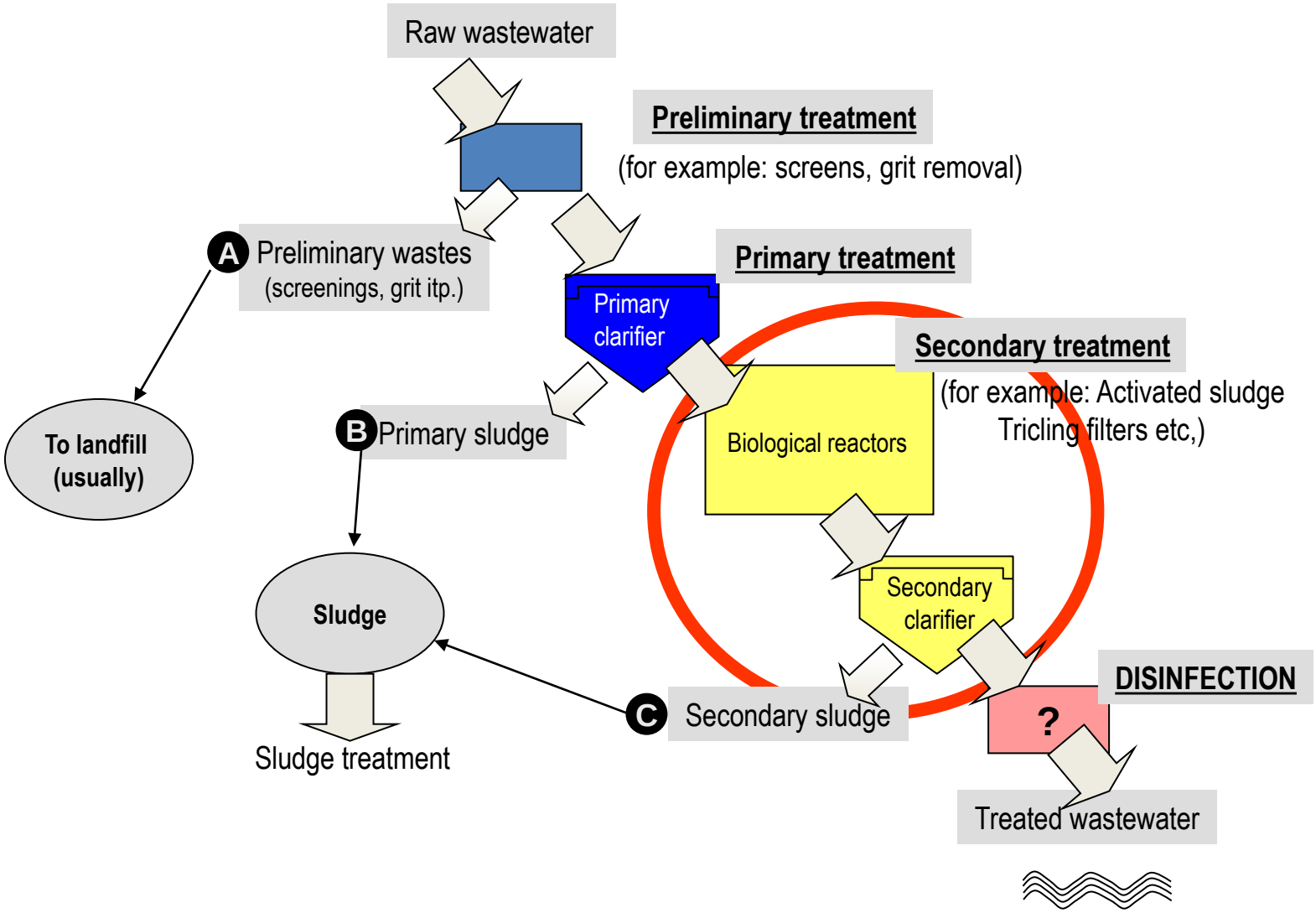
Wastewater Treatment Technology
Lecture 4

Organic compounds removal and sludge retention time

WWTP overall scheme



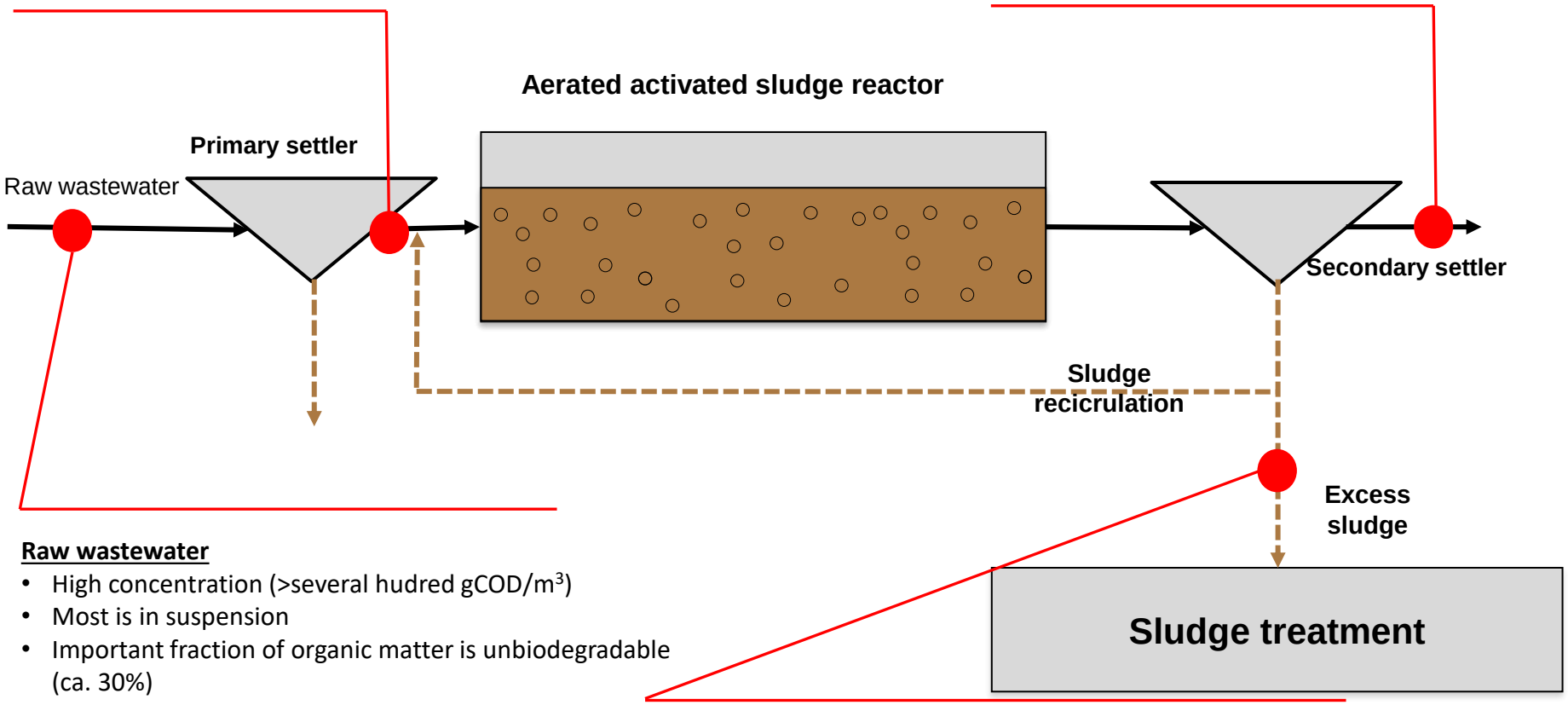
Organic compounds removal

Mechanically treated wastewater

- Concentration lowered by ca. 30%
- All organic compounds that are removed are suspended solids.
- Therefore fraction of dissolved organic compounds in total COD is increased

Treated wastewater

- Dissolved unbiodegradable matter is released



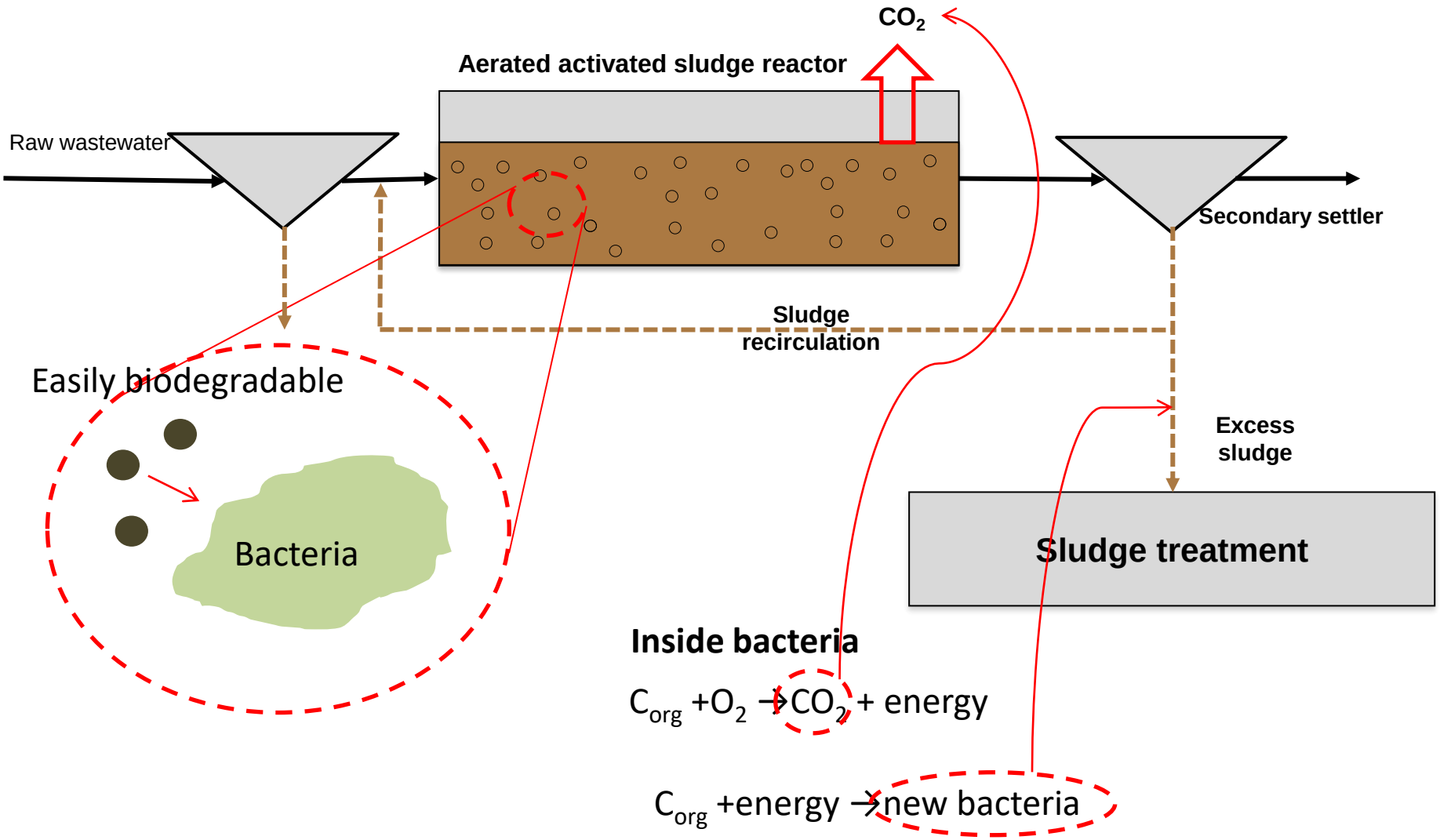
Raw wastewater

- High concentration (>several hudred gCOD/m^3)
- Most is in suspension
- Important fraction of organic matter is unbiodegradable (ca. 30%)

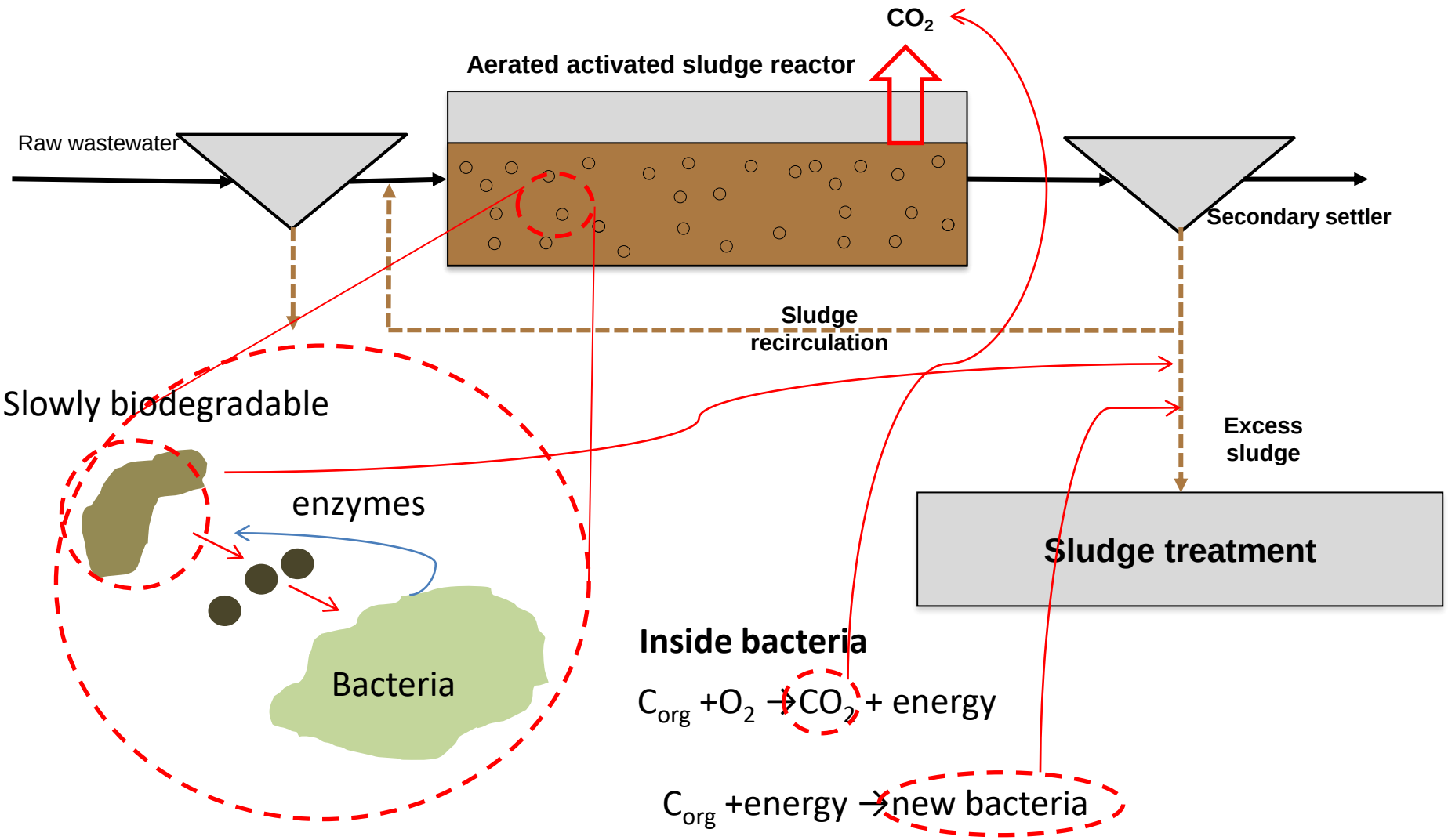
Excess sludge

- All unbiodegradable and undissolved organic compound are removed via this stream
- This stream contains also some slowly biodegradable matter

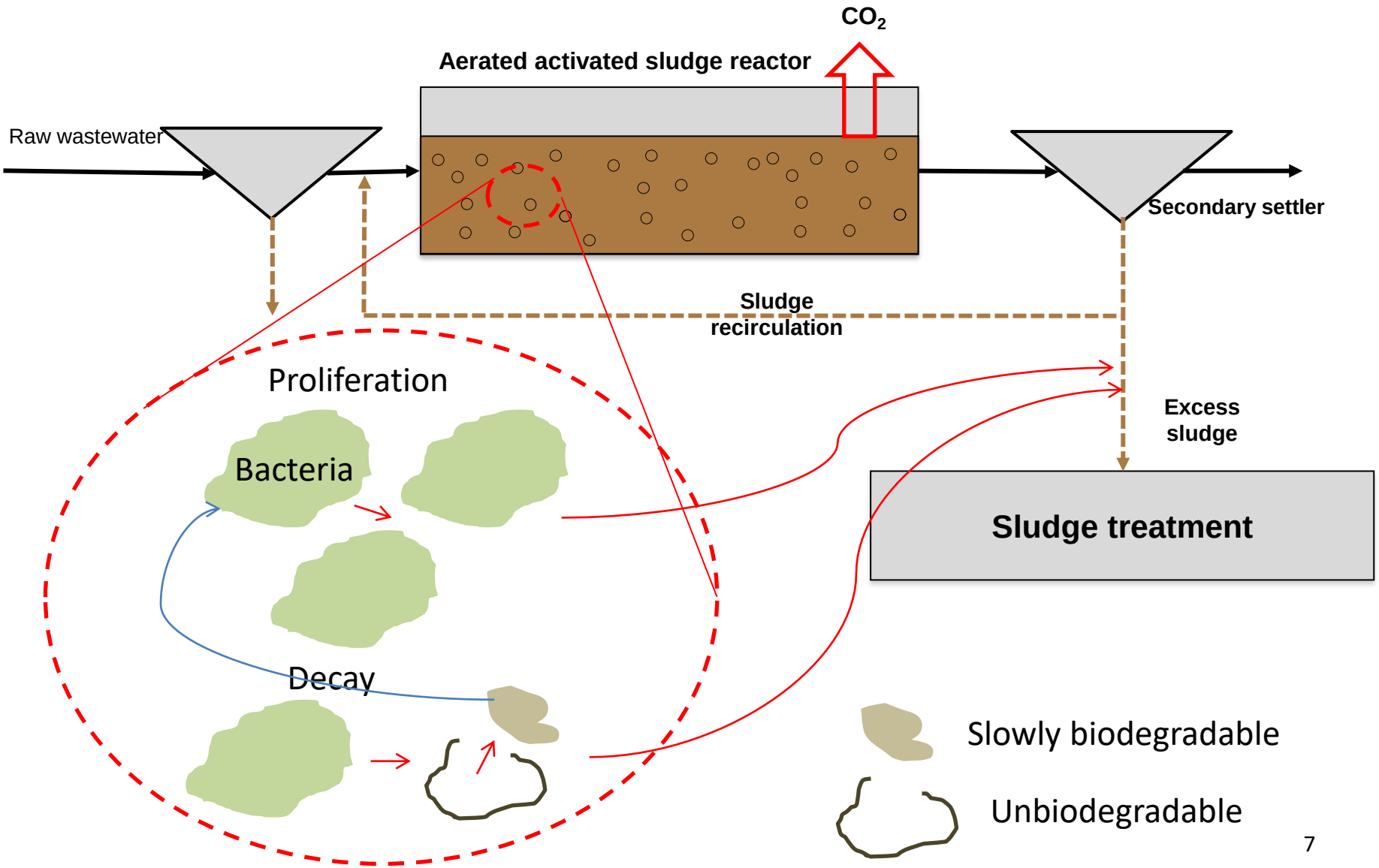
Easily biodegradable compunds



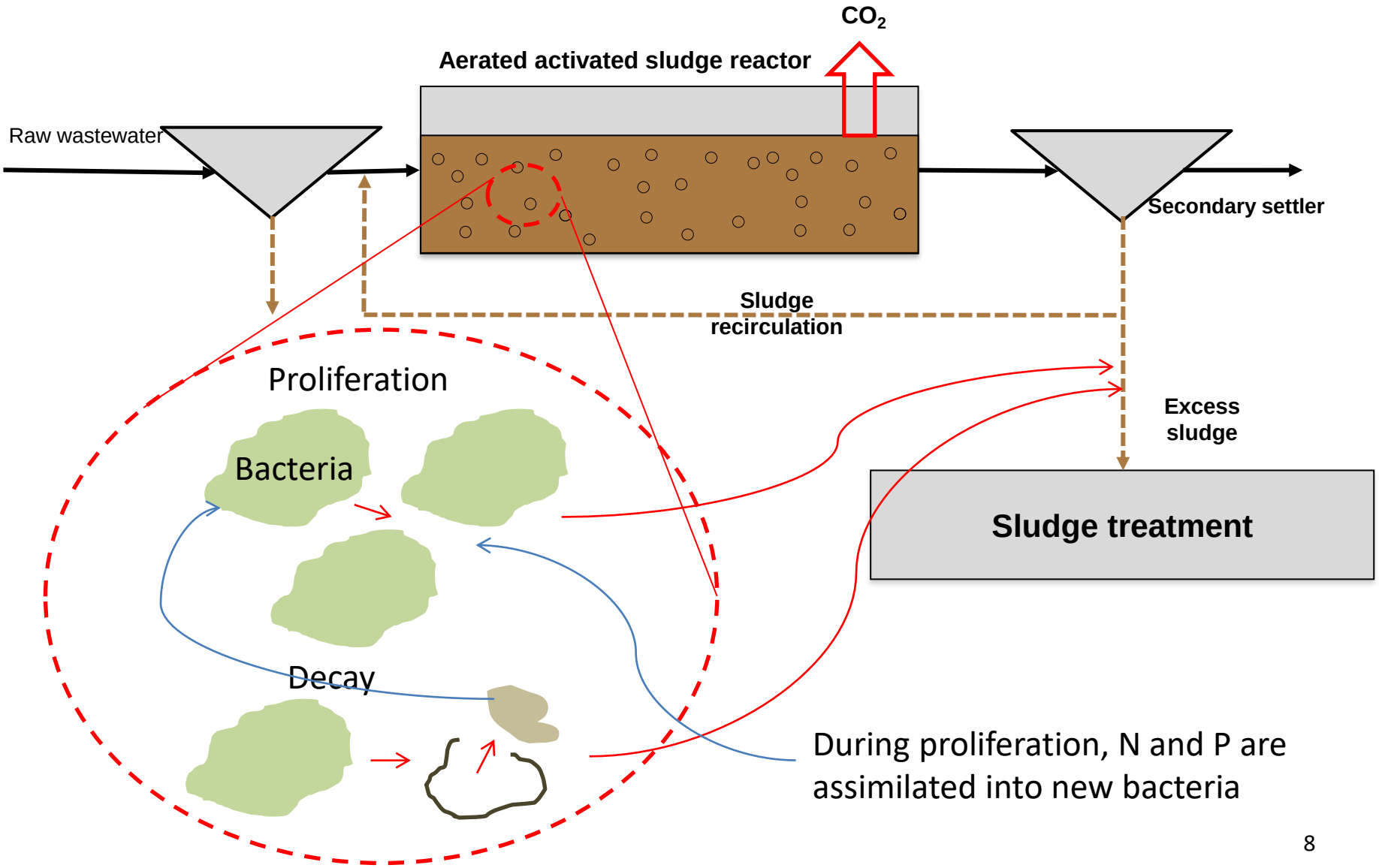
Slowly biodegradable compounds



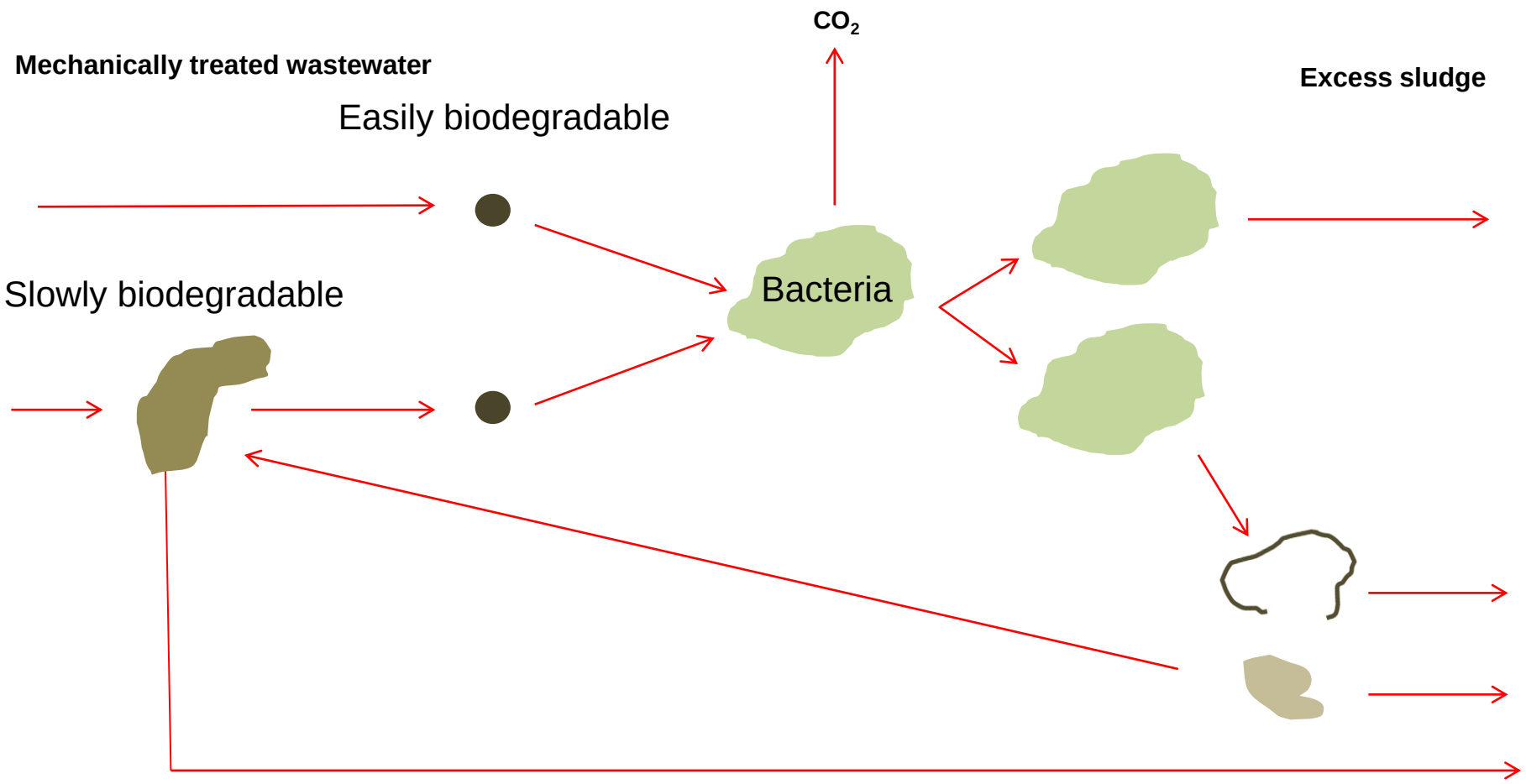
Bacteria


CO_2
Aerated activated sludge reactor
Raw wastewater
Secondary settler
Sludge recirculation
Proliferation
Bacteria
Decay
Excess sludge
Sludge treatment
Slowly biodegradable
Unbiodegradable

Removal of nitrogen and phosphorus during carbon removal



Overall scheme



Question?

To what extent do bacteria utilize organic compounds for energy production versus growth?

Inside bacteria

$C_{org} + O_2 \rightarrow CO_2$ + energy ?

C_{org} +energy →new bacteria?

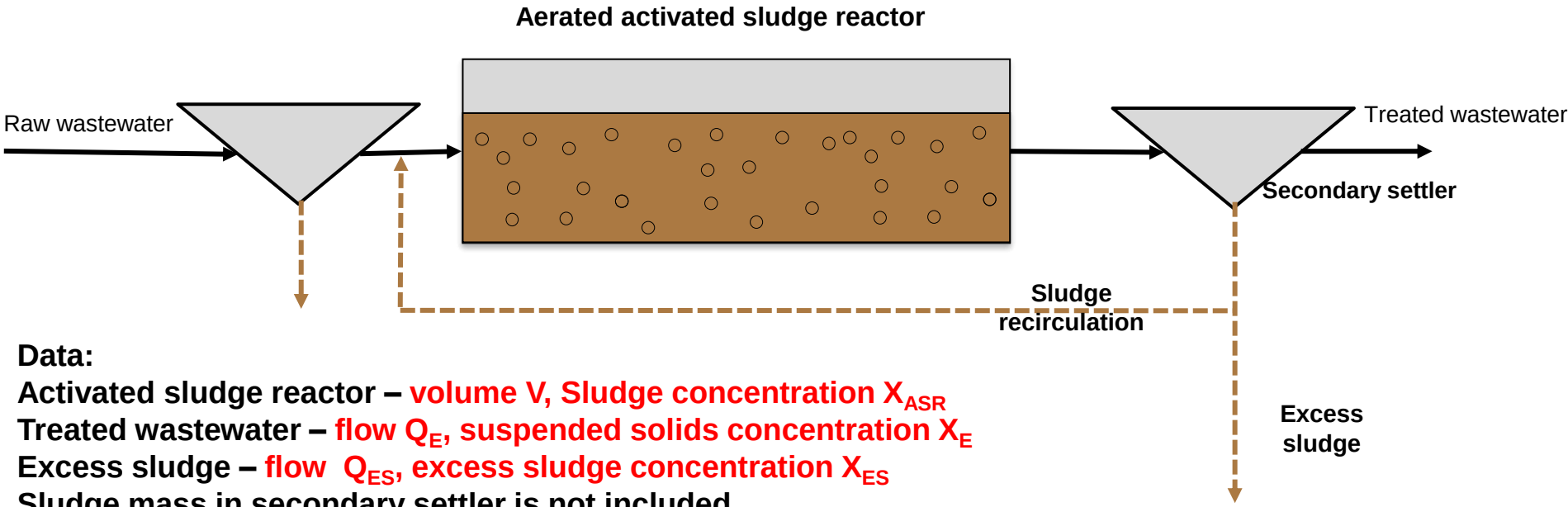
Primary parameters

Sludge retention time > 3 d
pH – 6.0 – 10.0
T – full range of temperature
O_2 in reactor > 0.5 gO_2/m^3

The full organic compound removal is not usually the problem

Sludge retention time

Sludge retention time definition (SRT)



Data:
Activated sludge reactor – volume V, Sludge concentration X_{ASR}
Treated wastewater – flow Q_E, suspended solids concentration X_E
Excess sludge – flow Q_{ES}, excess sludge concentration X_{ES}
Sludge mass in secondary settler is not included

Sludge mass in reactor, kg ss

$$SRT = \frac{V \cdot X_{ASR}}{Q_{ES} \cdot X_{ES} + Q_E \cdot X_E}, \text{d}$$

Suspended solids mass in treated wastewater, kg ss/d

Sludge mass in excess sludge, kg ss/d

Example

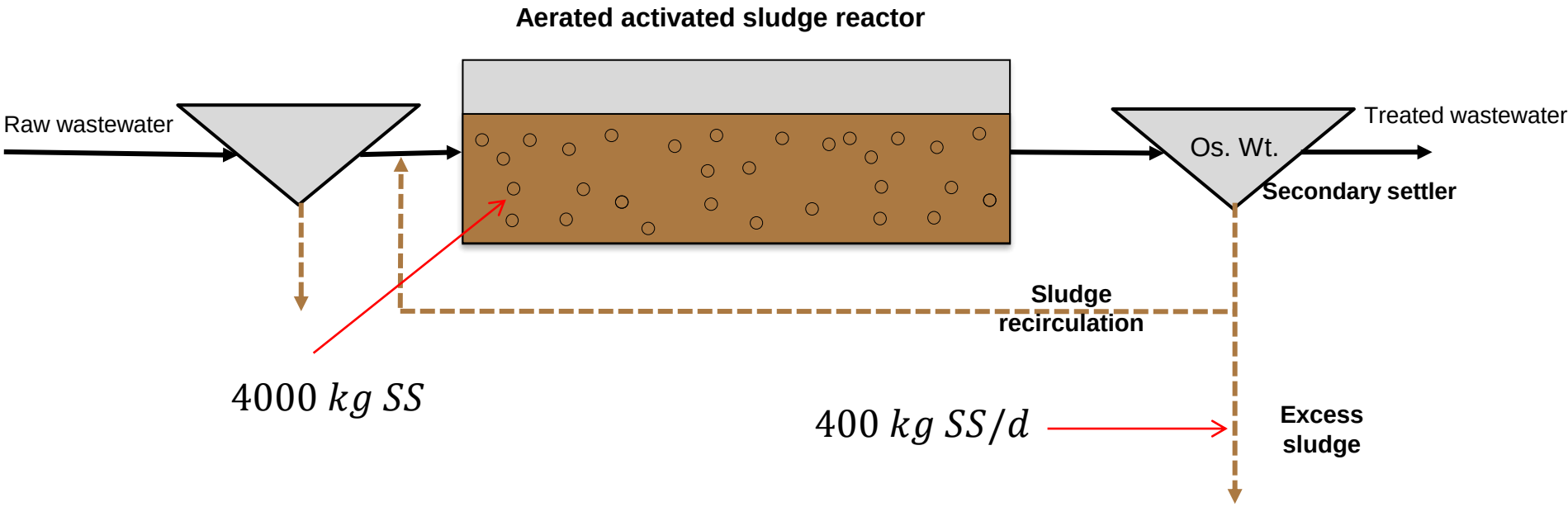
Necessary data:
Reactor volume:
volume V **– 1000 m^3,**
sludge concentration X **– 4 kg SS/m^3**
Treated wastewater
flow Q_E **– 1000 m^3/d**
suspended solids concentration X_E **– 10 g SS/m^3**
Excess sludge
flow Q_{ES} **– 50m^3/d**
Excess sludge concentration X_{ES} **– 8 kg sm/m^3**

$$SRT = \frac{V \cdot X}{Q_{ES} \cdot X_{ES} + Q_E \cdot X_E} = \frac{1000 \cdot 4}{50 \cdot 8 + 1000 \cdot 0.01} =$$

$$\frac{4000}{400 + 10} = 9.75\ d$$

Can be neglected

Physical sense of sludge retention time



Assumptions:

Suspended solids in treated wastewater are neglected

Questions

1. What transformations do readily biodegradable and slowly biodegradable compounds undergo?
2. What happens to unbiodegradable matter in activated sludge process?
3. What do bacteria use organic compounds for? Describe these processes
4. What are the factors that decides whether organic compounds are consumed for energy production or sludge mass growth?
5. Does N and P removal occur during organic carbon removal? If so, how?
6. Sludge retention time – what is it?
7. What is physical sense of sludge retention time?
8. What is the relation between sludge retention time and excess sludge production as well as Energy consuption for aeration