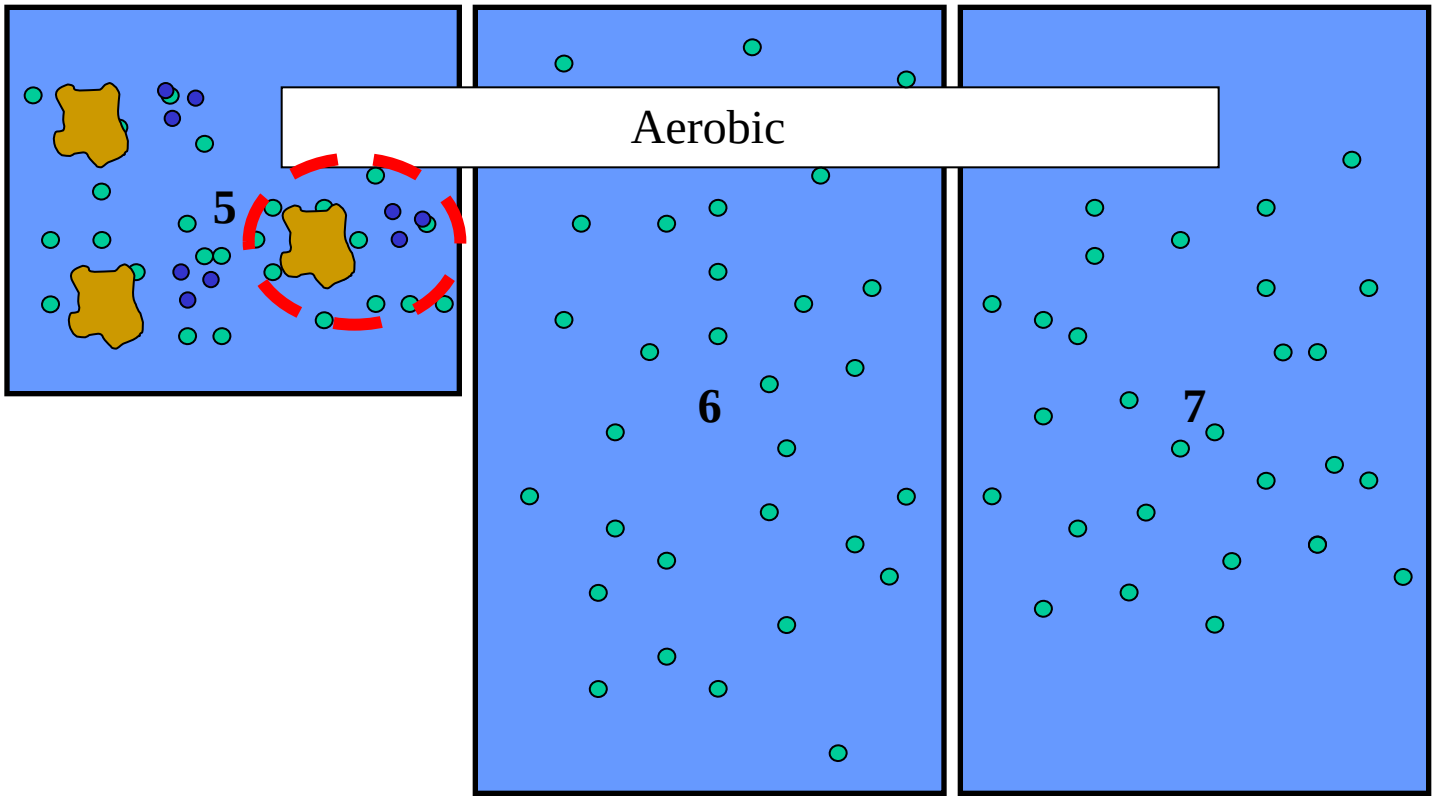

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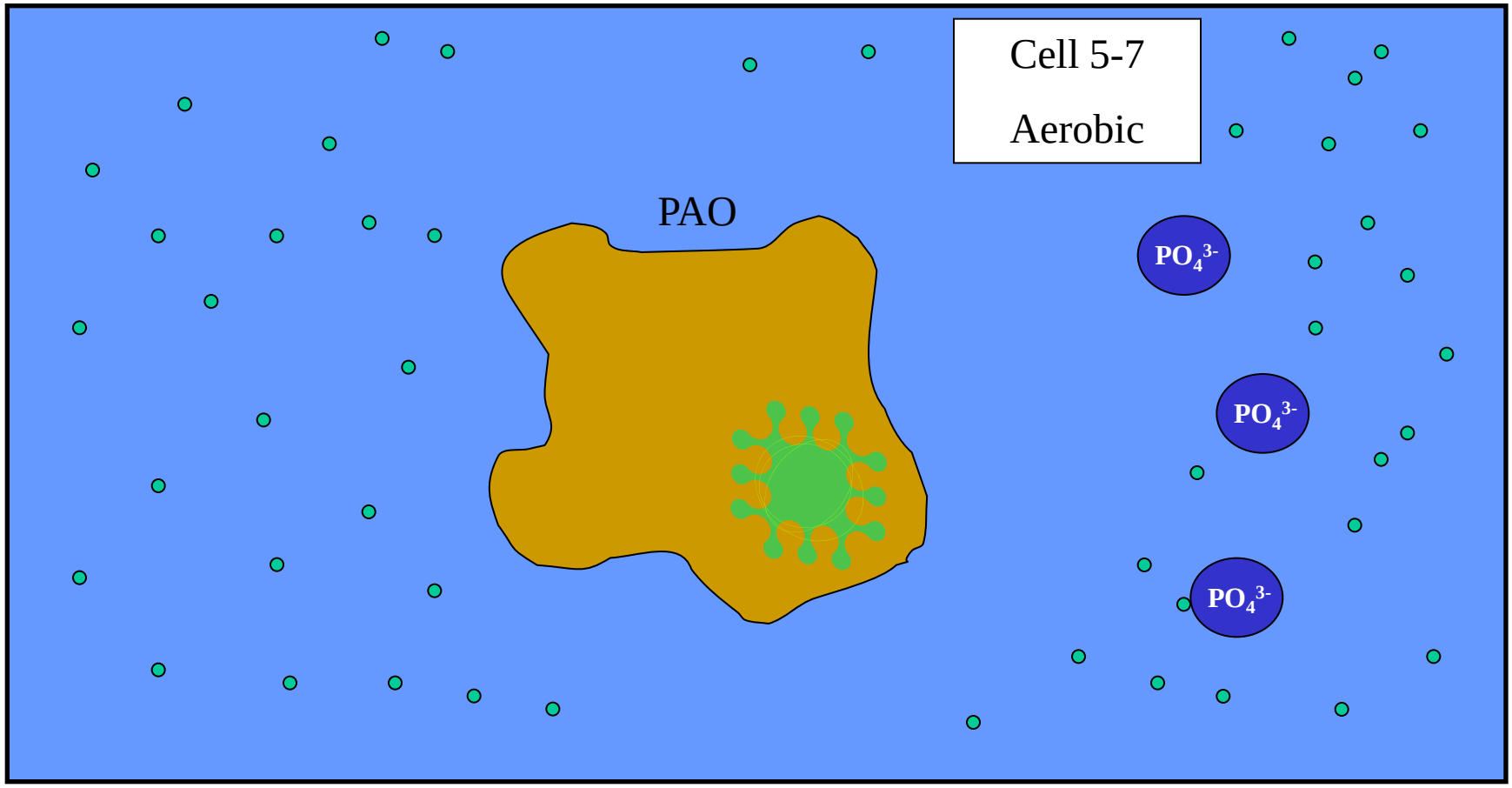
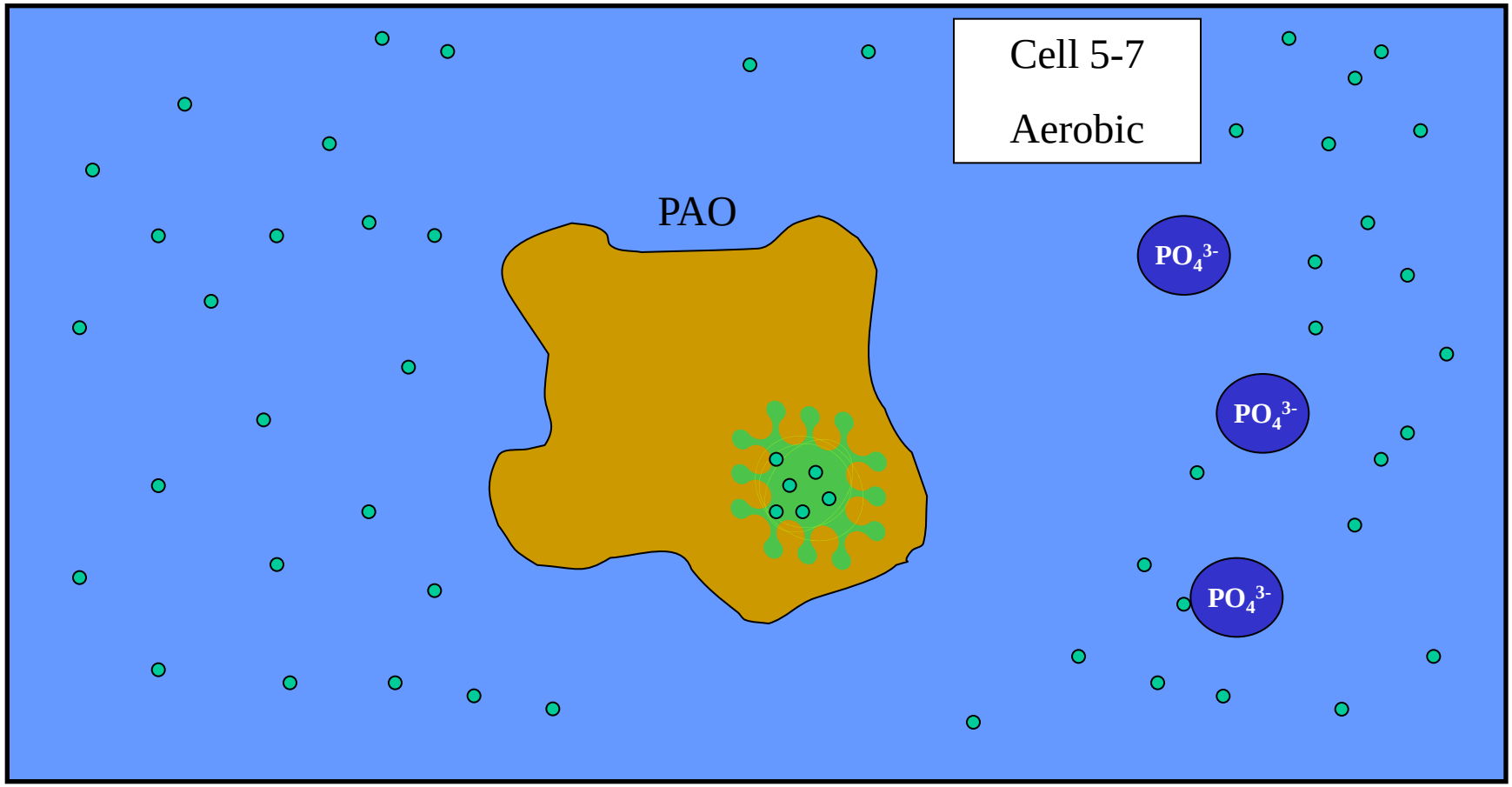
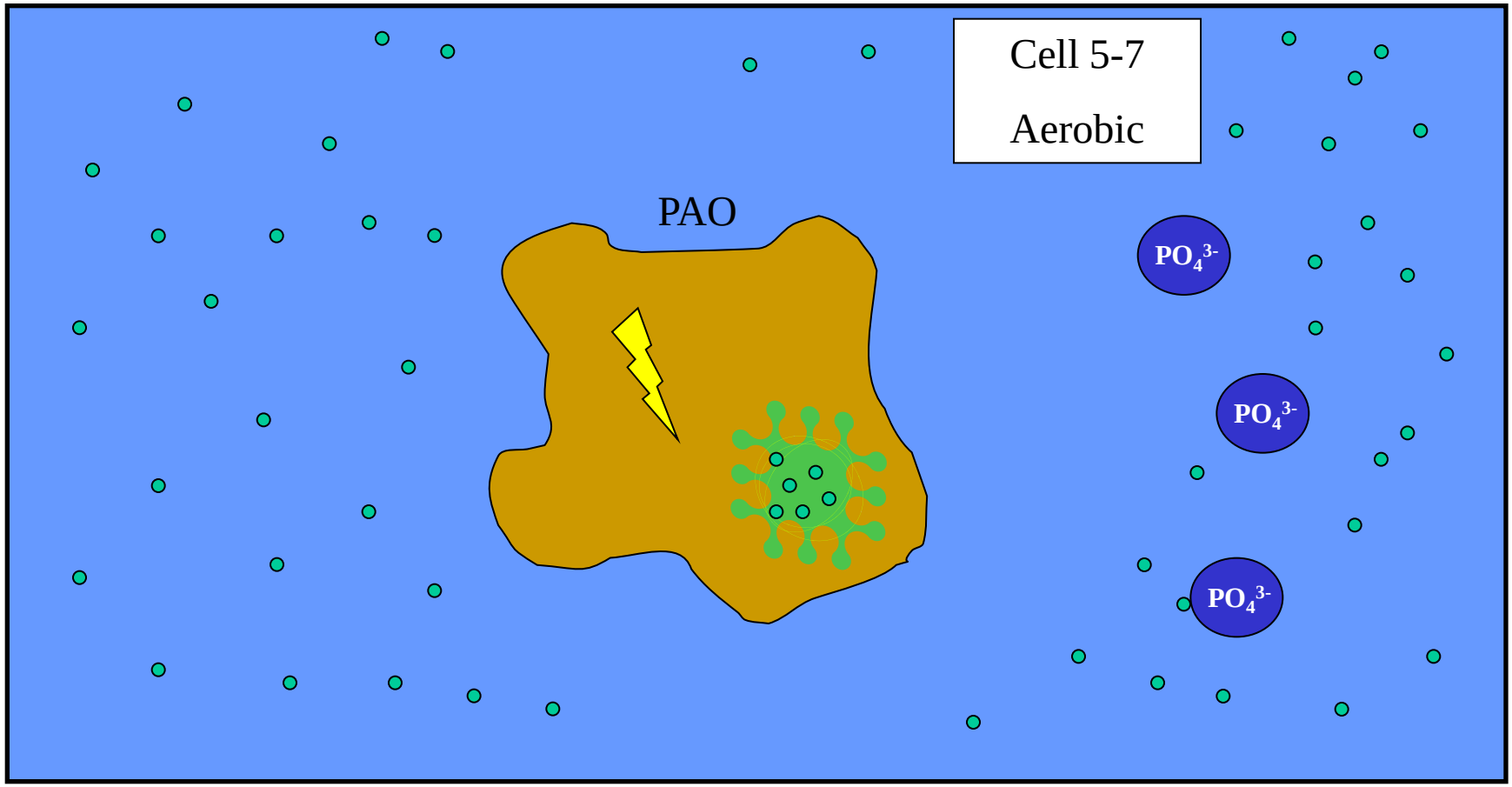


Phosphorus Removal



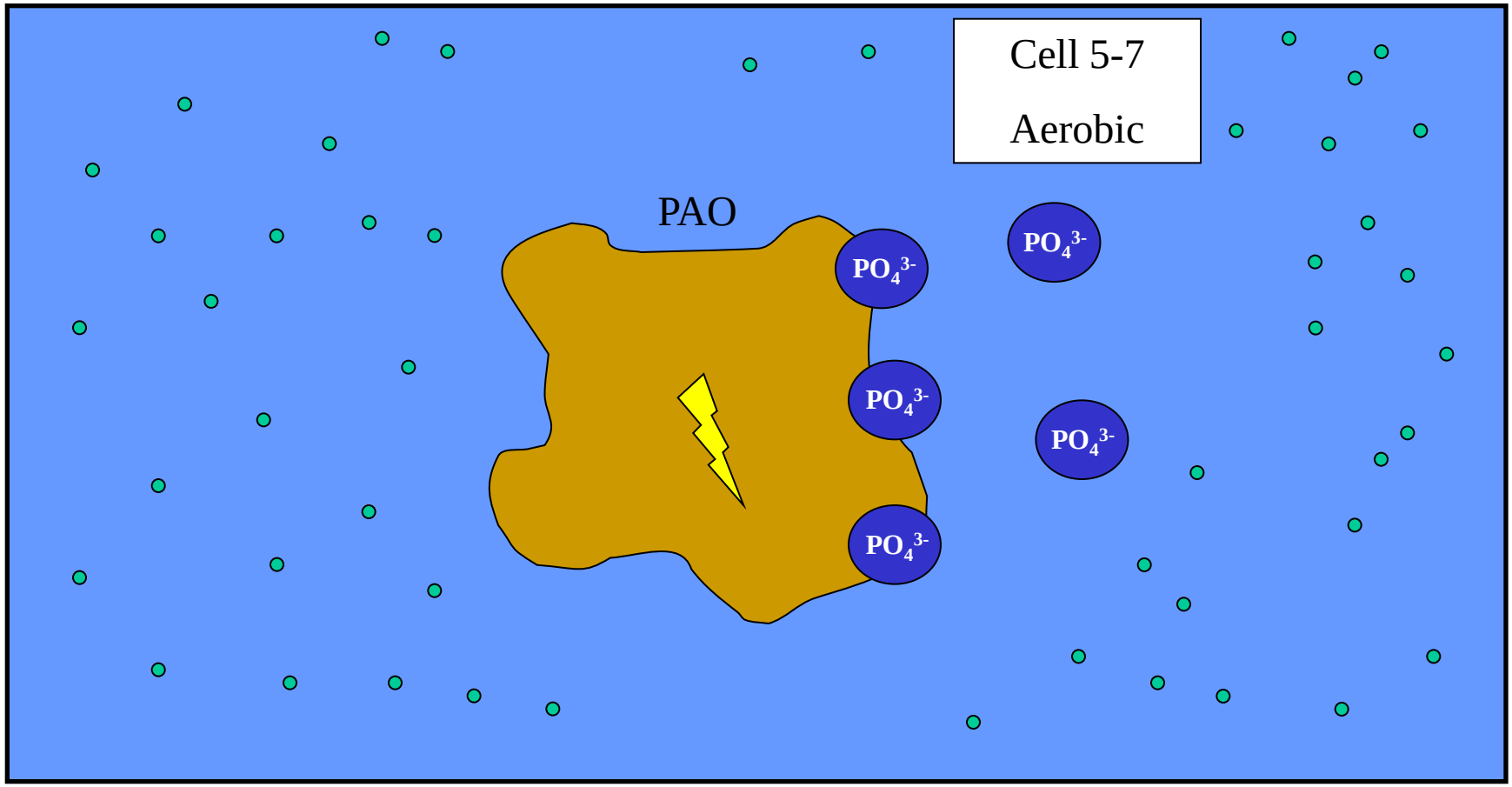
Stored Organic Material is oxidized in Aerobic Zone

Phosphorus Removal



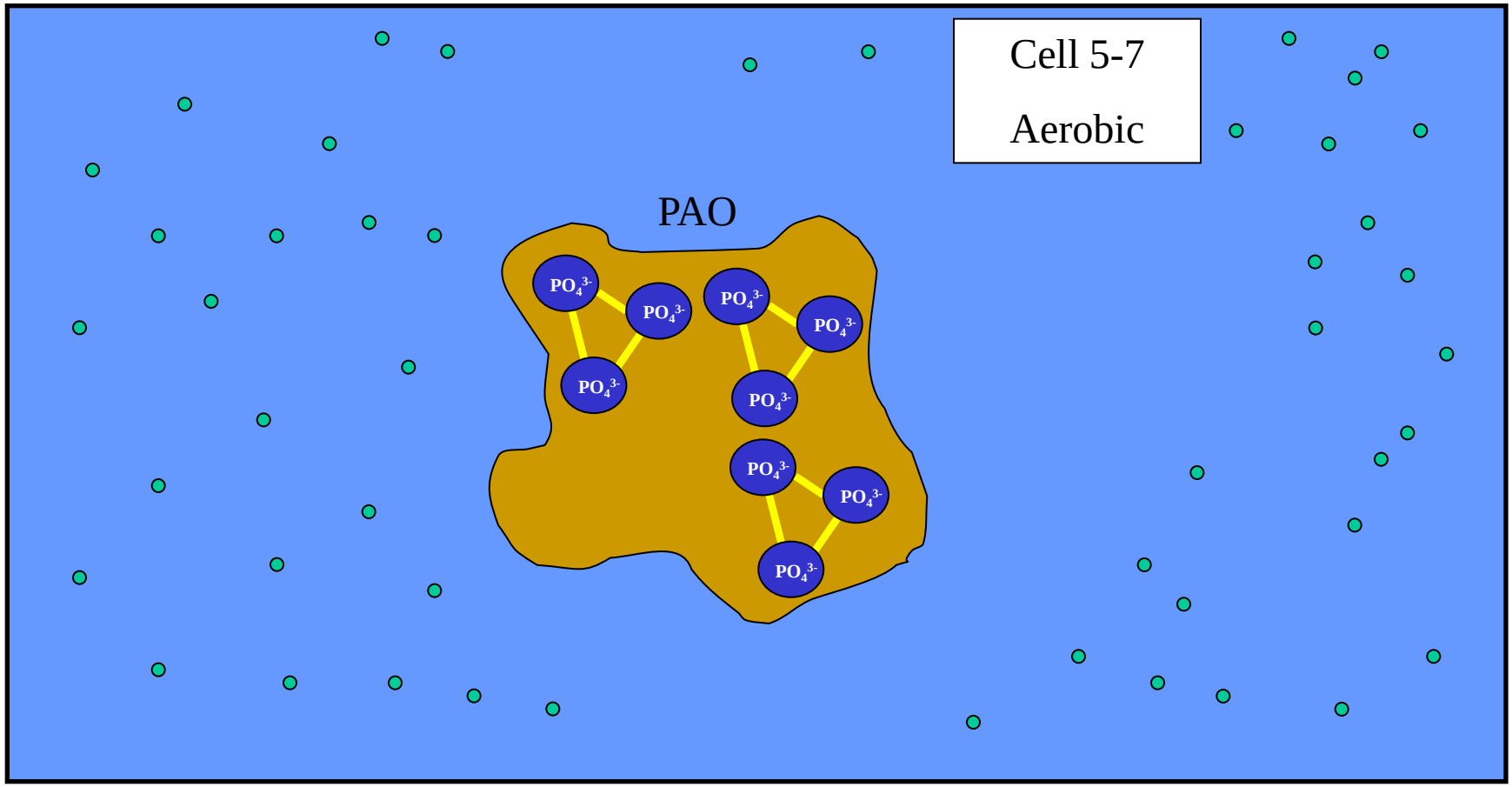
Energy is produced

Phosphorus Removal



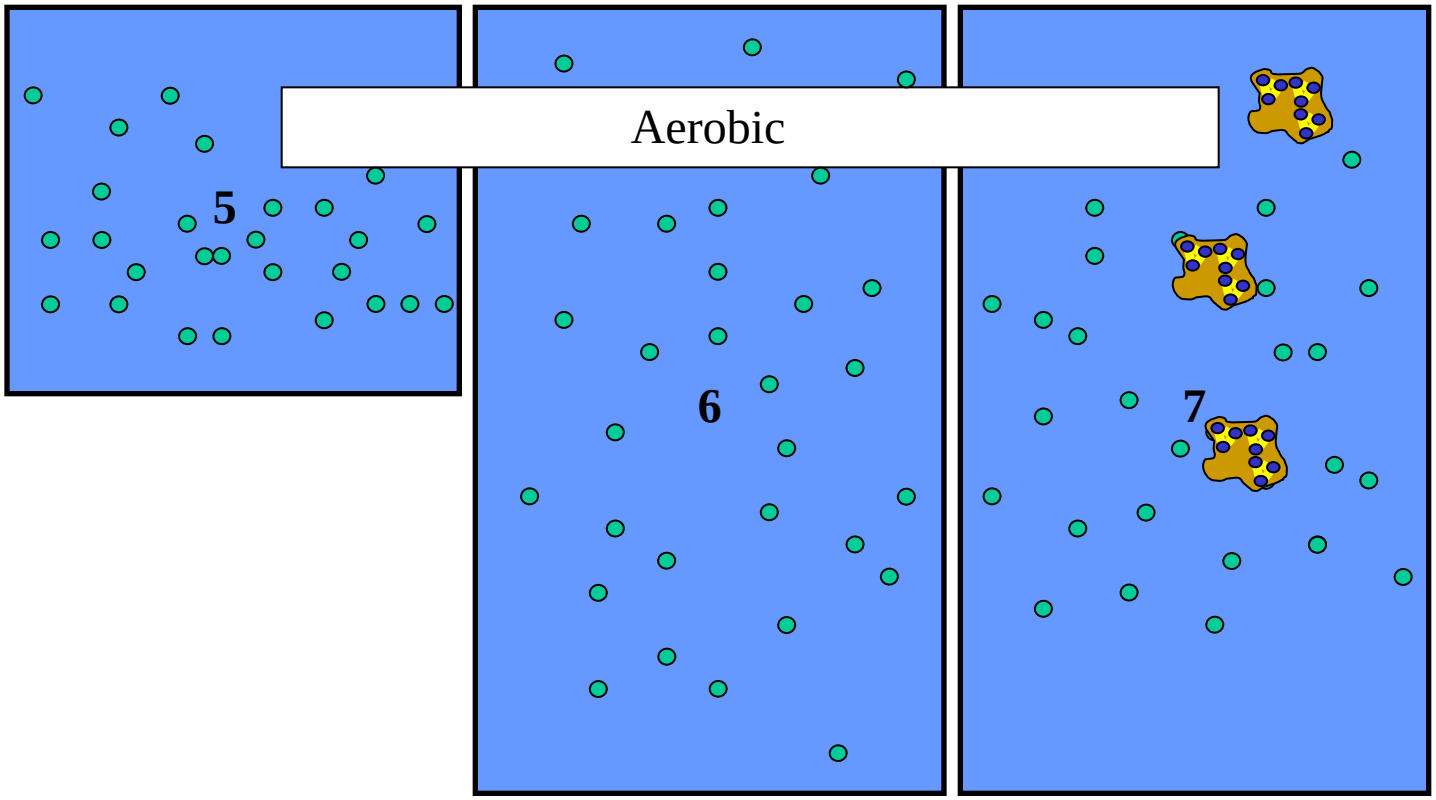
Phosphates are drawn towards the energy in order to form bonds

Phosphorus Removal



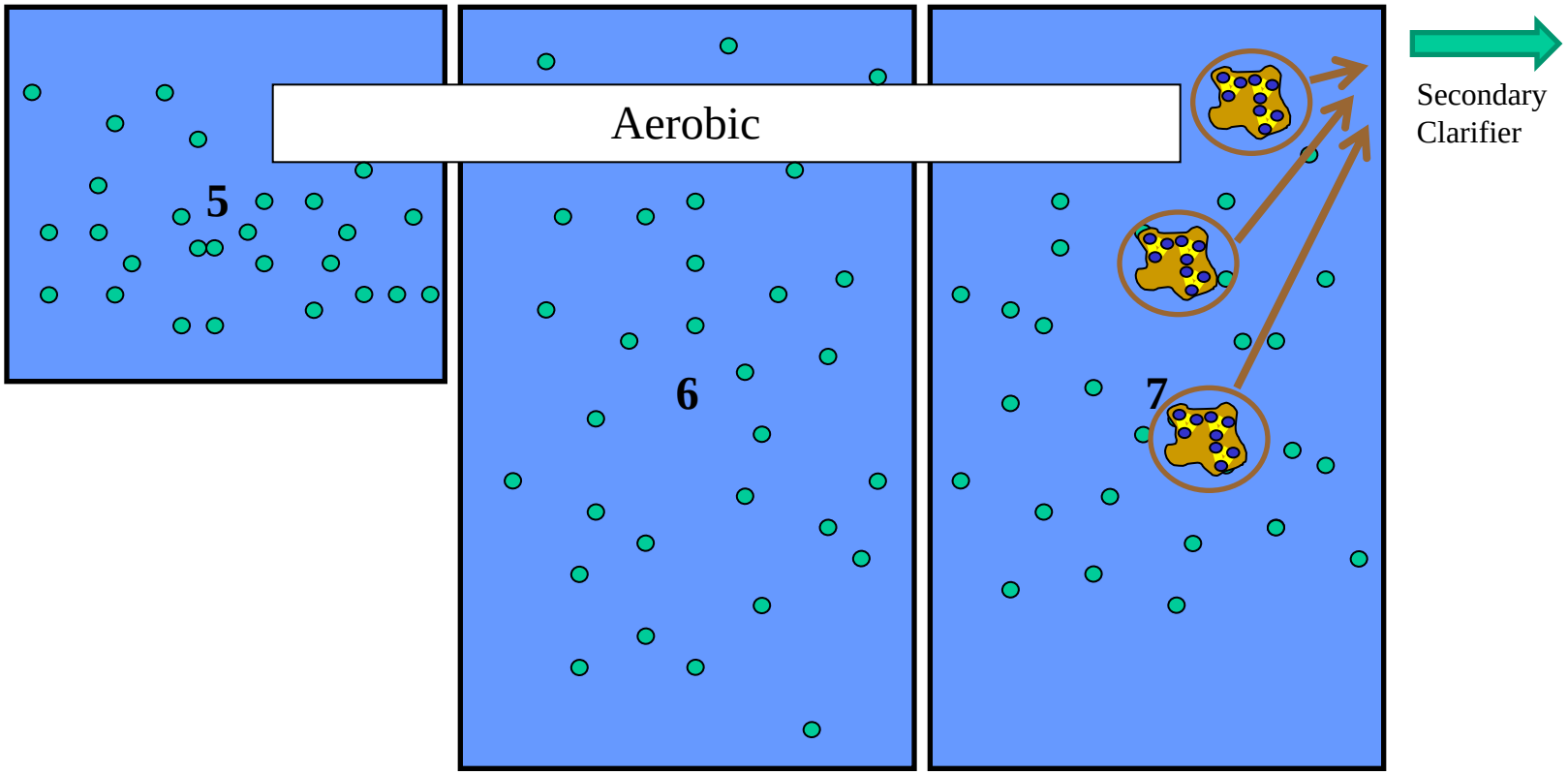
Energy is used to form bonds and uptake more phosphates than originally present

Phosphorus Removal



PAO's uptake phosphates as they travel through the aeration basin

Phosphorus Removal



PAO's are then wasted in WAS and therefore removed from solution in final effluent

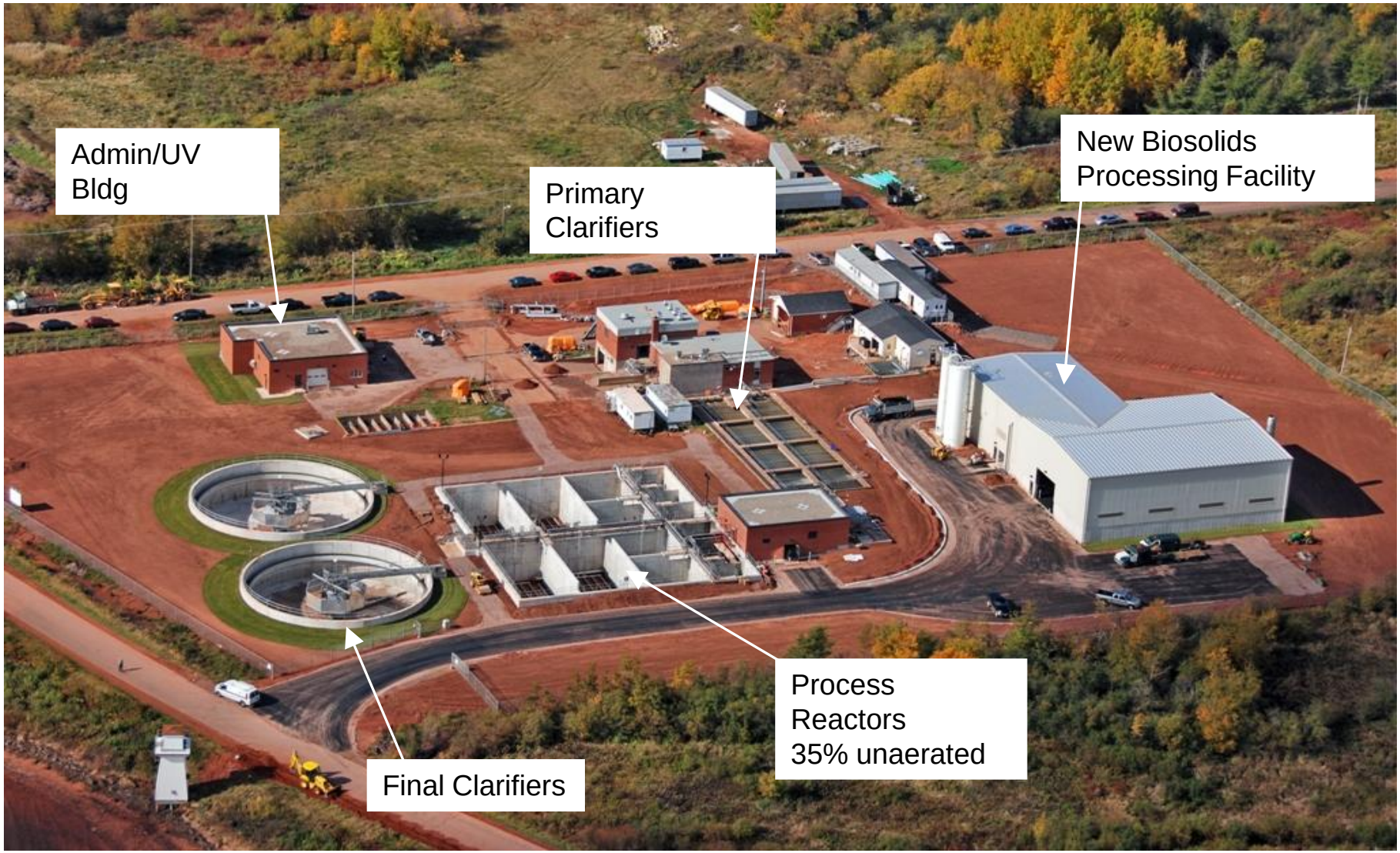
SWPCC Process Schematic

- Key Features:
  - Variation of the Activated Sludge process.
  - Efficient removal of BOD, TSS, Ammonia, Nitrogen & Phosphorus
  - Will comply with Canada Wide Strategy for Municipal Wastewater Effluent (25/25 non-toxic & Chlorine residual < 0.01)
  - Significantly reduces nutrient loads to the harbour

SWPCC – Effluent Criteria

Parameters	Effluent Requirements	BNR Effluent Objectives
CBOD, mg/L	25	10
TSS, mg/L	25	10
Ammonia, mg/L	16	5
Total N, mg/L	n/a	10
Ortho-phosphate, mg/L	n/a	0.5
Total P, mg/L	n/a	1.0
Fecal Coliforms, MPN/100 mL	200 avg 400 max	200 avg 400 max

SWPCC Aerial View



Control Room

Process control and monitoring

Laboratory

Daily testing and monitoring

Headworks Building

Initial screening and flow measurement

Primary Clarifiers

Constructed 1972 – Retrofitted 2007

Process Reactors

Anoxic and Anaerobic Zones

Process Reactors

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Prince Edward Island, Canada

Anaerobic cells, Aerobic cells and Secondary Clarifiers

Process Reactors

Aerobic Zone with DO control

Secondary Clarifier

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Plant Service Water

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Prince Edward Island, Canada

Treated Effluent Recycled for Operations

RAS Pumping Station

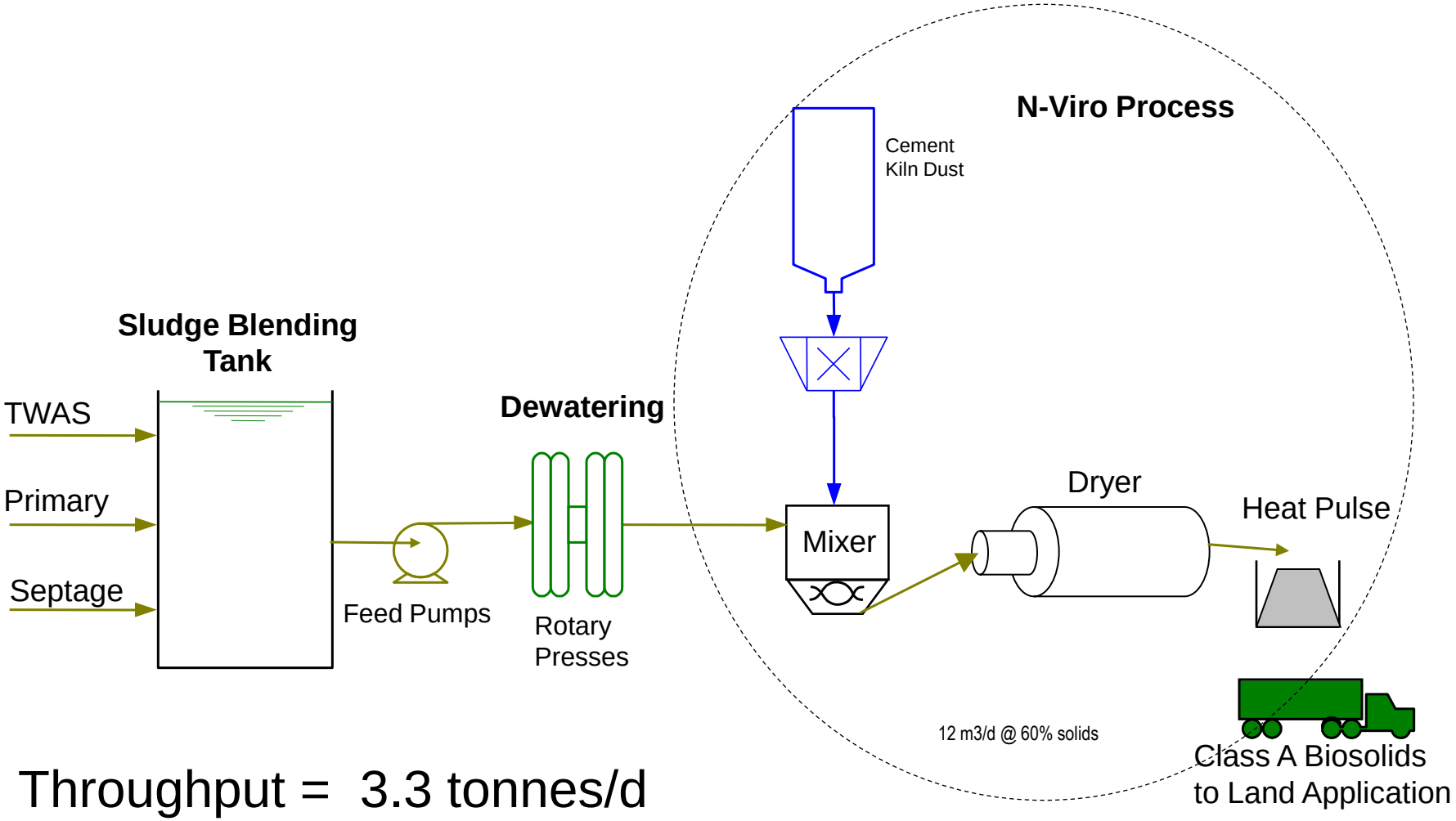
City of Summerside
Prince Edward Island, Canada

Flow Pacing Matches Plant Flow

UV Disinfection

Dose Pacing – flow and transmissivity

Sludge Treatment Process



Throughput = 3.3 tonnes/d

WAS Thickening

Rotary Drum Thickener

- Thickens WAS from 0.75% to 4% solids.
- Two units (1 duty, 1 stdby)

Dewatering

- Fournier Press
- Design throughput of 600 kg/h at 4% solids
- Expected Cake dryness 20 to 25% solids

Biosolids Treatment Process

Sludge mixer – Lime, Lime Dust and Sludge

Rotary Drum Dryer (N-Viro)

- Max throughput of 4 tonnes/hr (inlet)
- 5,000 cfm of air required.
- Oil fired Burner
- Output = 2.5 tonne/hr at 62% solids (wet).

Odour Control

- Exhaust from N-Viro system cooled and treated in biofilter.
- Odorous air from headworks and sludge storage added.

Biosolids Final Product

- 62 % Total Solids content
- Granular consistency
- Spread with lime spreaders

Major Lift Stations

Reads Corner

Eustane St.

Northumberland St.

Minor Lift Stations

Red Bridge

MacKenzie Drive

Crozier Drive

MacArthur Subdivision

Wedge Drive

Harbor Drive

Briggs Street

Granville Street

North St. Eleanor's Lagoon

The End

For Information Contact:

Waste Water Treatment Plant
1-902-432-1274
Supervisor: Frank Murphy
Staff : Everett Moase
Paul Cormier
Mike Gillis
Randy McCourt
Joe Noonan
Tours are available on request.

THANK YOU!

City of Summerside
Prince Edward Island, Canada