ES 200 ENVIRONMENTAL STUDIES

Module-C

Anthropogenic effects on ecosystem, water quality & health, water & wastewater treatment

Lecture-7

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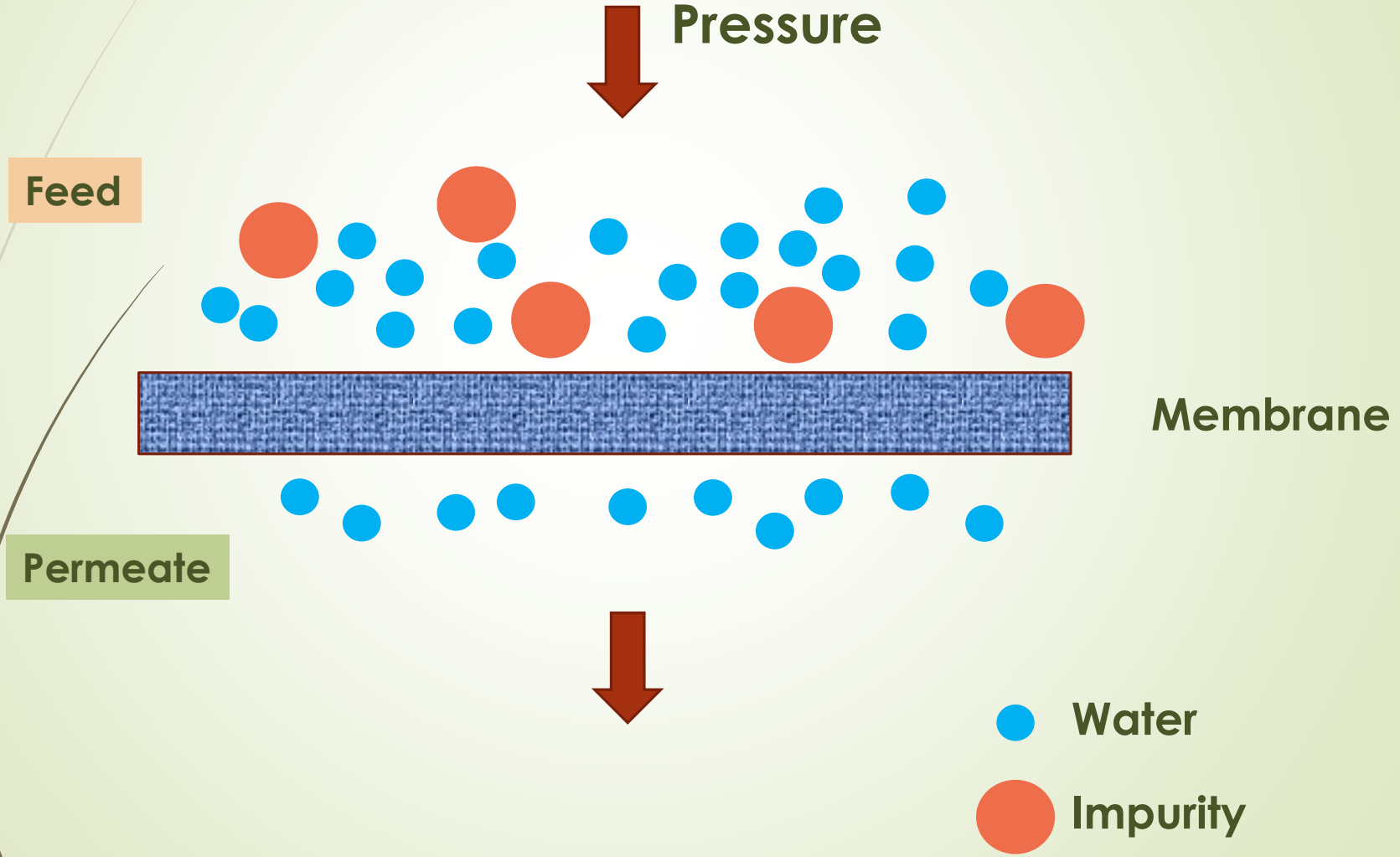
Learning Objectives

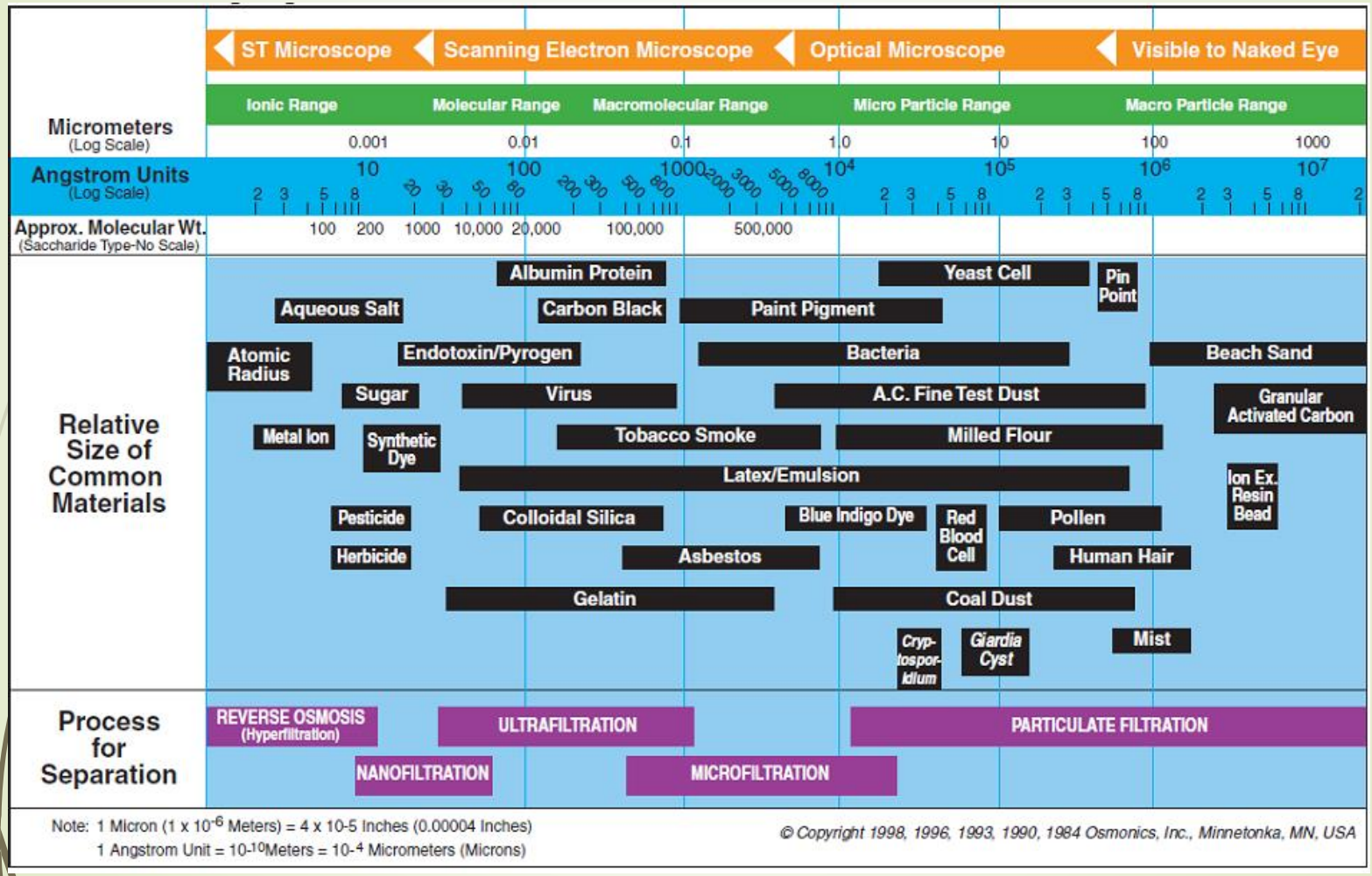
Alternate Water & Wastewater Treatment

- Membrane Filtration
- High Rate Algal Pond (HRAP)
- Advanced Integrated Wastewater Pond System (AIWPS)
- Photobioreactor
- Solar Disinfection (SODIS)

Membrane Filtration

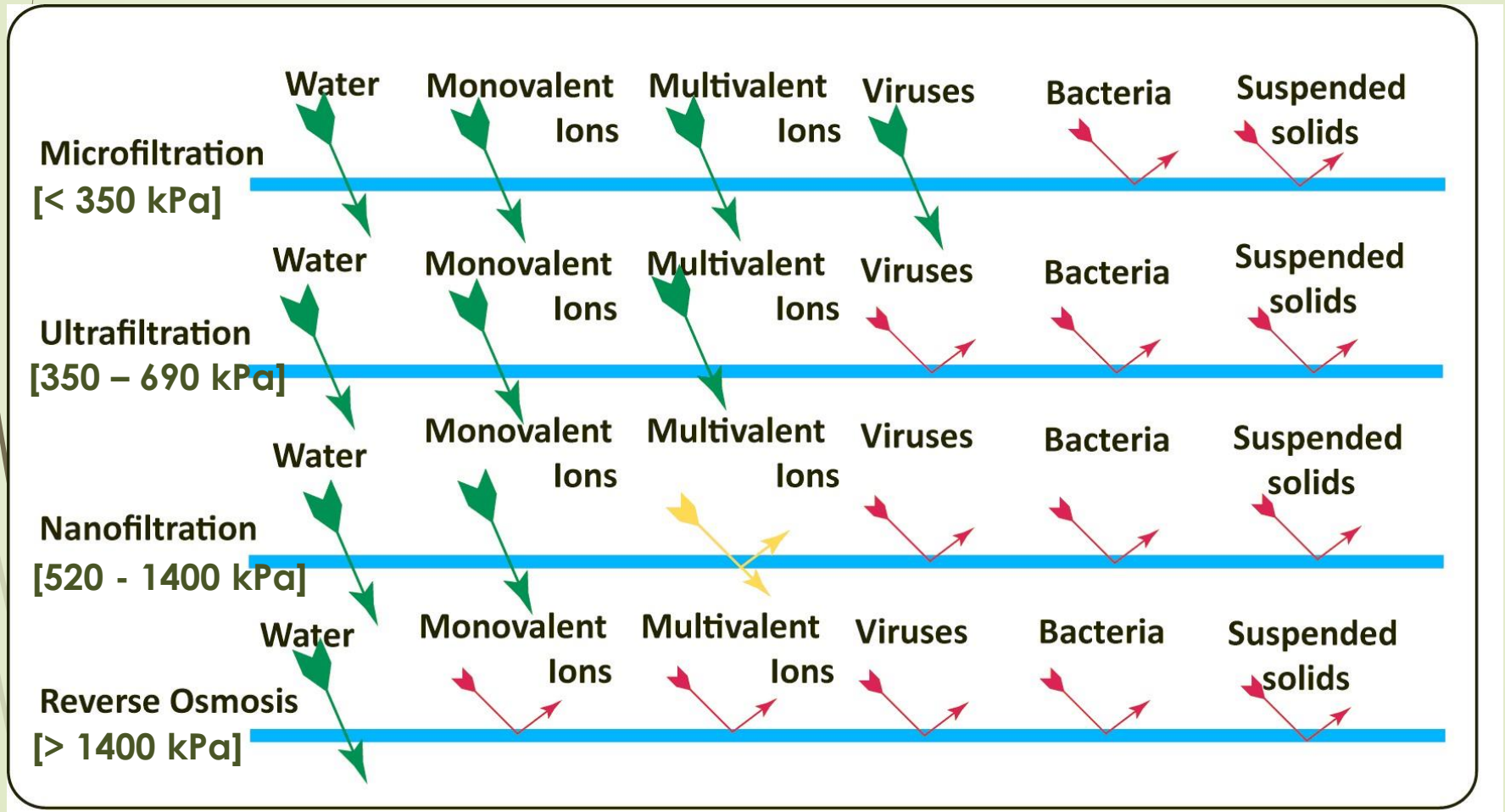


Membrane Filtration



http://www.sswm.info/sites/default/files/toolbox/RADCLIFF%202004%20Filtration%20Spectrum.png

Membrane Filtration



http://www.aquafieldservices.com/images/membrane%20types.jpg

Membrane Filtration

Common Membrane Material

Organic Membrane

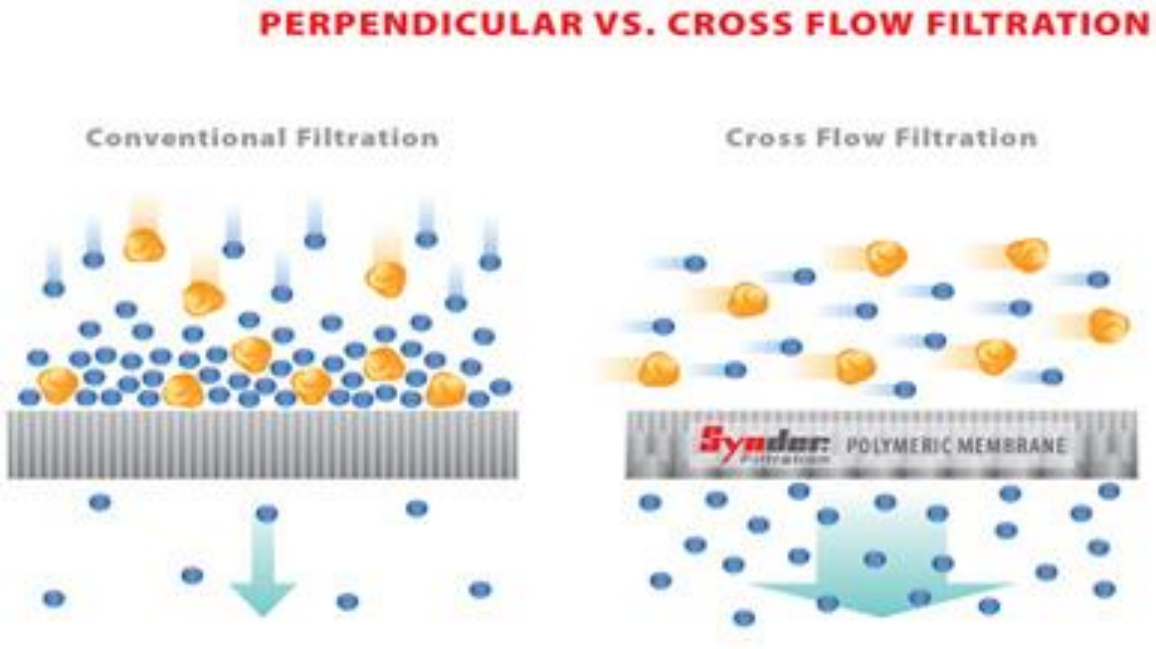
- Polyethersulfone (PES)
- Polyvinylidenedifluoride (PVDF)
- Polyacrylonitrile (PAN)
- Polytetrafluoroethylene (Teflon PTFE)
- Polyamide-imide (PAI)
- Polyvinylidenedifluoride (PVDF)
- Rubber
- Wool
- Cellulose

Inorganic Membrane

- Metallic Membrane (e.g. W, Pd)
- Ceramic Membrane
- Zeolite Membrane

Membrane Filtration

Membrane Operation



http://synderfiltration.com/2014/wp-content/uploads/2014/05/Cross-Flow-Ultrafiltration.jpg

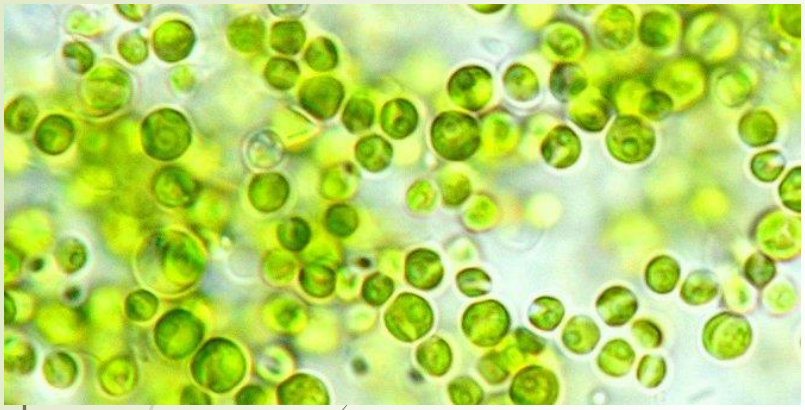
Membrane Filtration

Membrane Operation

Reading Assignment

- Read about the advantages and limitations of membrane technology.
- Read about the application of membrane technology for Sea Water Desalination in Israel and other such countries.

Algae Based Treatment Systems



http://www.valuefood.info/wp-content/uploads/2013/12/health-benefits-of-chlorella-670x337.jpg

- Algae produce oxygen during photosynthesis which can meet the aeration requirements in conventional treatment.
- Symbiotic relation between aerobic bacteria and algae could contribute in organic carbon as well as nutrients removal.
- Algae also have potential to uptake various micropollutants.
- The generated algal biomass has huge commercial value.

Algae Based Treatment Systems

High Rate Algal Ponds (HRAP)

http://www.aban.com/ABANBIOTECH/img14/2.jpg

HRT ~ 4-10 days
Depth ~ 0.3-1 m
Flow velocity ~ 30 cm/sec

- Optimum algal growth in HRAP results in substantial nutrients removal.
- Algal growth in HRAP result in the pH levels to rise up to 9.5 – 10. These high pH levels result in increased disinfection rate.
- Algae grown in HRAP have better settling properties.

Algae Based Treatment Systems

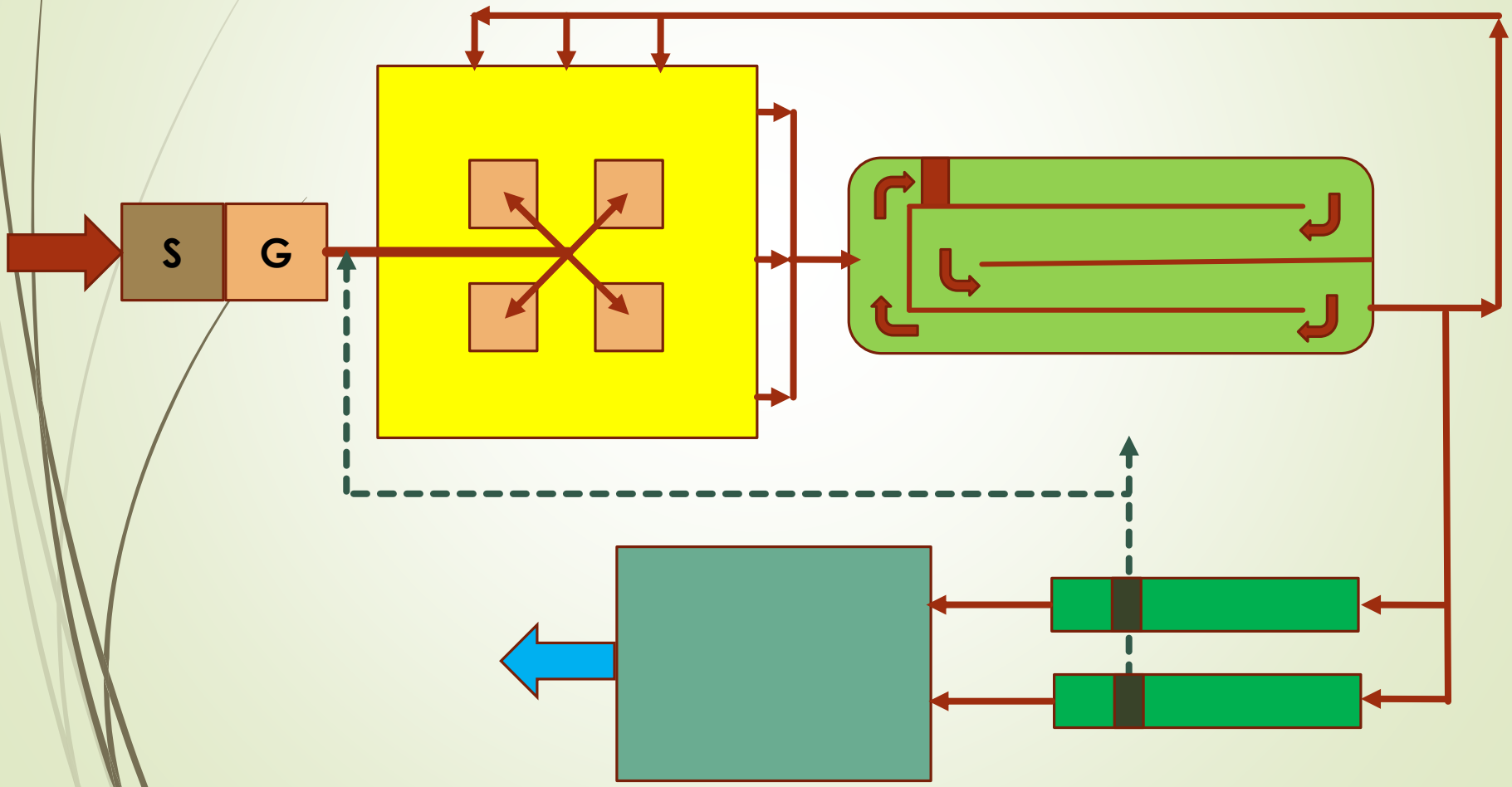
Advanced Integrated Wastewater Pond System (AIWPS)

AIWPS consist of a series of at least four ponds, each designed to best perform one or more of the best treatment processes.

- **First** is a facultative pond with an aerobic surface and an extremely anoxic internal pit for sedimentation and fermentation.
- **Second** is a high rate algal pond or raceway pond.
- **Third** is an algal settling pond.
- **Fourth** is a maturation pond.

Algae Based Treatment Systems

Advanced Integrated Wastewater Pond System (AIWPS)



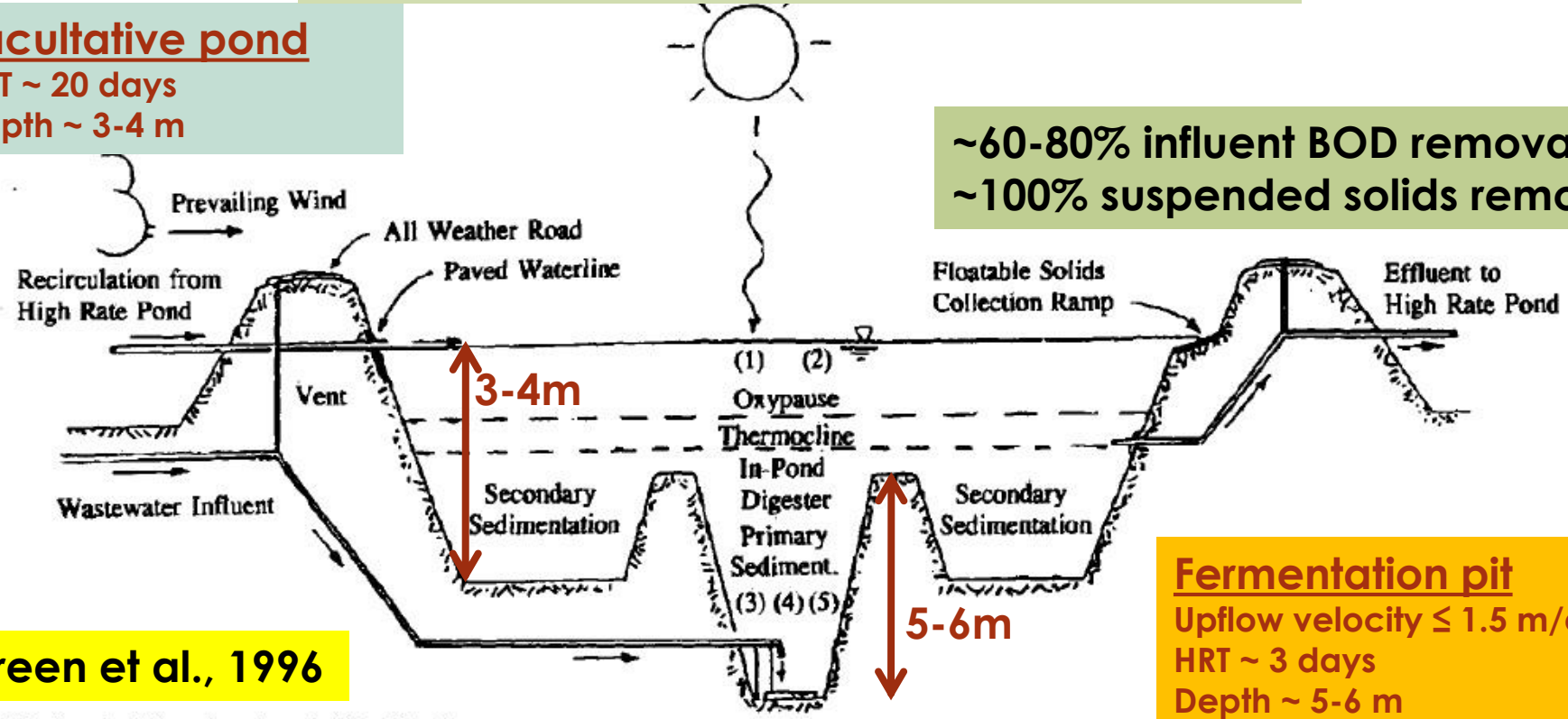
Algae Based Treatment Systems

Advanced Integrated Wastewater Pond System (AIWPS)

1. Facultative pond with fermentation pits

Facultative pond
HRT ~ 20 days
Depth ~ 3-4 m

~60-80% influent BOD removal
~100% suspended solids removal



Green et al., 1996

Fermentation pit
Upflow velocity ≤ 1.5 m/d
HRT ~ 3 days
Depth ~ 5-6 m

Biochemical Reactions Located by Number

(1) Photosynthesis: $CO_2 + H_2O \rightarrow CH_2O + O_2$
(2) Aerobic Oxidation: $CH_2O + O_2 \rightarrow CO_2 + H_2O$
(3) Organic Acid Formation: $2CH_2O \rightarrow CH_3COOH$
(4) Methanogenesis: $CH_3COOH \rightarrow CH_4 + CO_2$
$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$
(5) Heterotrophic Nitrification: Fixed $N \rightarrow NO_3^-$
Denitrification: $2NO_3^- + 3CH_2O \rightarrow N_2 + 3CO_2 + 3H_2O$

Algae Based Treatment Systems

Advanced Integrated Wastewater Pond System (AIWPS)

2. High Rate Algal Ponds (HRAP)

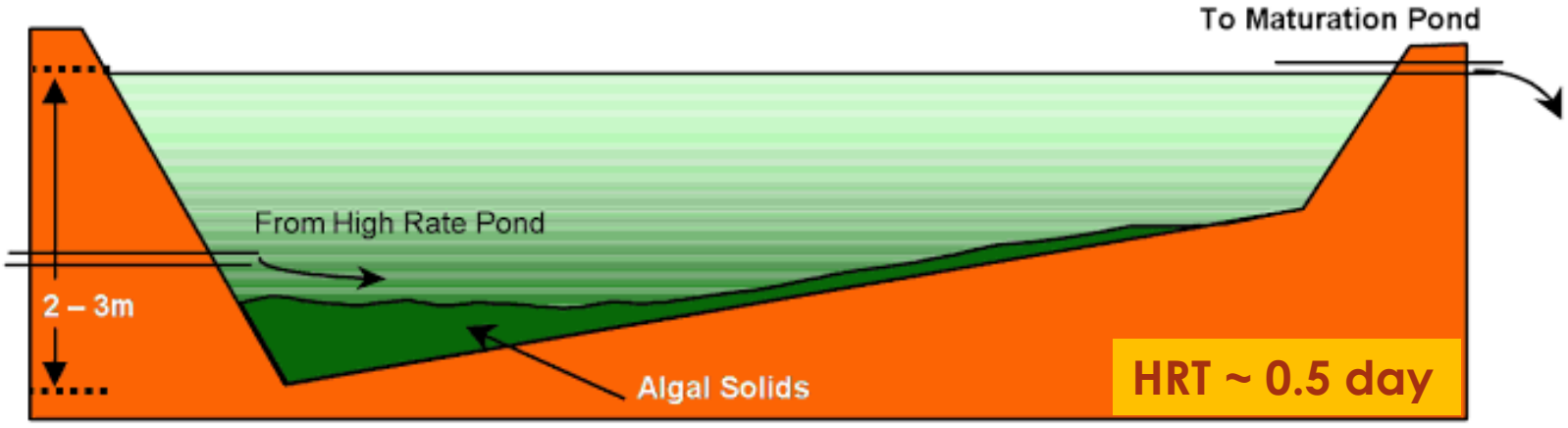
http://www.makebiofuel.co.uk/wp-content/uploads/2010/10/Seambiotic_Ponds_540x354.jpg

- Recirculation of highly oxygenated water from HRAP to top layer of facultative pond helps in odor removal.

Algae Based Treatment Systems

Advanced Integrated Wastewater Pond System (AIWPS)

3. Algae Settling Pond



Craggs, R., 2006

Algae Based Treatment Systems

Advanced Integrated Wastewater Pond System (AIWPS)

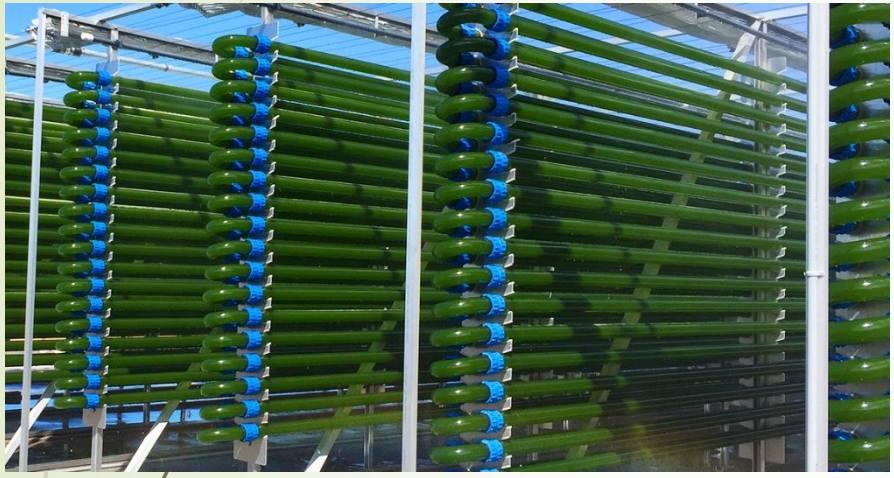
4. Maturation Pond

http://gemma.upc.edu/images/fotos/Maturation%20pond%20in%20Verdu-Lleida-Spain.jpg

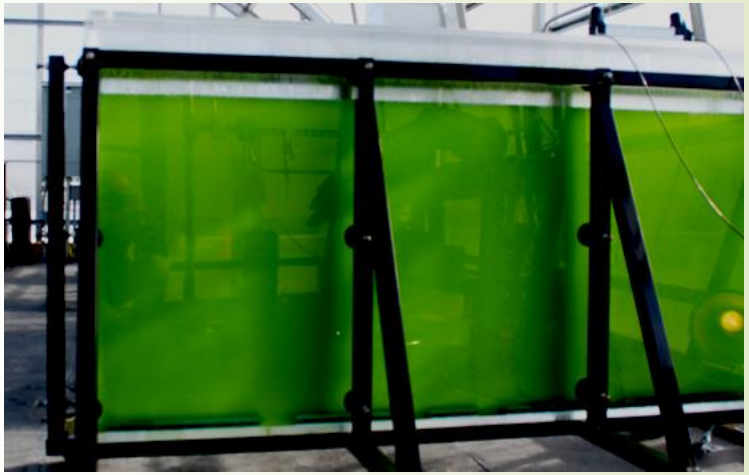
- These ponds serve to inactivate pathogenic bacteria and viruses through the action of sunlight and the greater algal activity in these shallow ponds, which raises the pH above 8.5.

Algae Based Treatment Systems

Photobioreactor



http://www.variconaqua.com/wp-content/uploads/2016/08/index2.jpg



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Algae Based Treatment Systems

Photobioreactor

http://www.archinspace.com/Ver3/files/attach/images//252/004/04d13aa0e8821fad6cd8b74404cc28f9.jpg

http://www.internethaber.com/images/other/yosun-bina-1.jpg

https://s-media-cache-ak0.pinimg.com/originals/30/d4/f0/30d4f0bacb68adae1fdc0a7f5f5f383a.jpg

http://www.evolo.us/wp-content/uploads/2010/05/flying-city-4.jpg

Solar Disinfection (SODIS)

http://buildsolar4betterlife.com/wp-content/uploads/2016/05/sodis.jpg

Polyethylene terephthalate (PET) Bottles

Solar Thermal Disinfection

Infrared radiation from surface heat up the water to ~60-80 °C which helps in disinfection.

Solar UV-A Disinfection

The UV-A radiation (~320-400 nm) in incoming sunlight generate oxygen radicals that oxidize the cellular materials of pathogens and result in disinfection.

Solar Disinfection (SODIS)

World Health Organization

eawag aquatic research

COMITE INTERNATIONAL GENEVE

ICRC

unicef

https://static1.squarespace.com/static/52bc920fe4b0038bd3d0dc80/t/56f8deccd51cd4e0ef0c5686/1459150552805/

Solar Disinfection (SODIS)

Attraction

- ✓ Credible disinfection from virus, bacteria, and protozoa
- ✓ Impressive track record in reducing diarrheal disease
- ✓ Very simple technique

Over 2 million people in 28 developing countries use SODIS for daily drinking water treatment.

Limitations

- ❖ Not effective with turbid water
- ❖ Limited volume can be treated in one batch
- ❖ Lengthy process
- ❖ Does not treat chemical contaminants

Best of Luck for Your Exams!