Polyphosphate Accumulating Organisms (PAOs) are Neisser positive staining bacteria that can sometimes be seen in and surrounding bacterial flocs. They can be hard to distinguish but appear like clusters of grapes. They have such a large polyphosphate content that they stain completely purple.

PAOs (Figure 1) are favoured in enhanced biological phosphorus removal (EBPR) processes as they have a special cyclical metabolic pathway that allows them to store phosphorus. This process is relies on a cycle of anaerobic and aerobic conditions. During anaerobic conditions, the PAOs harness energy for growth by releasing stored poly-phosphate and using this to consume volatile fatty acids (VFAs). During aerobic conditions, they re-absorb the released poly-phosphate to produce biomass. Therefore PAOs can remove both carbon and phosphorus from the influent.

PAOs are most readily observed at the end of aerobic stages and are favoured by low COD/P ratios (10 to 20 mg/mg) and moderate temperatures and sludge ages (around 20°C and 10 days). At warmer temperatures, a pH of greater than 7.5 is preferred.

PAOs compete with a rival bacterial group called Glycogen Accumulating Organisms (GAOs). GAOs also stain Neisser positive (Figure 2), but in contrast to PAOs, GAOs stain darker at their cells walls and appear a more translucent throughout. GAOs can be observed in tetrad and larger colonial cluster shapes.

GAOs also uptake VFAs anaerobically but only use glycogen as their energy source which means. They also do not gain any energy from the release and uptake of phosphorus compounds. Their presence only serves to remove VFAs that could otherwise be utilised by PAOs. VFAs are often the limiting substance in the process and additional dosing is costly, therefore the presence of GAOs in is detrimental to EBPR. It doesn’t mean phosphorus removal isn’t possible, but the presence of GAOs can often mean limited VFA concentrations.

GAOs prefer higher temperatures (>30°C), high influent COD/P ratios (>50), high solids retention times, long unaerated detention times, strong wastes with low amino acid/proteins, polysaccharides fed into the anaerobic zone, and low mixed liquor pH. GAOs can also be encouraged by carbon dosing with sugars and alcohols. To encourage PAOs you can reduce the SRT to the minimum, add alkalinity when the pH drops below 7 and dose with a combination of propionic and acetic acid (e.g. molasses).

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Hot gossip down at the periodic table: “So anyway, I heard that Oxygen and Magnesium were going out, and I was like O Mg!”