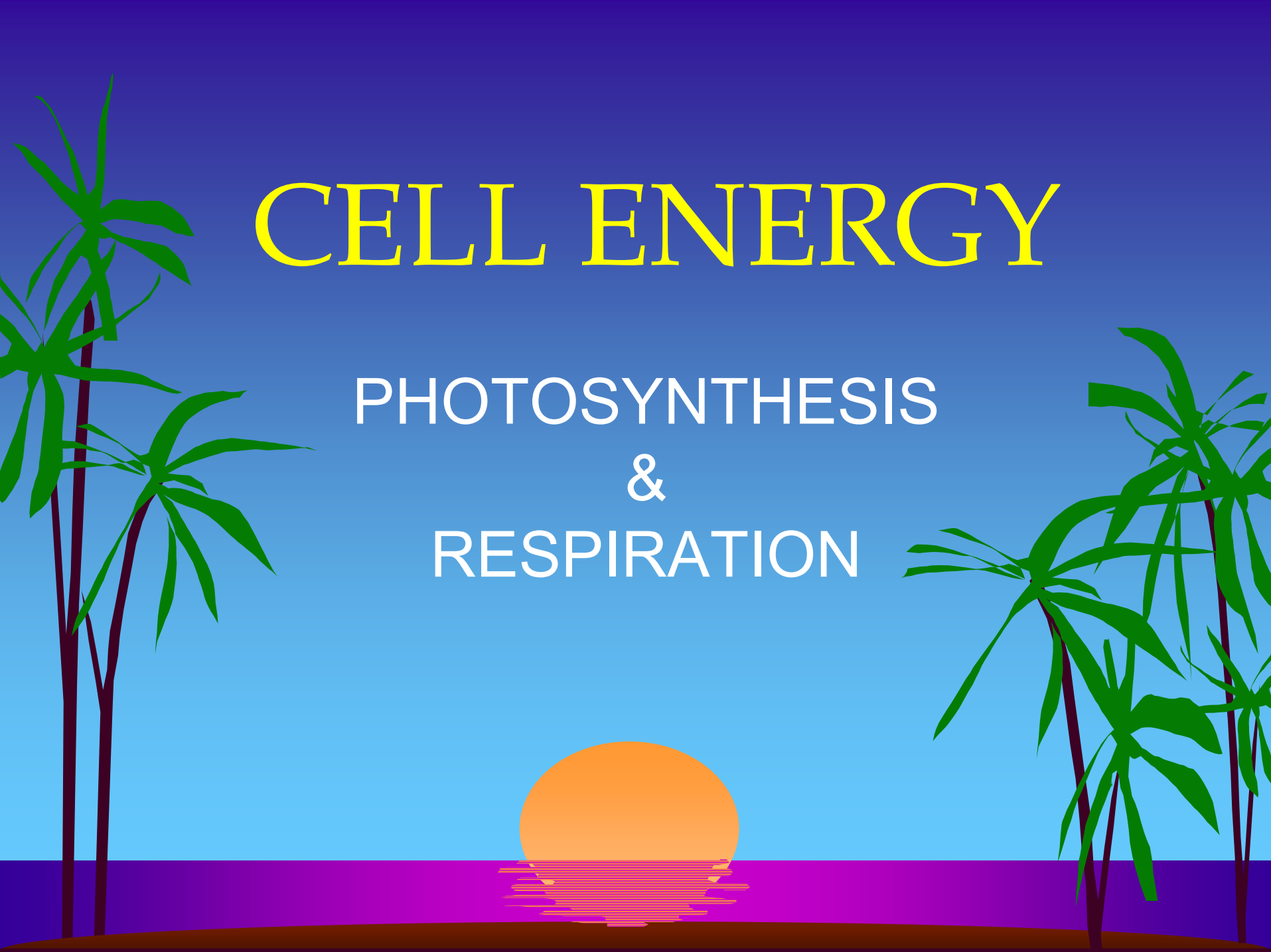

CELL ENERGY
PHOTOSYNTHESIS
&
RESPIRATION

PHOTOSYNTHESIS

- PLANTS CONVERT ENERGY FROM SUNLIGHT TO CHEMICAL ENERGY
  - –SUNLIGHT => CARBOHYDRATES

$$CO_2 + H_20 \Longrightarrow (CH_2O)_N + 0_2$$

$$6CO_2 + 6H_20 \Longrightarrow C_6H_{12}0_6 + 60_2$$

BALANCED

REQUIREMENTS FOR PHOTOSYNTHESIS

- SUNLIGHT:
  - autotrophs - green plants that produce their own food
  - heterotrophs - organisms that obtain food from others
- PIGMENT:
  - colored substances that absorb light.
    - Chlorophyll - green (primary pigment), absorbs red and blue light
- ADENOSINE TRIPHOSPHATE (ATP):
  - ATP => ADP + P + ENERGY
  - ADP => AMP + P + ENERGY

LIGHT REACTIONS

- LIGHT REACTIONS USE LIGHT TO CAPTURE ENERGY AND STORE ENERGY
- 4 BASIC PROCESSES:
  - LIGHT ABSORPTION
  - ELECTRON TRANSPORT
  - OXYGEN PRODUCTION
  - ATP FORMATION

LIGHT REACTIONS - LIGHT ABSORPTION

- Pigment molecules called photosystems capture energy from the sun
  - PHOTOSYSTEM I & PHOTOSYSTEM II
- Pigments absorb sunlight in the color spectrum that chlorophyll can't absorb
- absorption of light causes a flow of energy throughout the cell
- special pairs of chlorophyll molecules are able to convert light energy into a useful chemical form

LIGHT REACTIONS - ELECTRON TRANSPORT

- Energy captured by the chlorophyll pair is transferred by electron carriers along an electron transport chain

- NADP+ : special carrier converts electrons to NADPH; a more useful form of energy

LIGHT REACTIONS - OXYGEN PRODUCTION

- As electrons move energy away from the chlorophyll to the NADP+, new electrons are put back from H_2O

$$2H_2O \Longrightarrow 4H^+ + O_2$$

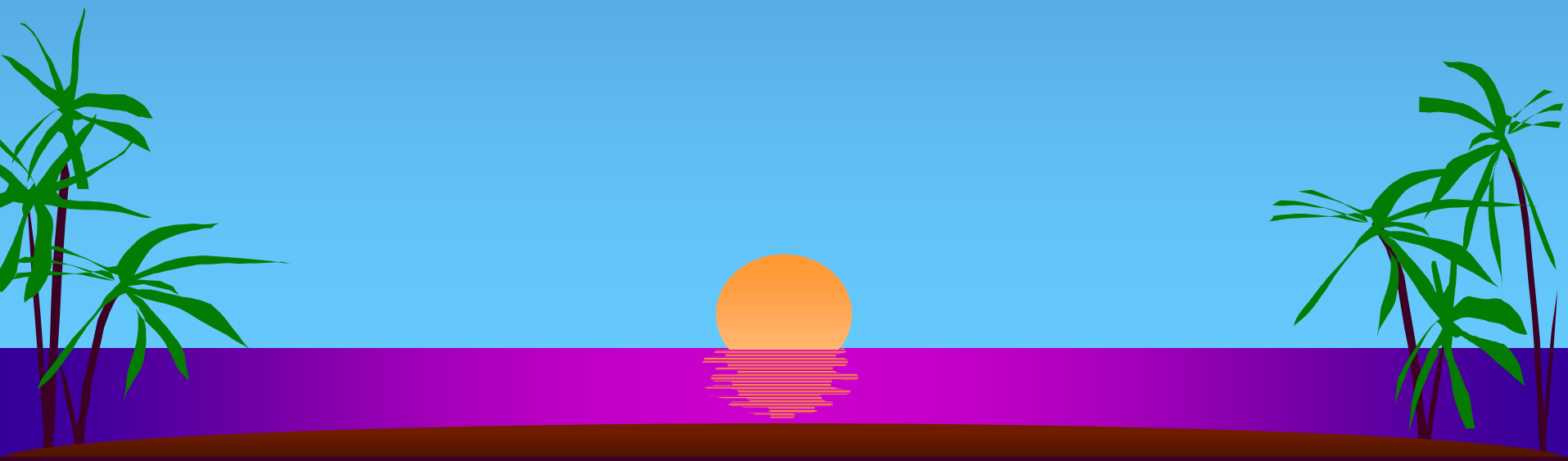
- 4 ELECTRONS ARE RELEASED

LIGHT REACTIONS - ATP FORMATION

- The H+ ions left after water is split are released and build up concentration in the cell.
  - Outside membrane becomes negatively charged
  - Inside membrane becomes positively charged
- As the membrane balances out the charge ATP is formed

Summary of light reactions

- Light reactions:
  - use water, ADP, NADP+
  - produce oxygen, ATP, NADPH

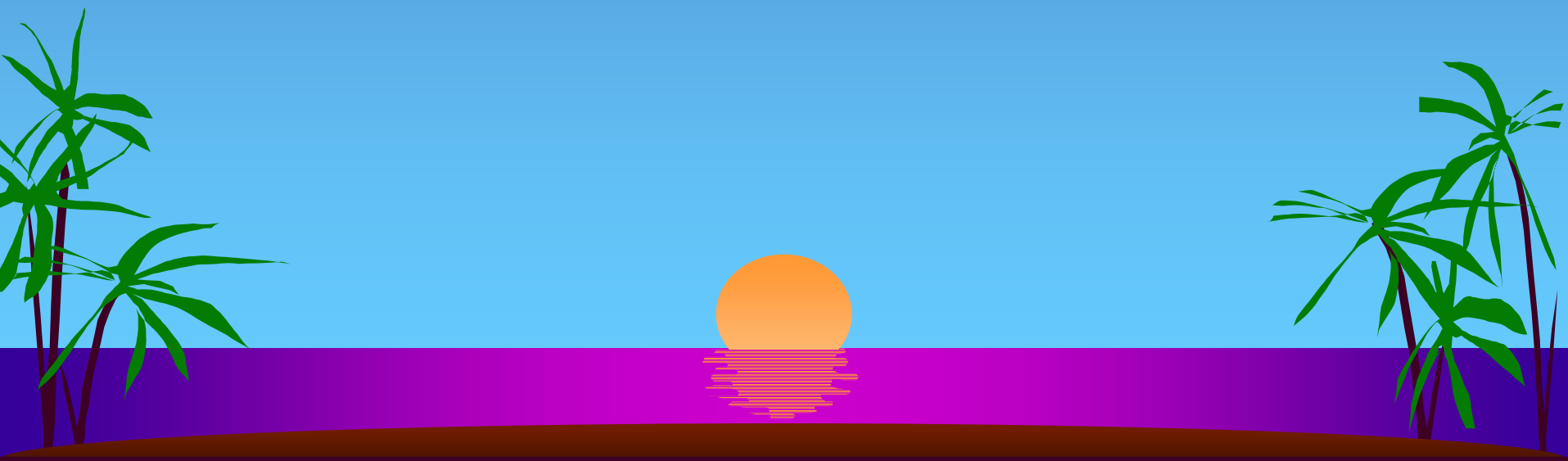


STEPS OF RESPIRATION

- DARK REACTIONS
  - Generally take place in the light
  - use products of light reactions
  - uses CO_2 to make complex organic molecules
  - operates in a cycle (Calvin cycle)

STEPS OF DARK REACTIONS

- 5 Carbon sugar + CO_2 => 3 carbon rubisco (enzyme)
- 3 carbon converts to PGAL with the help of ATP and NADPH



GLYCOLYSIS

- THE BREAKDOWN OF GLUCOSE
  - OPPOSITE REACTION AS PHOTOSYNTHESIS

$$C_6H_{12}O_6 + 6O_2 \Longrightarrow 6CO_2 + 6H_20$$

*REACTION PRODUCES ENERGY

(3811 CALORIES PER GRAM OF $C_6H_{12}O_6$)

STEPS OF GLYCOLYSIS

- Glucose goes through several reactions and splits into two 3 carbon PGAL molecules
  - uses 2 ATP molecules in the process
- 2 PGAL molecules breakdown into 2 pyruvic acid molecules (a 3 carbon molecule)
  - makes 4 ADP and 2 NADH molecules
- * 4 ATP molecules are made from 4 ADP molecules
- * NET GAIN OF 2 ATP MOLECULES

RESPIRATION

- THE BREAKDOWN OF FOOD TO ENERGY WITH THE HELP OF OXYGEN
  - AEROBIC PROCESS: requires oxygen
  - occurs in both plants and animals
  - takes place in the mitrochondria
    - 1st set of reactions - inner membrane
    - 2nd set of reactions - between the inner membrane

STEPS OF RESPIRATION

- KREBS CYCLE
  - 1st set of reactions of respiration
  - takes the pyruvic acid from glycolysis
  - does not produce any end products

STEPS OF THE KREBS CYCLE

- Pyruvic acid in cytoplasm converts to CO_2 and acetic acid in the mitochondria
- acetic acid enters the Krebs cycle
  - acetic acid + 4 C => citric acid (6C)
- 18 other reactions take place
  - 2 places CO_2 is released
  - 4 places electrons transfer
  - 1 place GDP is converted to GTP to make ATP

ENERGY TOTALS

- GLYCOLYSIS
  - 2 ATP USED
  - 4 ATP MADE
  - 2 ATP RESERVE
  - 4 NADH (10 ATP)
  - TOTAL 12 ATP
- RESPIRATION
  - 6 NADH, 2 $FADH_2$ (22 ATP)
  - 2 GTP (2 ATP)
  - TOTAL 24 ATP

FOR EACH GLUCOSE MOLECULE 36 ATP MOLECULES ARE PRODUCED

SUMMARY

- Photosynthesis = “deposits” energy
- Respiration = “ withdraws” energy
    - they are opposite reactions
- photosynthesis is the opposite of the breakdown of glucose
- the products of photosynthesis are the reactants of glucose breakdown

ANAEROBIC PROCESSES

- LACTIC ACID FERMENTATION
  - Energy made in the absence of oxygen
  - Regenerates NAD+ to be used by glycolysis
- ALCOHOLIC FERMENTATION
  - Pyruvic acid combines with NADH to produce alcohol + carbon dioxide and NAD+