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PLANT FUNDAMENTALS

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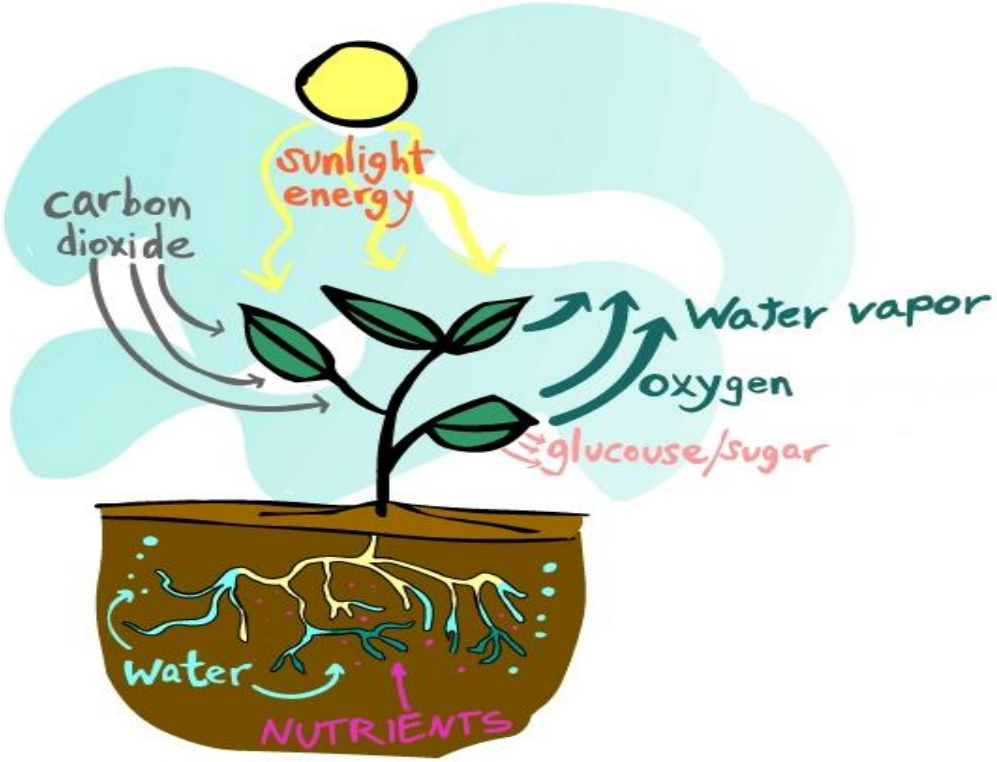

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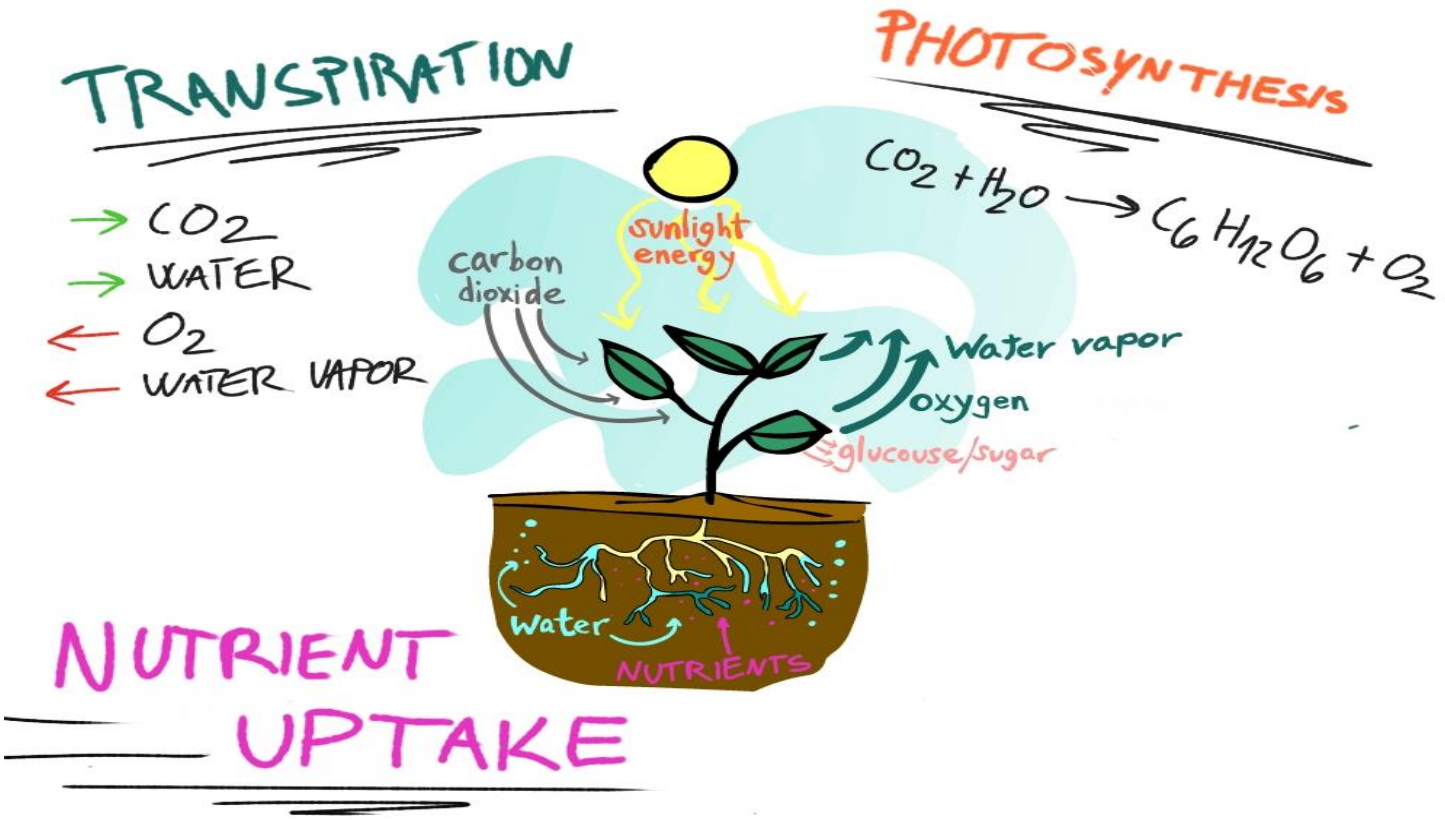

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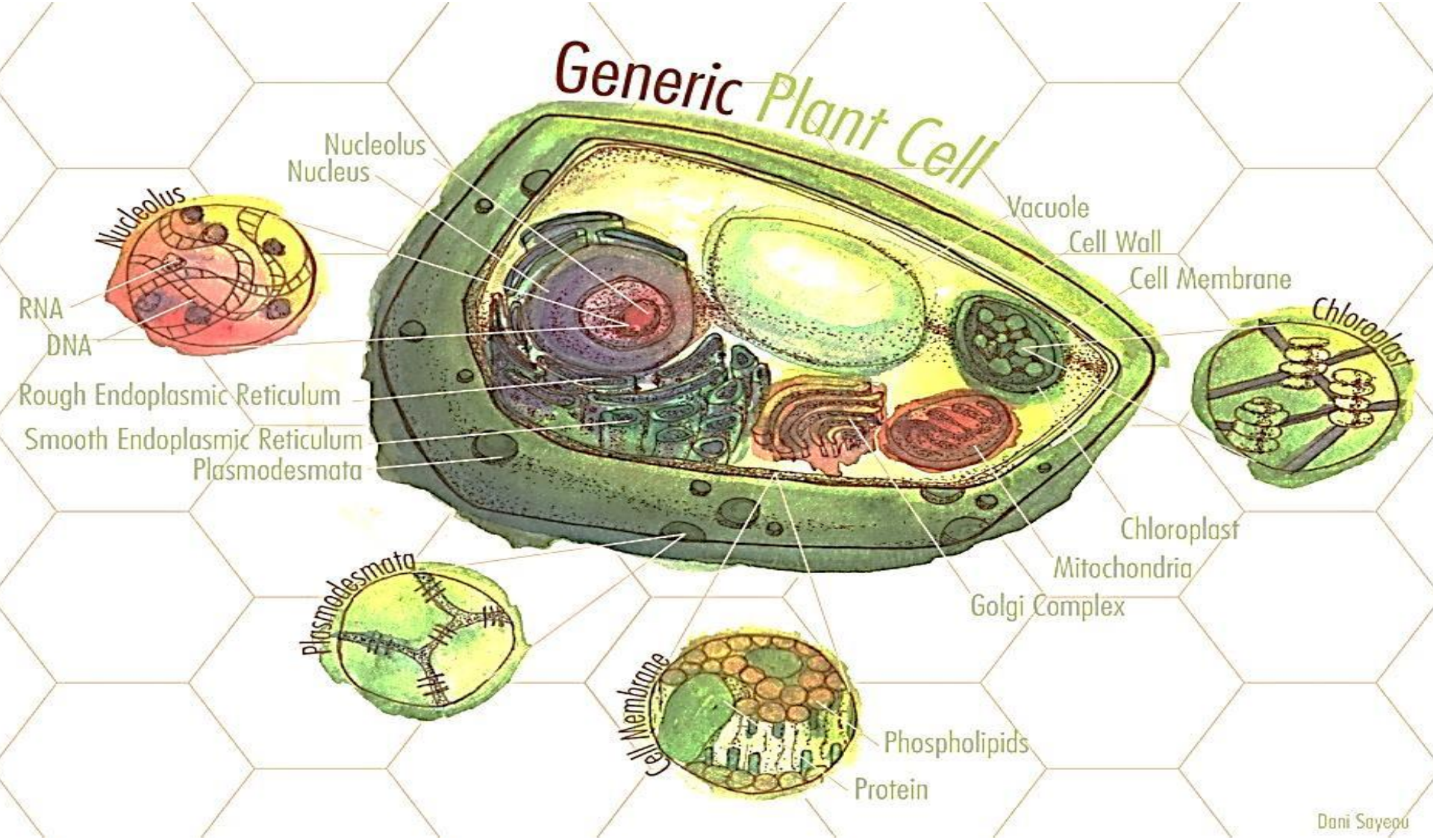

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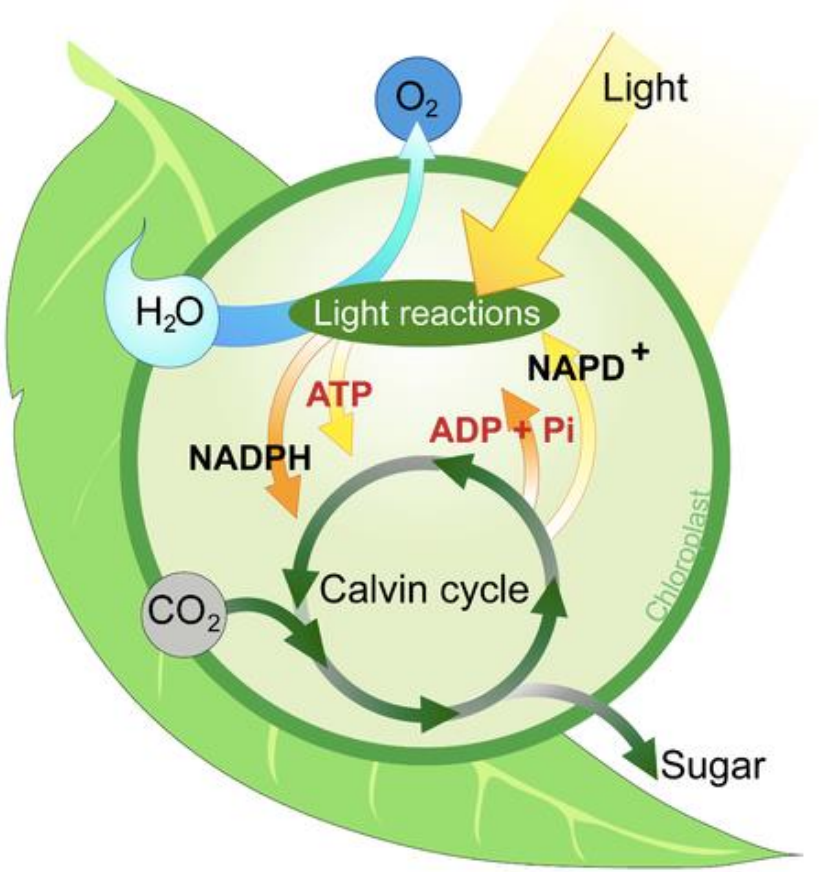

www.youtube.com/watch?v=0UzMaoaXKaM&ab_channel=TED-Ed

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FUN FACTS FROM WIKIPEDIA

- Today, the average rate of energy capture by photosynthesis globally is approximately 130 terawatts, which is about **three times** the current power consumption of human civilization.

- Photosynthetic organisms also convert around 100–115 thousand million metric tones of carbon into biomass per year.

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WHY DO PLANTS TRANSPIRE?

- Gas exchange
- Water uptake
- Accessing nutrients
- Evaporative cooling

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PROBLEM?

- Gas exchange inevitably leads to loss of water through stomata.
- No gas exchange and increased oxygen concentration results in increased photorespiration
- *Google photorespiration :)*
- *Controlling the indoor environment helps controlling gas exchange and transpiration*

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NUTRIENT UPTAKE

Nutrient	Functions
Nitrogen (N)	Synthesis of proteins for growth
Phosphorus (P)	Cellular division, formation of energetic structures
Potassium (K)	Transport of sugars, formation of starch, stomata control, co-factor of enzymatic reactions, reduces susceptibility to plant diseases
Calcium (Ca)	Building block in cell walls, reduces susceptibility to plant diseases
Magnesium (Mg)	Part of chlorophyll molecule
Sulfur (S)	Synthesis of essential amino acids
Boron (B)	Cell wall formation, germination and elongation of pollen tube, metabolism and transport of sugars
Copper (Cu)	Influences the metabolism of nitrogen and carbohydrates
Iron (Fe)	Chlorophyll synthesis
Manganese (Mn)	Aides in photosynthesis
Molybdenum (Mo)	Component of nitrate-reductase and nitrogenase enzymes
Zinc (Zn)	Auxin synthesis

PLANT NUTRIENT CONTENTS

macronutrients **micronutrients**

%	Leaves	Stems	Fruits	Roots		mg/kg	Leaves	Stems	Fruits	Roots
N	4	1.5	3	3		Fe	100	40	100	800*
P	0.5	0.2	0.5	0.2		Mn	75	20	50	25
K	4	3	4	2		B	30	10	30	5
Ca	2	0.5	0.2	0.2		Zn	30	20	30	30
Mg	0.6	0.1	0.2	0.2		Cu	10	2	10	10
S	0.4	0.3	0.2	0.2		Mo	2	1	1	1
						Cl	100	100	100	1

* Iron precipitates on the root surface

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PASSIVE AND ACTIVE UPTAKE

Nutrients can be taken up by the plant **using energy (active transport)** or **using concentration differences (passive transport)**.

Passive transport can be facilitated with additional energy (intermediate transport).

Active - N, P, K, Mn

Intermediate – Mg, S, Fe, Zn, Cu, Mo, Cl

Passive - Ca, B

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MOBILE AND IMMOBILE NUTRIENTS

Transportability of nutrients within the plant

- **Mobile:** N, P, K, Mg, Cl, Zn, Mo
- **Immobile:** Ca, S, Fe, B, Cu

Deficiency of mobile elements – older leaves

Deficiency immobile elements – younger leaves

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LUMENS ARE FOR HUMANS

Important units are:

- PPF - photosynthetic photon flux (mol/s)
- PPFD – PPF density (mol/s m2)
- DLI – daily light integral (mol/m^2d)

3 to 6 mol/m^2d – low-light crops
6 to 12 mol/m^2d medium-light crops
12 to 18 mol/m^2d high-light crops
18 mol/m^2d very high-light crops

Winter cloudy day 3-5 mol/m^2d
Winter sunny day 5-10 mol/m^2d
Summer cloudy day 10-15 mol/m^2d
Summer sunny day 20-30 mol/m^2d

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EXERCISE 2

How much light does a HPS light with 100 µmol/m^2s light flux provide in the period of 12h?

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EXERCISE

How much light does a HPS light with 100 µmol/m^{2}s light flux provide in the period of 12h?

$$\frac{100\ \mu mol/s\ m^2\ *\ 43{,}200\ (\text{number of seconds in a 12h})}{10^6\ (\text{number of µmol in a mol})}$$

That gives us a total of 4.2 mol/d m^2.

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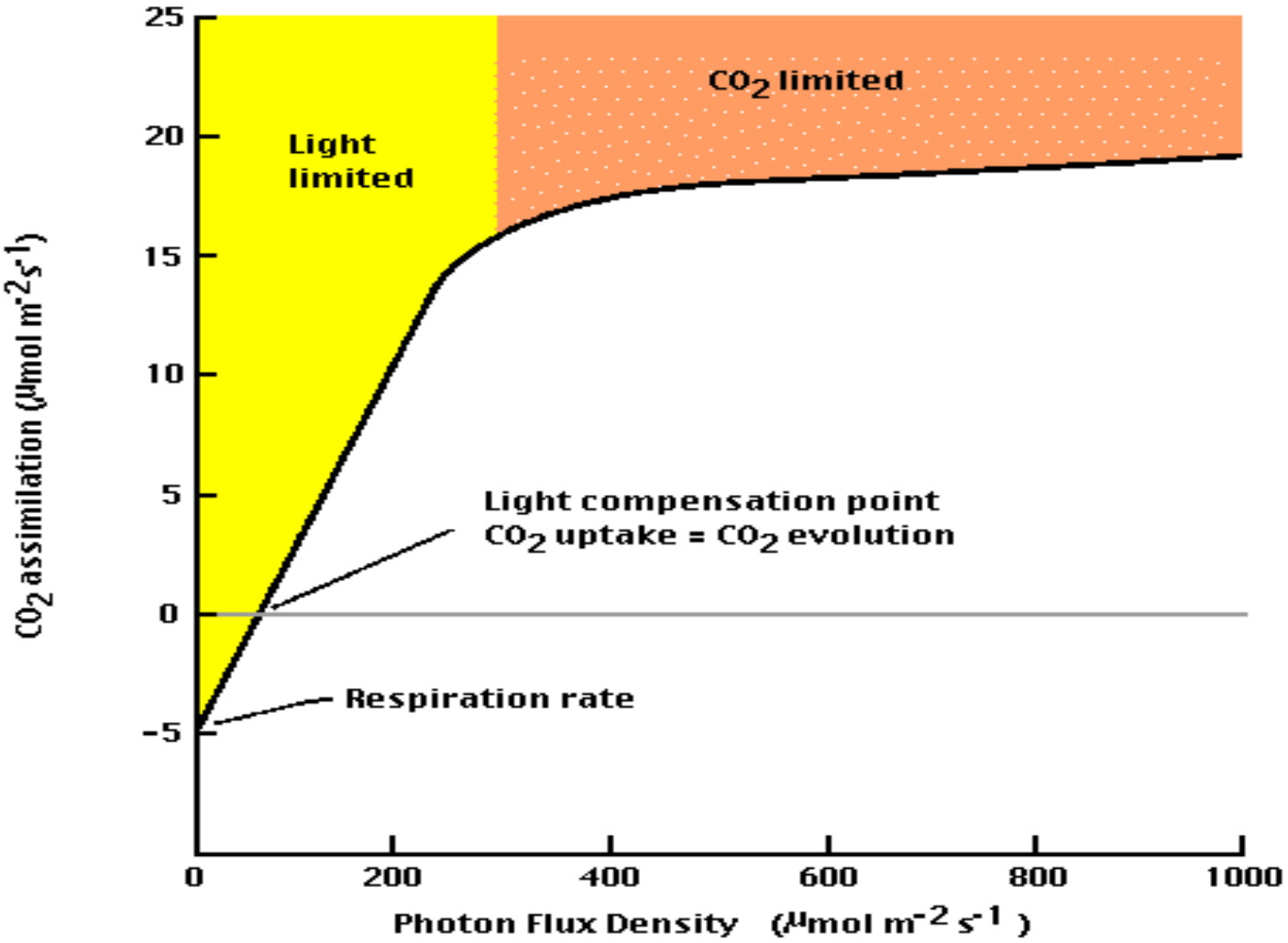

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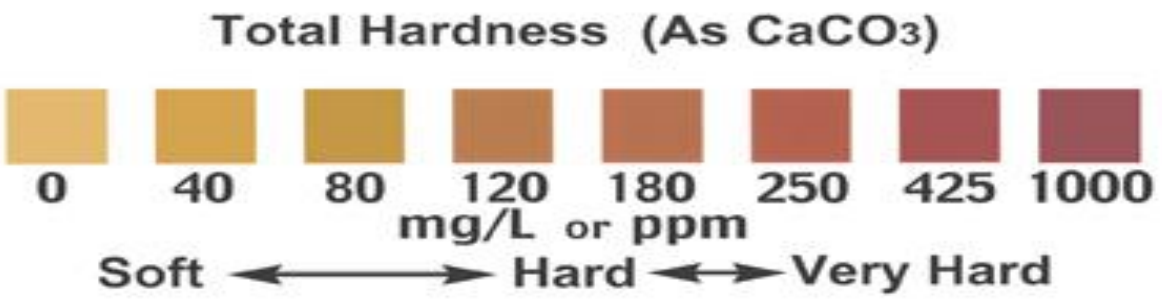
WATER HARDNESS

Concentration of multivalent cations in the water (usually Ca^{2+} and Mg^{2+})

Hardness acts as buffer for water pH

$$CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + CO_2(g) + H_2O\ (l)$$



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ELECTRICAL CONDUCTIVITY

- Useful for estimating amount of total dissolved ions (nutrients?) in water.
- Expressed in S/cm (Siemens per centimeter).
- Most plants prefer values in the 1-3 mS range.

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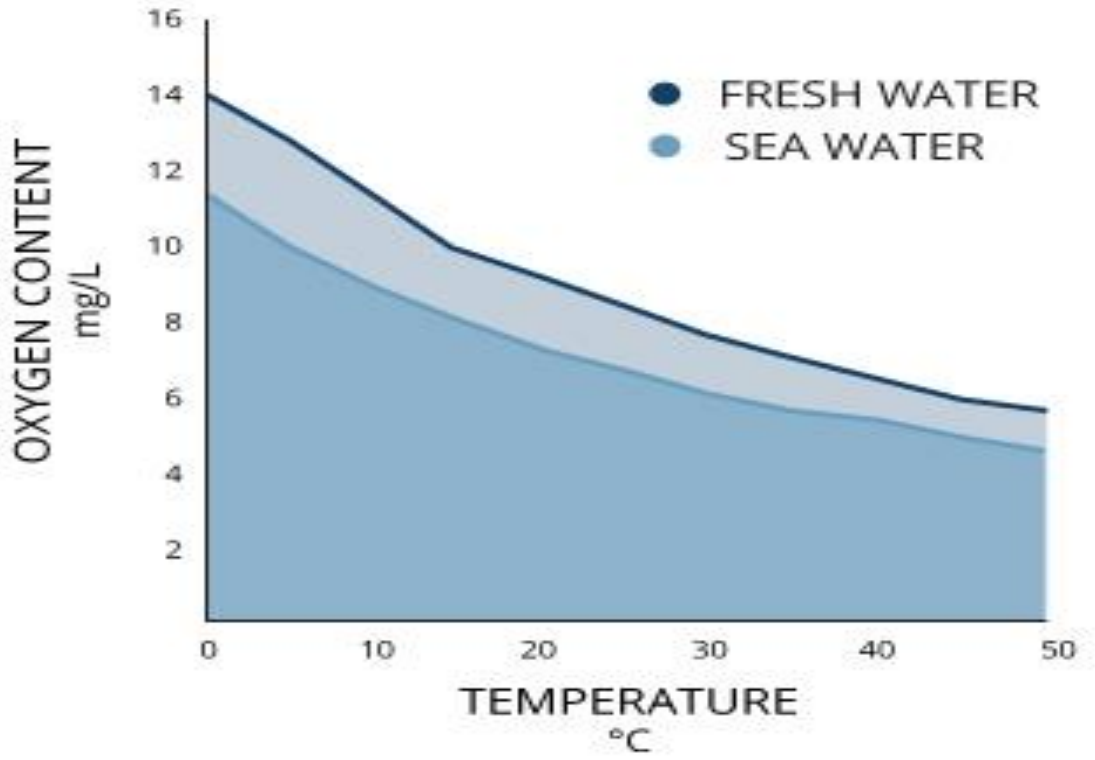
DISSOLVED OXYGEN

Most crops prefer about 6 ppm DO



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