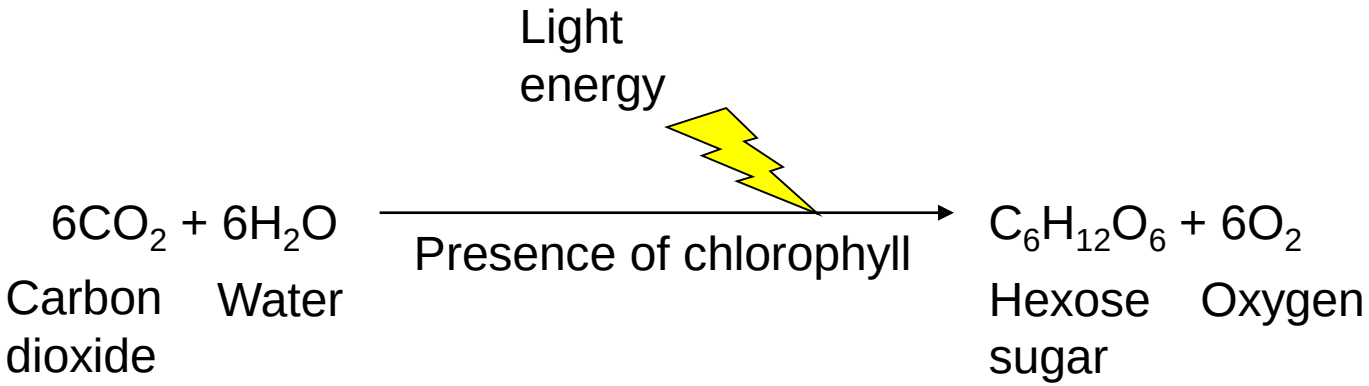
What Affects Photosynthesis?

- Discuss the limiting factors in photosynthesis – with reference to carbon dioxide concentration, light intensity and temperature.
- Describe the effect on the rate of photosynthesis of changing the light intensity.
- Describe the effect on the levels of glycerate 3-phosphate (G3P), ribulose bisphosphate (RuBP) and triose phosphate (GALP) of changing the carbon dioxide concentration, light intensity and temperature.
- Describe how to investigate experimentally the factors that affect the rate of photosynthesis.

What factors affect photosynthesis?

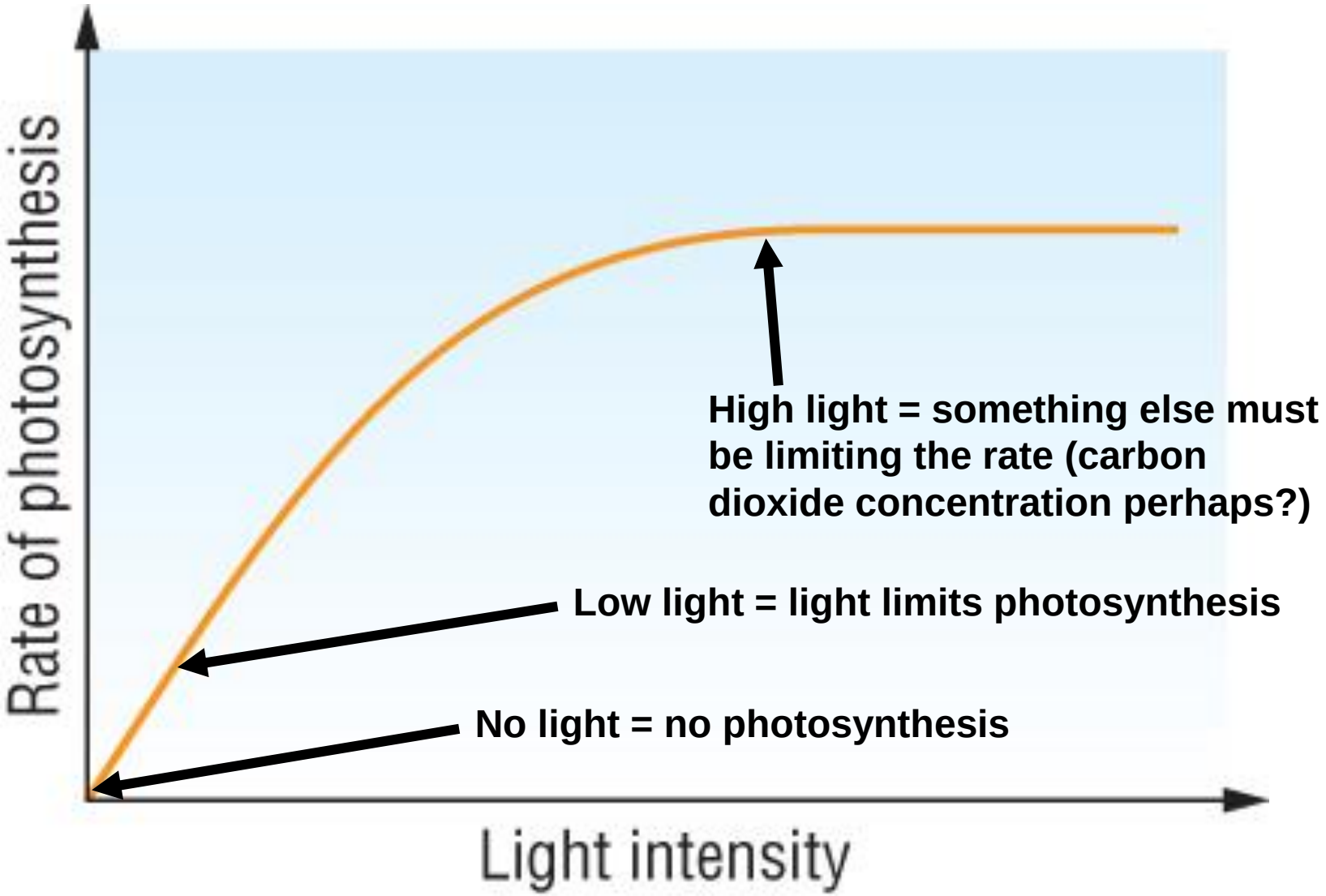


- Chlorophyll is present in the chloroplasts.
- Carbon dioxide, light, temperature & water may affect the rate of photosynthesis.

Limiting factors

- At any given moment, the rate of photosynthesis is limited by the factor that is present at the least favourable (often lowest) value.

Varying light intensity with all other factors held constant.



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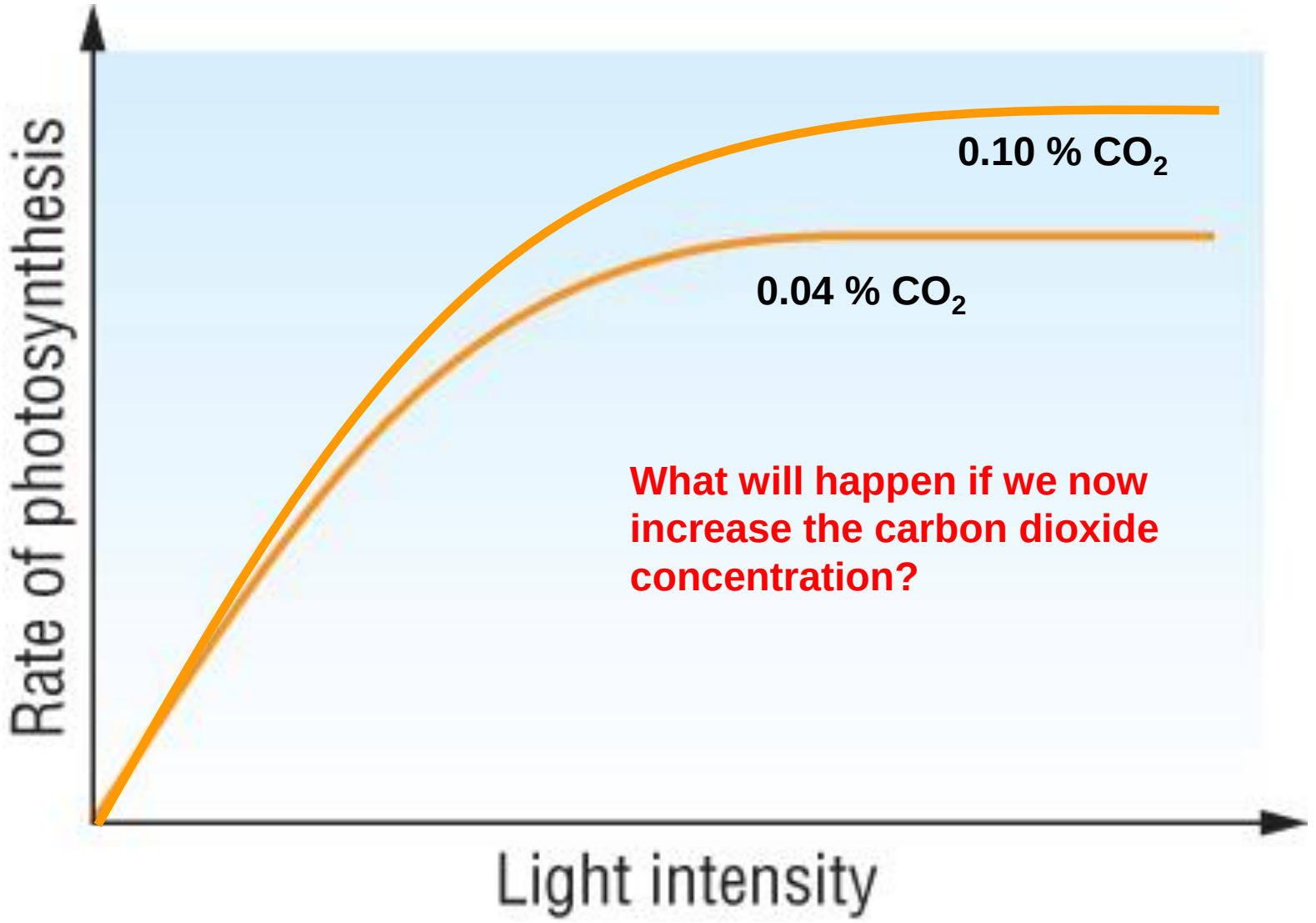


How do these factors affect photosynthesis?

- Light intensity
- Carbon dioxide concentration
- Temperature

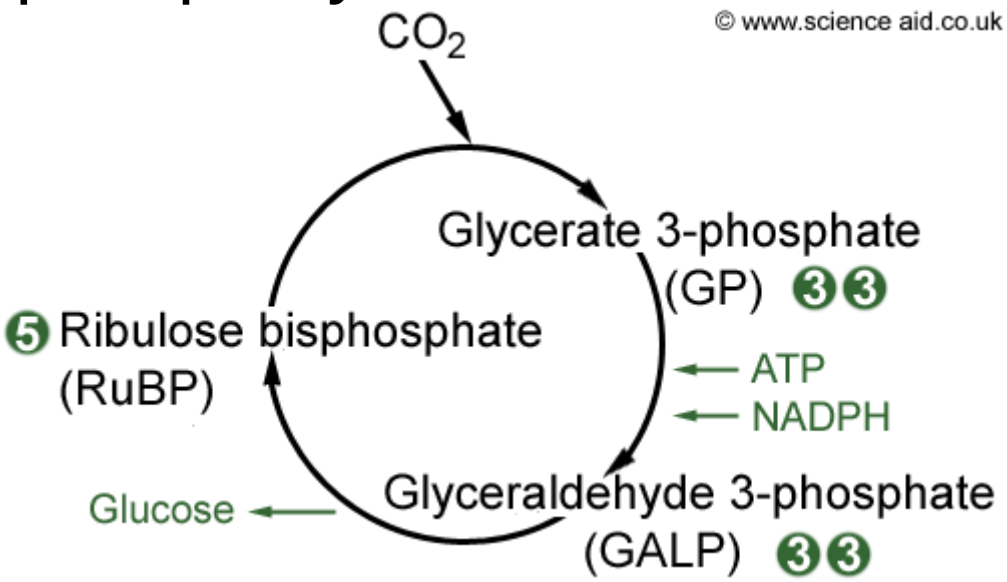
- Taking each in turn…

Light Intensity

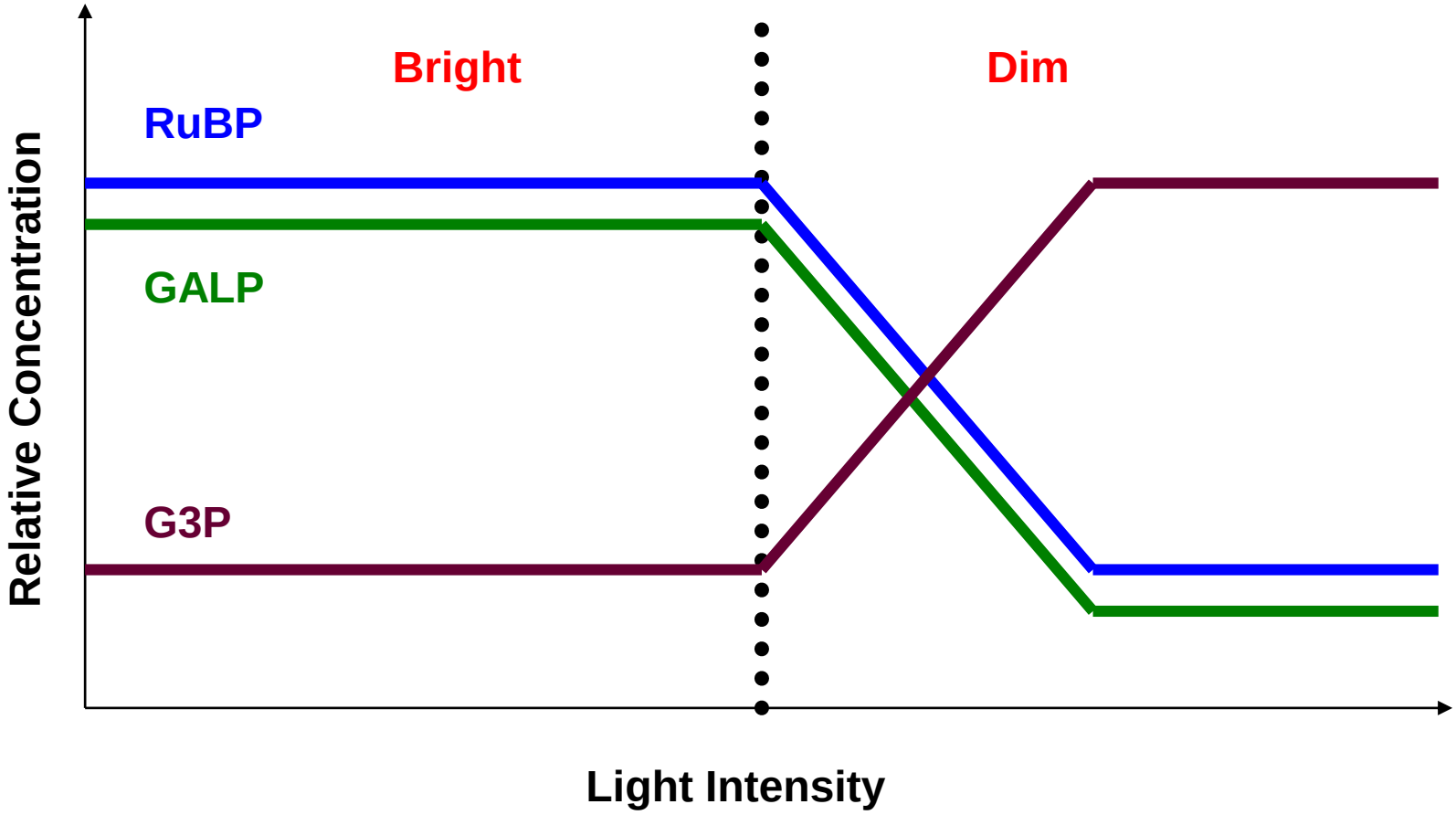
- Has three main effects:
  - Causes stomata to open, allowing CO_2 to enter.
  - Excites electrons in chlorophyll molecules.
  - Splits water into protons, electrons & oxygen.
- These allow ATP and reduced NADP to be available to the Calvin cycle.
- Light intensity varies in daily & yearly cycles.
- Follows the inverse square law.

How does light intensity affect the levels of G3P, GALP & RuBP?

- Light intensity is proportional to the production of ATP & reduced NADP.
  - These are both used in the Calvin cycle to reduce G3P to GALP.
  - ATP is also used to phosphorylate most GALP to RuBP.



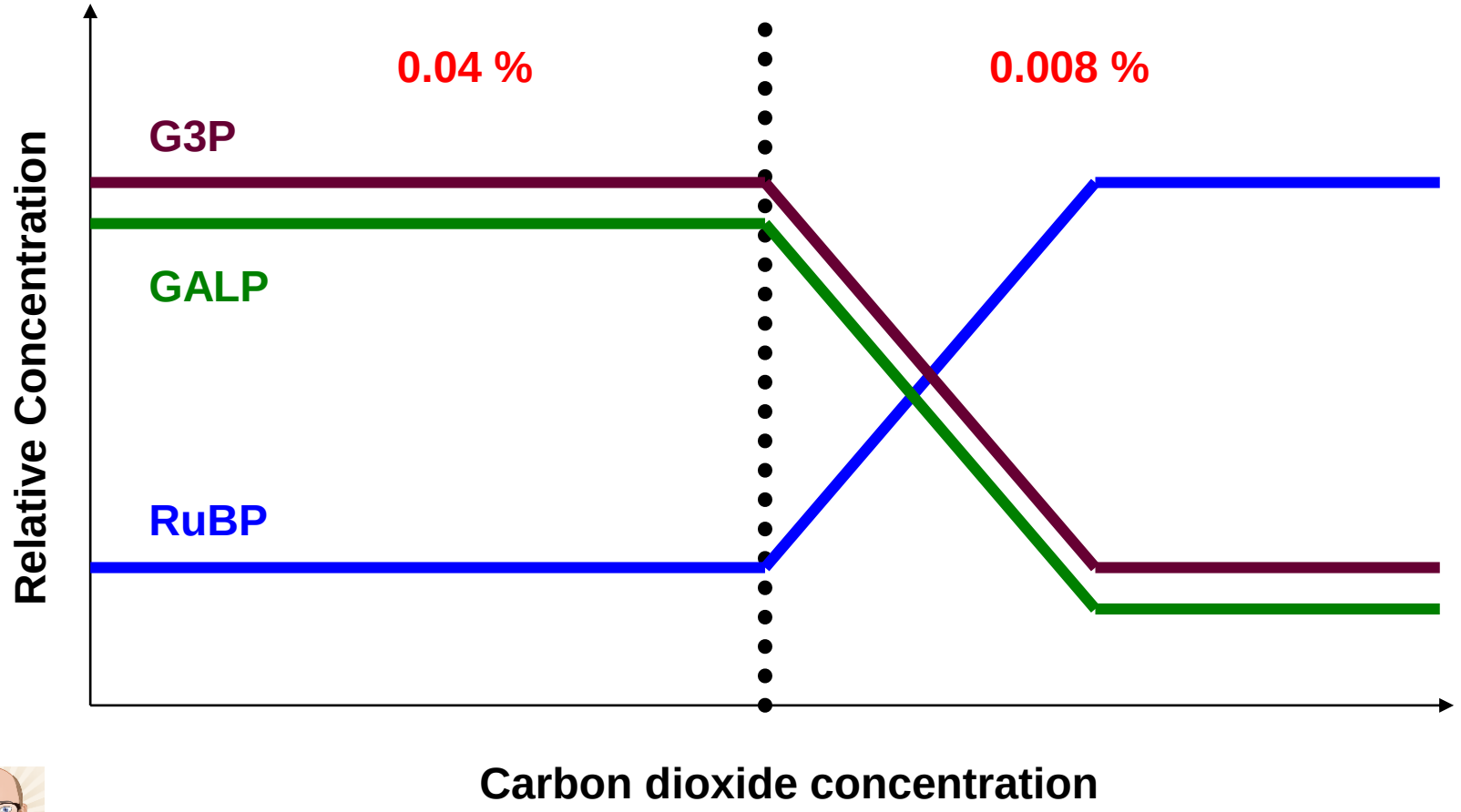
How does light intensity affect the levels of G3P, GALP & RuBP?



CO_2 Concentration

- 0.03 – 0.06% of air depending on location.
- Growing forests absorb CO_2 but mature forests are CO_2 neutral.
- In greenhouses CO_2 can drop to 0.02%.

How does CO_2 Concentration affect the levels of G3P, GALP & RuBP?



Temperature

- Little effect on light dependent reactions.
  - Except photolysis of water.
- Mainly affects enzyme catalysed reactions of the Calvin cycle.
  - Initially, increasing temperature will increase rate of photosynthesis.
  - At about 25^{o}C, oxygenase activity of Rubisco increases.
  - Stomata also close as water loss increases.
  - At high temperatures, enzymes & other proteins become denatured.

Measuring the rate of photosynthesis

- Could measure:
  - Uptake of substrates
    - Rate of CO_2 uptake
    - Rate of water uptake
  - Production of products
    - Rate of O_2 production
    - Rate of biomass increase
  - Often we measure volume of O_2 produced over time.
    - Beware: Some O_2 will be used in respiration.