



ACIDS PRECIPITATE

ACID RAIN

AQUATIC HABITAT pH BALANCE DISRUPTED



T

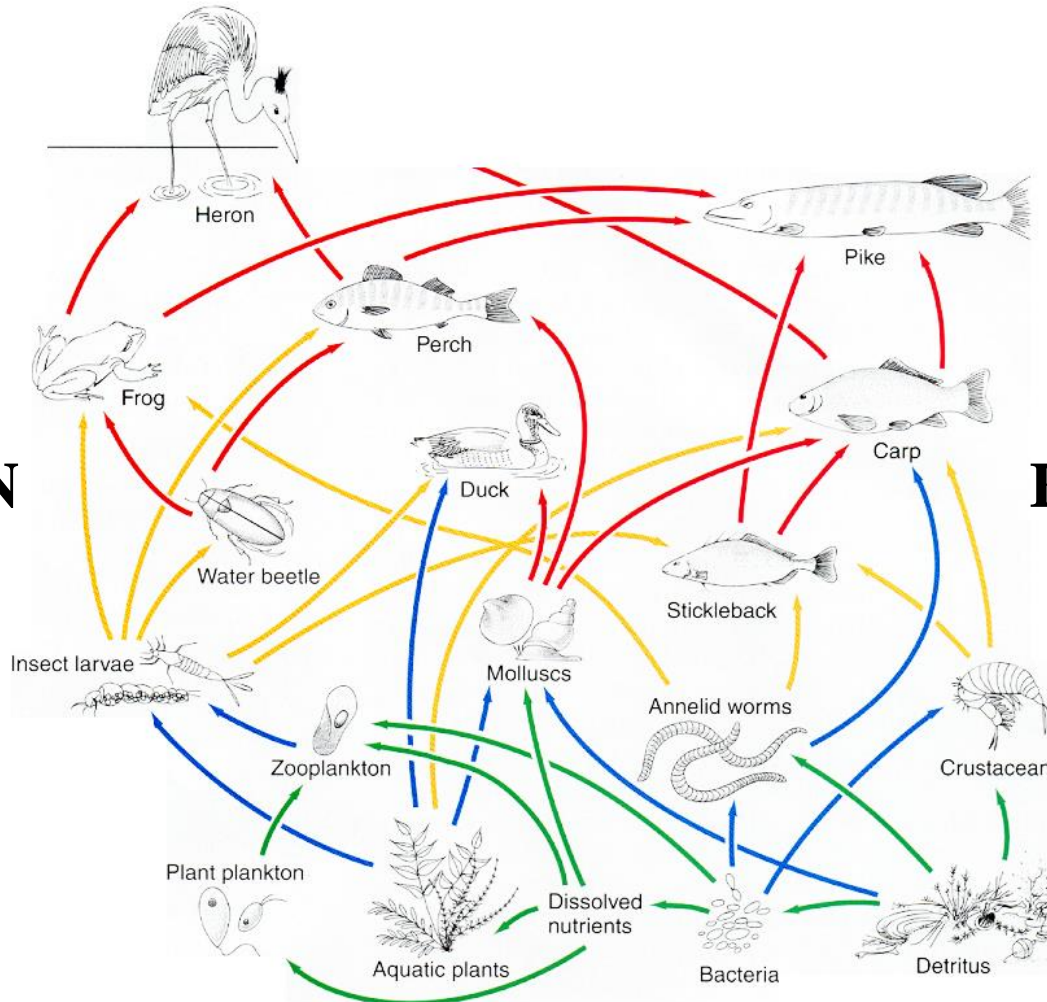




AQUATIC ORGANISMS

NARROW pH TOLERANCE

**AQUATIC
FOOD CHAIN**

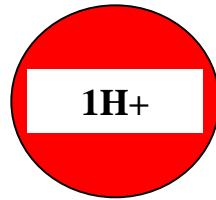
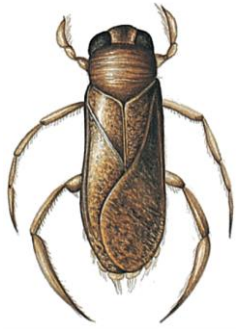


**AQUATIC
FOOD CHAIN**

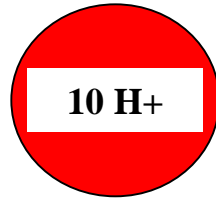


AQUATIC ORGANISMS

NARROW pH TOLERANCE



pH = 7



pH = 6

ORGANISMS
THRIVE

ACIDS PRECIPITATE

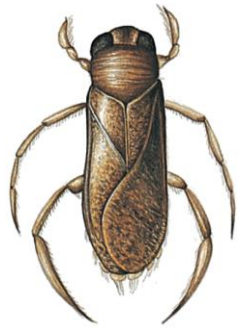


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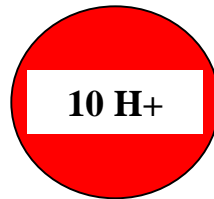
ACID RAIN



AQUATIC ORGANISMS NARROW pH TOLERANCE



pH = 7

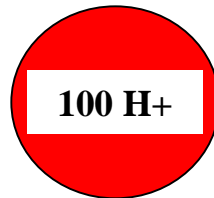


pH = 6

**ORGANISMS
THRIVE**

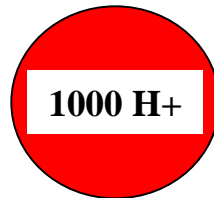
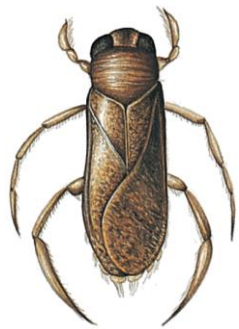
TOLERANCE

THRESH-HOLD



pH = 5

**ORGANISMS
DIE**



pH = 4

An electron micrograph showing a cross-section of a cell. The image displays various organelles, including a large nucleus with a prominent nucleolus, rough endoplasmic reticulum with ribosomes, and several mitochondria with visible internal folds (cristae). The text is overlaid in a large, bold, red, italicized font.

***CELL
METABOLISM
DISRUPTED***

METABOLISM

GLUCOSE

METABOLISM

HEXOKINASE



ATP



ADP

GLUCOSE-6-PHOSPHATE

PHOSPHOGLUCOISOMERASE

FRUCTOSE-6-PHOSPHATE

PHOSPHOFRUCTOKINASE

ATP



ADP

FRUCTOSE-1-6-PHOSPHATE

ENZYMES
VITAL TO LIFE

ENZYMES
VITAL TO LIFE



METABOLISM

METABOLISM

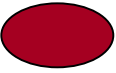
GLUCOSE

HEX  ASE

ATP

 **ENERGY**

ADP



GLUCOSE-6-PHOSPHATE

PHOSPHOG  ISOMERASE

FRUCTOSE-6-PHOSPHATE

PHOSPHO  KINASE

ATP

 **ENERGY**

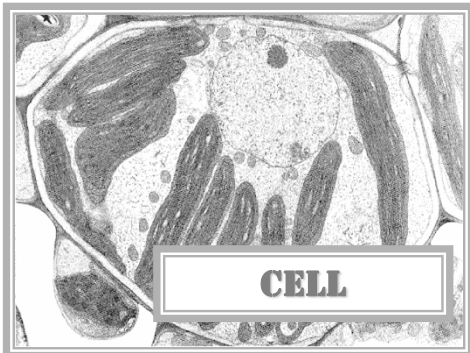
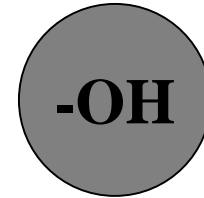
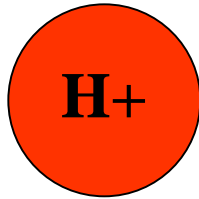
ADP

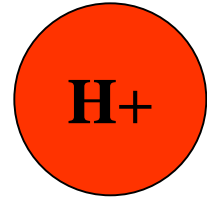
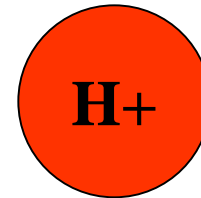
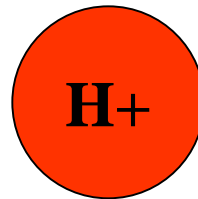
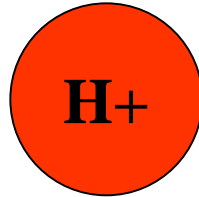
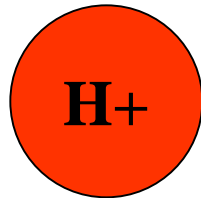
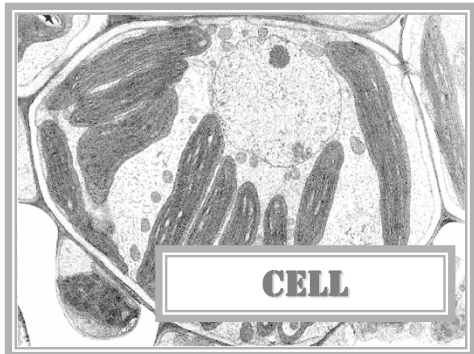
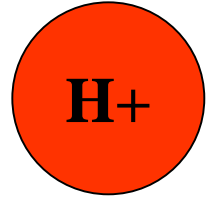
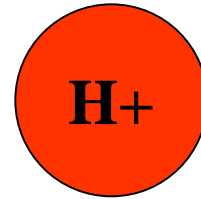
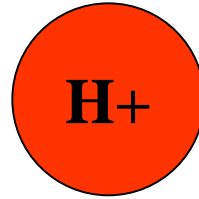
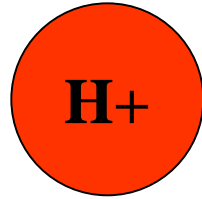
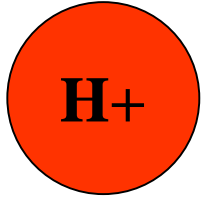
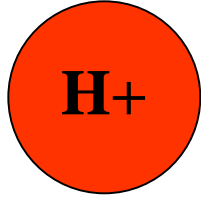
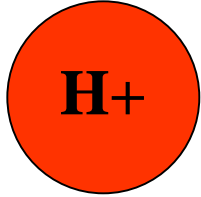
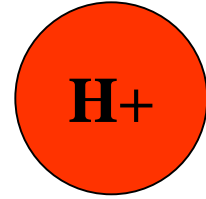
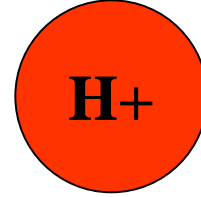
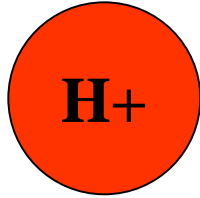
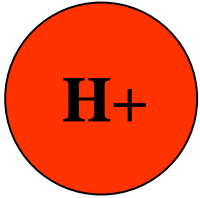
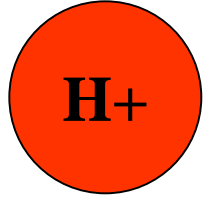
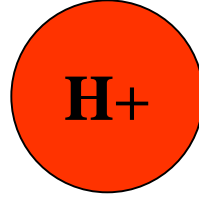
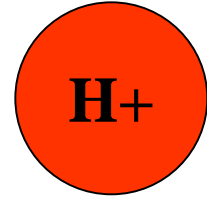
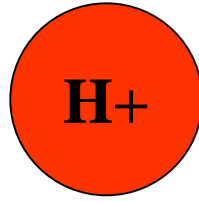
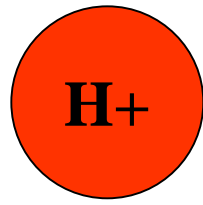
FRUCTOSE-1-6-PHOSPHATE

ENZYMES
VITAL TO LIFE

ENZYMES
VITAL TO LIFE

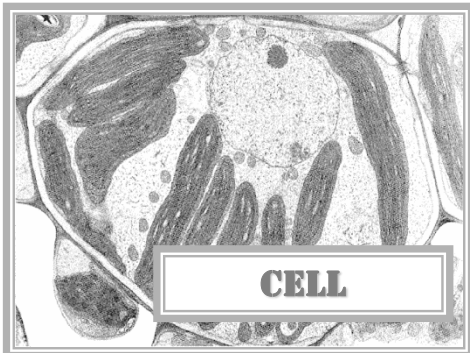
 = ENERGY



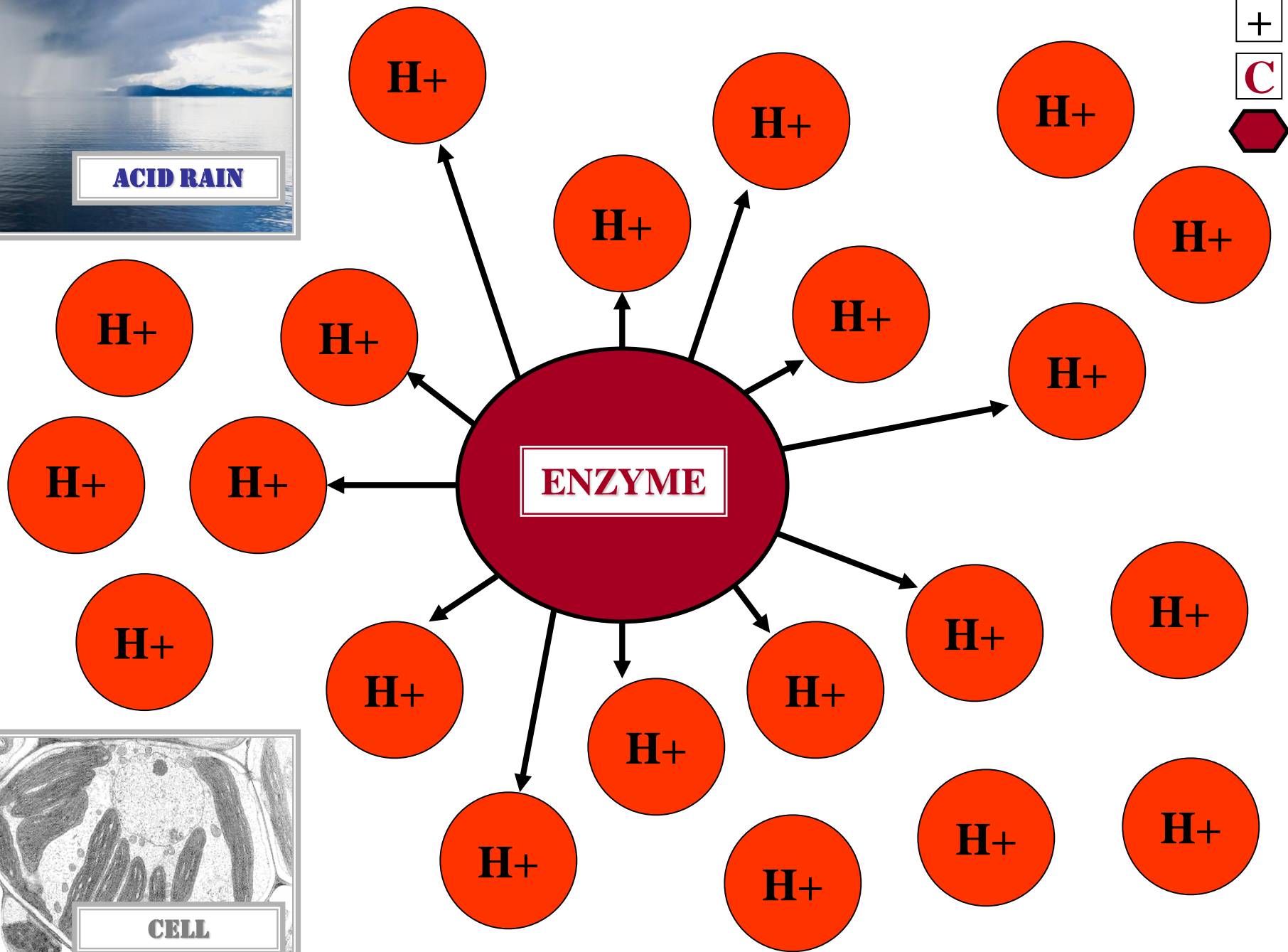




ACID RAIN

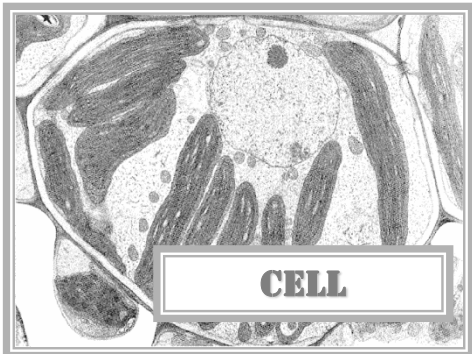
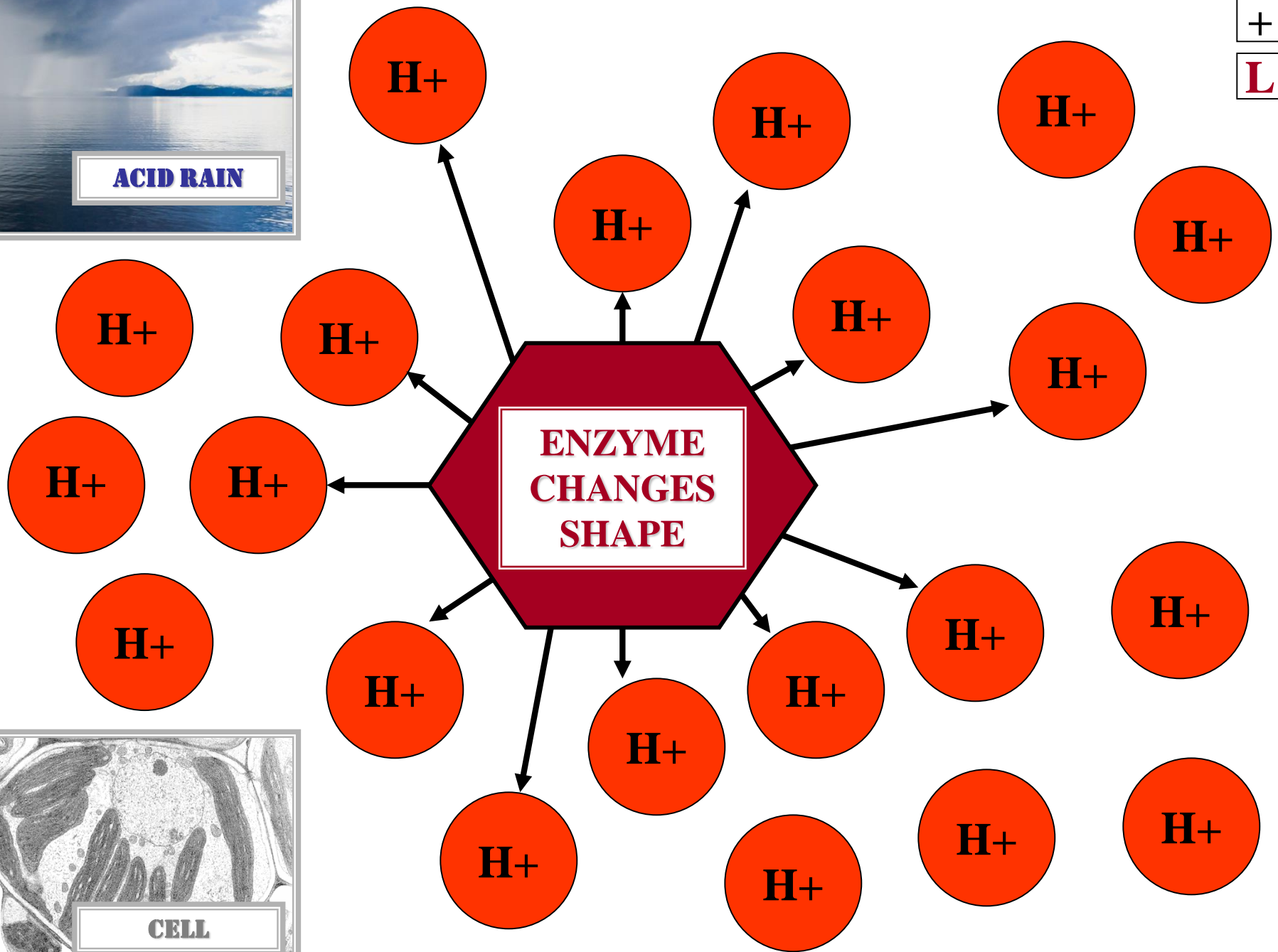


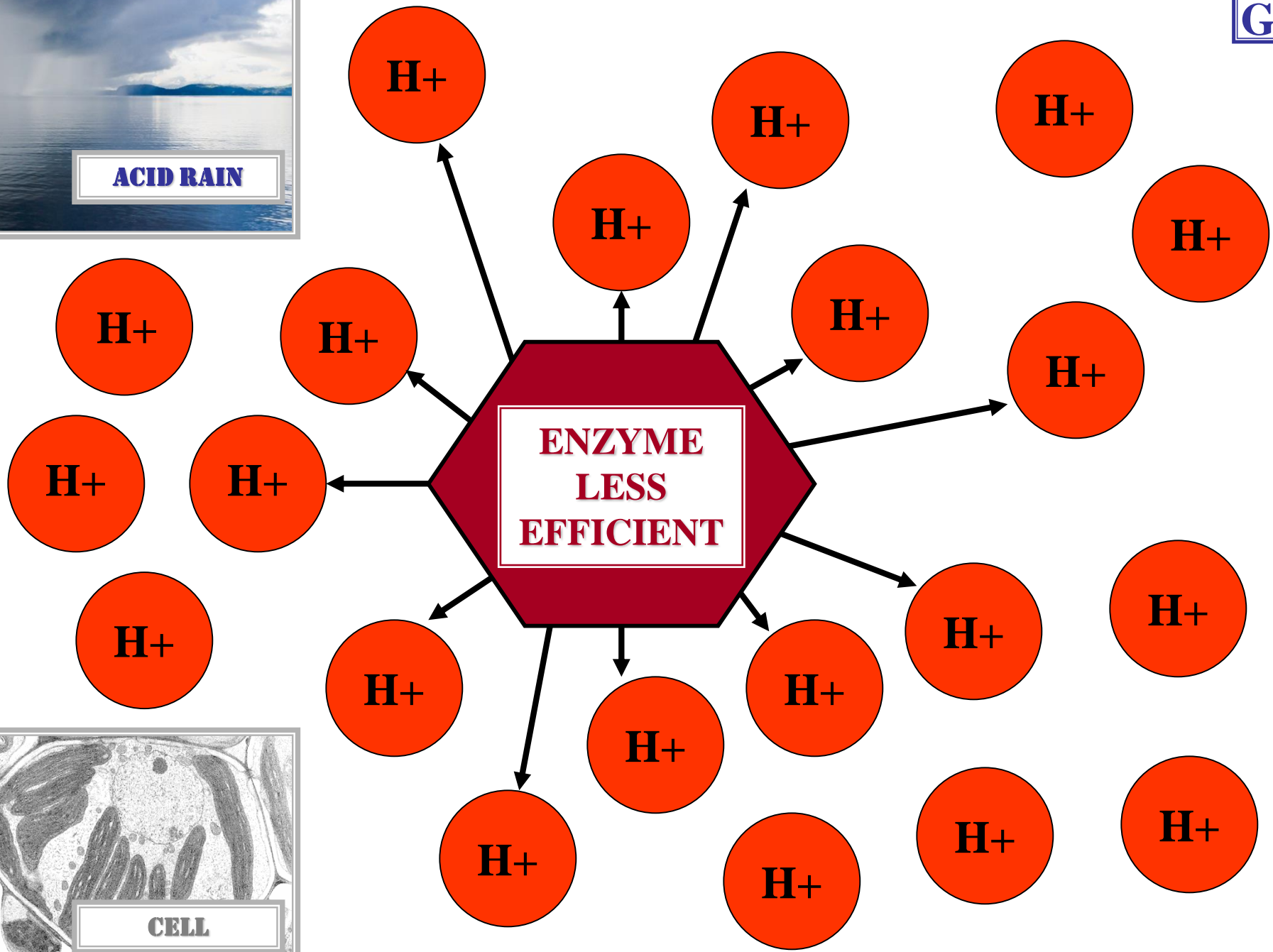
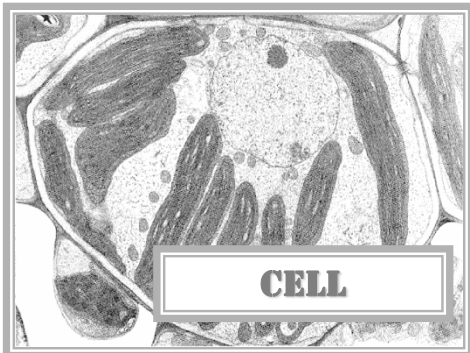
CELL





+
L





METABOLISM

GLUCOSE

METABOLISM

HEXOKINASE



ATP



ADP

GLUCOSE-6-PHOSPHATE

PHOSPHOGLUCOISOMERASE

FRUCTOSE-6-PHOSPHATE

PHOSPHOFRUCTOKINASE

ATP



ADP

FRUCTOSE-1-6-PHOSPHATE

ENZYMES
VITAL TO LIFE

ENZYMES
VITAL TO LIFE



METABOLISM

METABOLISM

GLUCOSE

HEX  ASE

ATP

 **ENERGY**

ADP



+

GLUCOSE-6-PHOSPHATE

PHOSPHOG  ISOMERASE

FRUCTOSE-6-PHOSPHATE

PHOSPHO  KINASE

ATP

 **ENERGY**

ADP

ENZYMES
VITAL TO LIFE

ENZYMES
VITAL TO LIFE

FRUCTOSE-1-6-PHOSPHATE

 = ENERGY

***CELL
METABOLISM
DISRUPTED***



***HOMEOSTASIS
DISRUPTED***



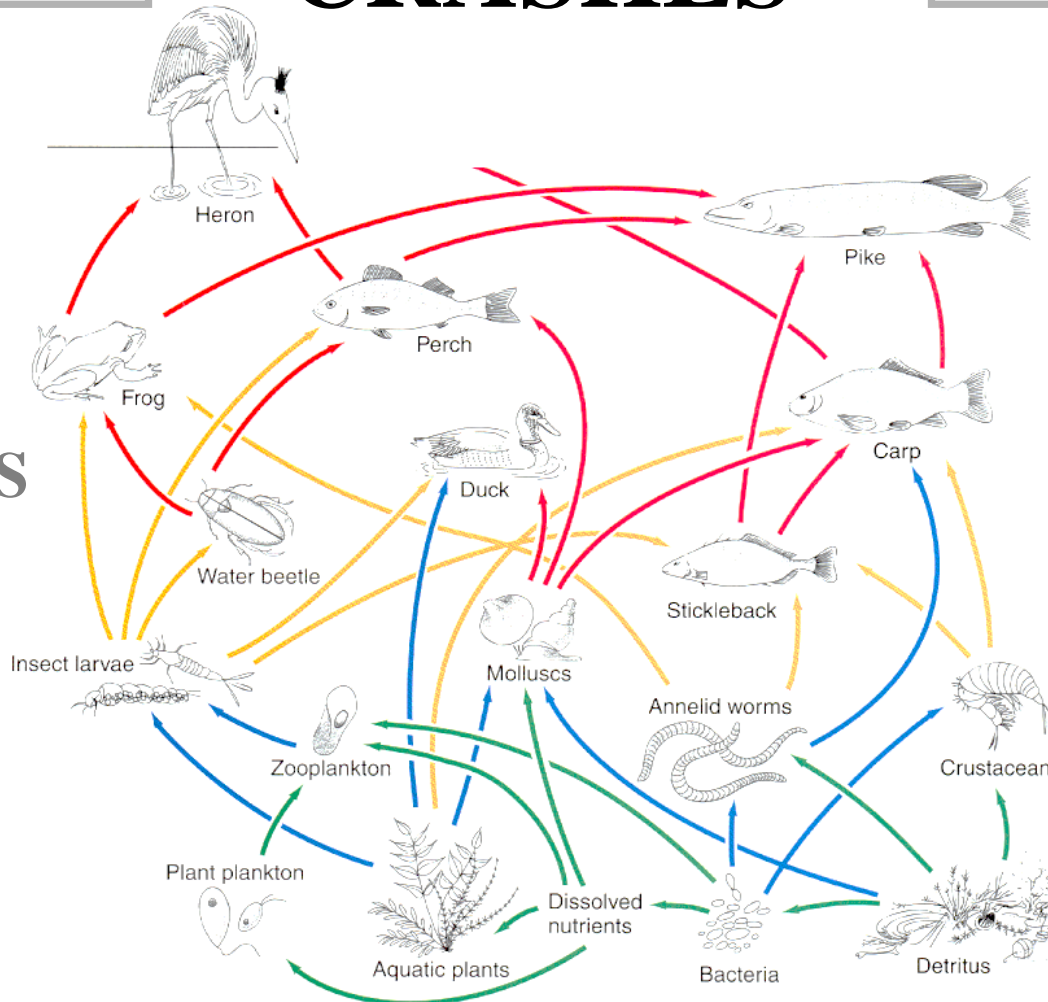


AQUATIC FOOD CHAIN CRASHES



**ORGANISMS
DIE**

**ORGANISMS
DIE**

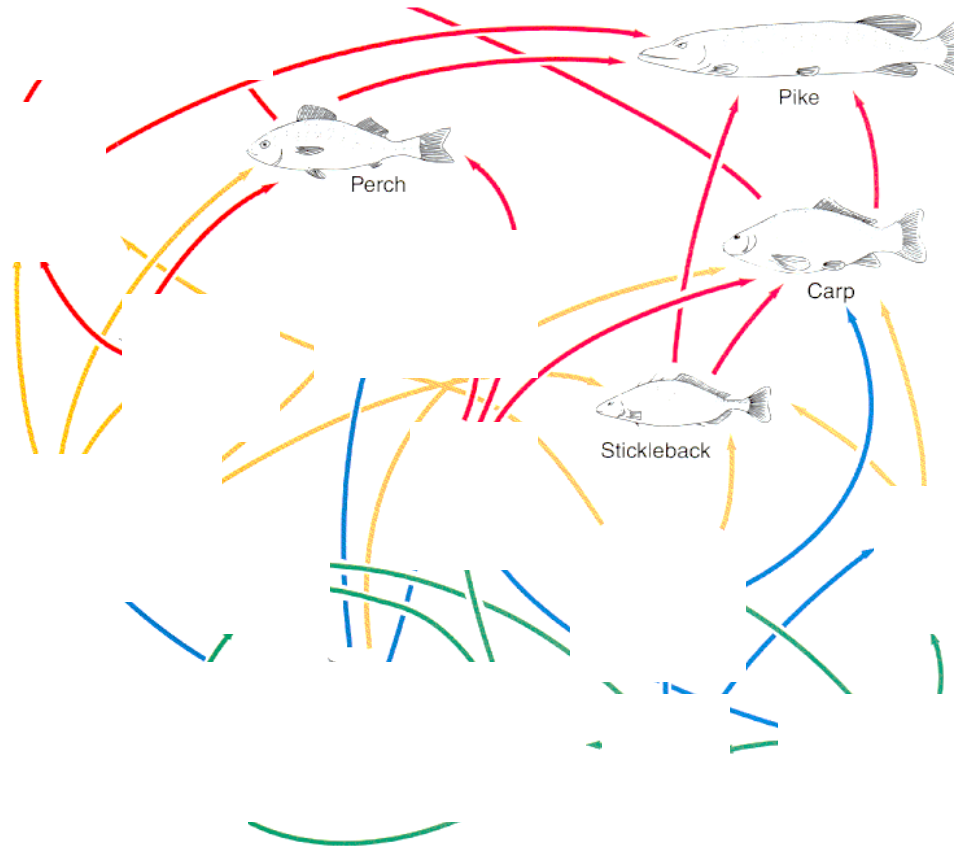




AQUATIC FOOD CHAIN CRASHES



**ORGANISMS
DIE**



**ORGANISMS
DIE**

ACID RAIN



?

FISH KILL





**ACID RAIN
FISH KILL
WHO CARES?**

ACID RAIN

NORTH AMERICA

GREAT LAKES REGION



**ACID RAIN
PROBLEM**



NEW YORK STATE



ACID RAIN PROBLEM



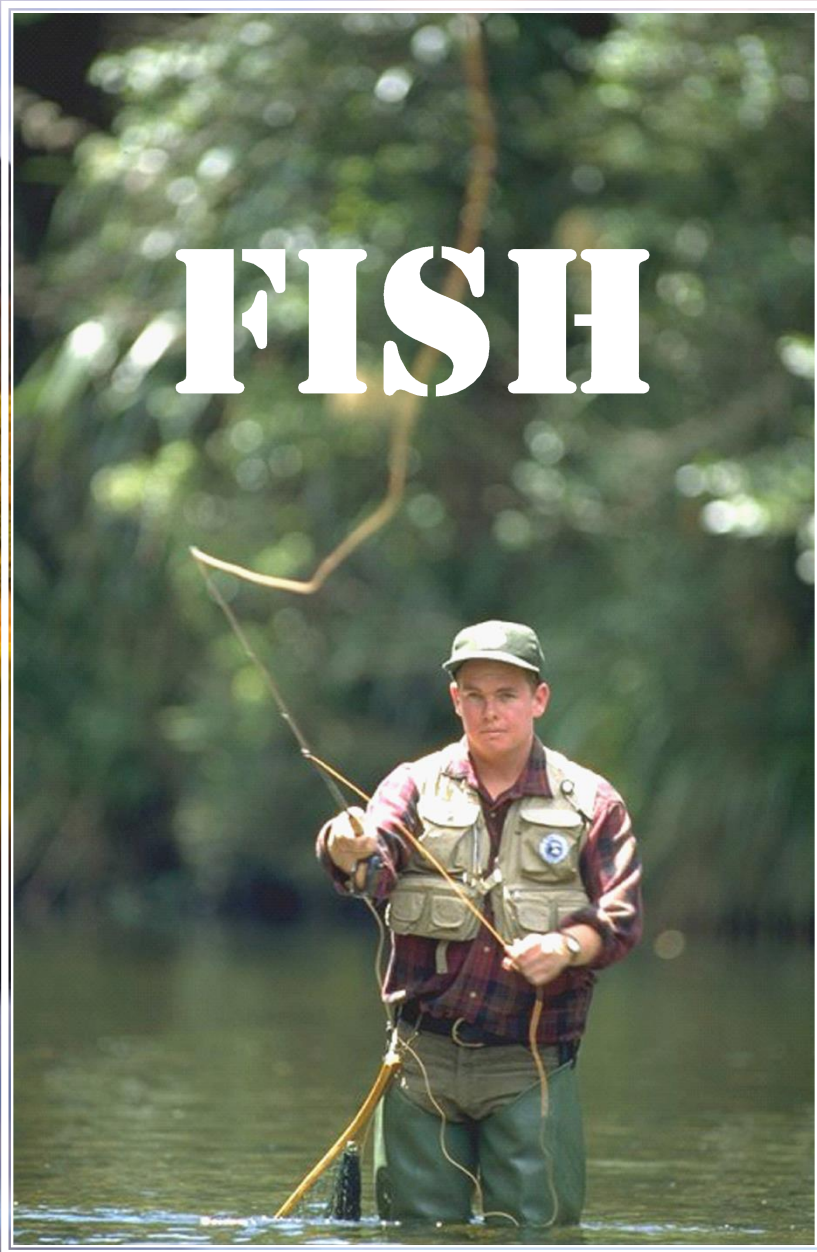
ADIRONDACK LAKE



FALL COLORS



FISH







BROOK TROUT





ACIDS PRECIPITATE

ACID RAIN

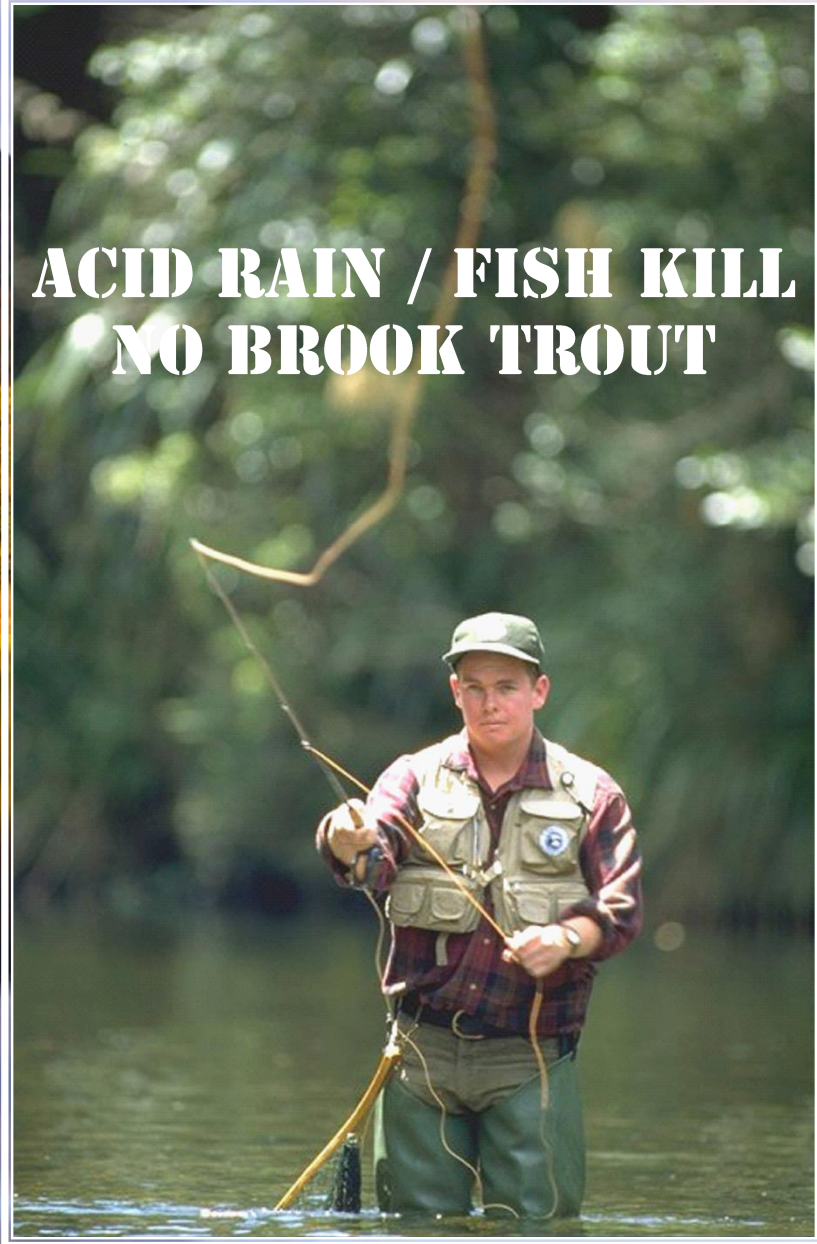


BROOK TROUT





**ACID RAIN / FISH KILL
NO BROOK TROUT**





ADIRONDACK PARK ECONOMIC LOSS



ACID RAIN EMISSIONS

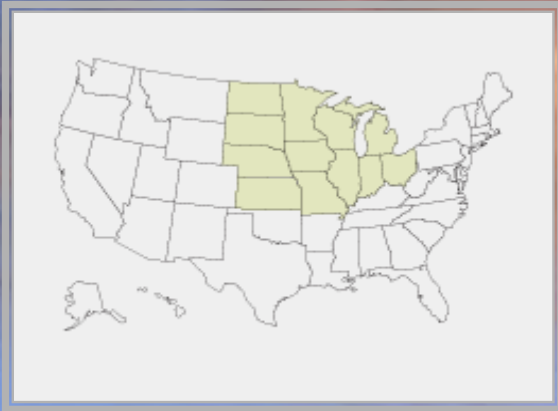
**MIDWEST COAL FIRED
ELECTRIC POWER PLANT**





ACID RAIN EMISSIONS

**MIDWEST COAL FIRED
ELECTRIC POWER PLANT**



ACID RAIN EMISSIONS

**MIDWEST COAL FIRED
ELECTRIC POWER PLANT**



ACID RAIN

The Boston Globe Magazine



THE POLITICS OF ACID RAIN POLLUTION

Midwestern power plants are dramatically cleaner than they were a decade ago, thanks to the Clean Air Act of 1990. But, for the most part, rainfall in the Northeast is as acidic as ever.

By Michael Kranish, Globe Staff

Donald Buso steers the snowmobile up a twisting path deep in New Hampshire's White Mountains. Higher and higher, Buso climbs, thundering into a government preserve, then clicking off the engine as he approaches a cascading stream. In the distance, a parade of peaks forms a majestic curtain around Waterville Valley and Sandwich Notch. Nearby, a waterfall beats steadily, the only sound breaking the silence in this snowy white, seemingly pure landscape.

pH SCALE

1 UNIT = 10X ION CONCENTRATION CHANGE

GENERAL PUBLIC



GENERAL PUBLIC



GENERAL PUBLIC



GENERAL PUBLIC

AQUATIC ORGANISMS

NARROW pH TOLERANCE

GENERAL PUBLIC



GENERAL PUBLIC

pH = 7

pH = 6



AQUATIC ORGANISMS NARROW pH TOLERANCE

GENERAL PUBLIC



GENERAL PUBLIC

SMALL pH CHANGE

pH = 7

pH = 6

pH = 5

pH = 4



AQUATIC ORGANISMS

NARROW pH TOLERANCE



**1000X FOLD ION
CONCENTRATION
CHANGE**

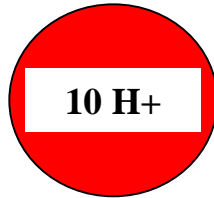


HUGH pH CHANGE



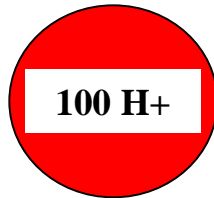
pH = 7

10X ION CHANGE



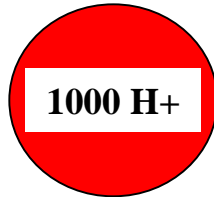
pH = 6

10X ION CHANGE



pH = 5

10X ION CHANGE



pH = 4



AQUATIC ORGANISMS

NARROW pH TOLERANCE



2

?



1H⁺

pH = 7

10X ION CHANGE

10 H⁺

pH = 6

10X ION CHANGE

100 H⁺

pH = 5

10X ION CHANGE

1000 H⁺

pH = 4



FISH KILL



ECONOMIC LOSS



E

ACID RAIN FISH KILL WHO CARES?

ACID RAIN

A scenic landscape photograph of a calm lake reflecting the surrounding forest and mountains. The trees are in full autumn foliage, with vibrant oranges, yellows, and reds. In the background, a dark, forested mountain rises under a cloudy sky. The water in the foreground is still, creating a clear reflection of the trees and sky above.

ADIRONDACK PARK ECONOMIC LOSS



***CELL pH
IMPACTS
METABOLISM***

BUFFERS

BUFFERS



BUFFERS

**CHEMICAL AGENTS
W/IN CELL
STABILIZE CELL pH**

BUFFERS

***BUFFERS
STABILIZE
CELL pH***

***EFFICIENT
CELL
METABOLISM***



HOMEOSTASIS

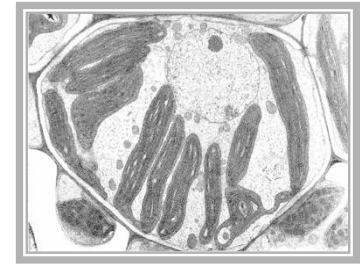
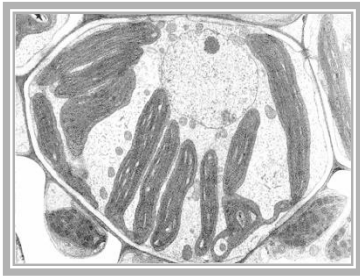




BUFFERS
VITAL
CELL
METABOLISM

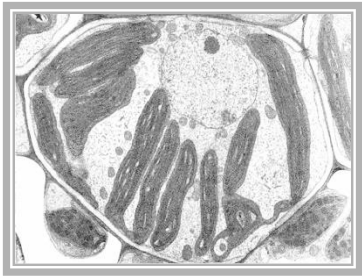


BUFFERS: APPLIED



CELL pH TOO BASIC



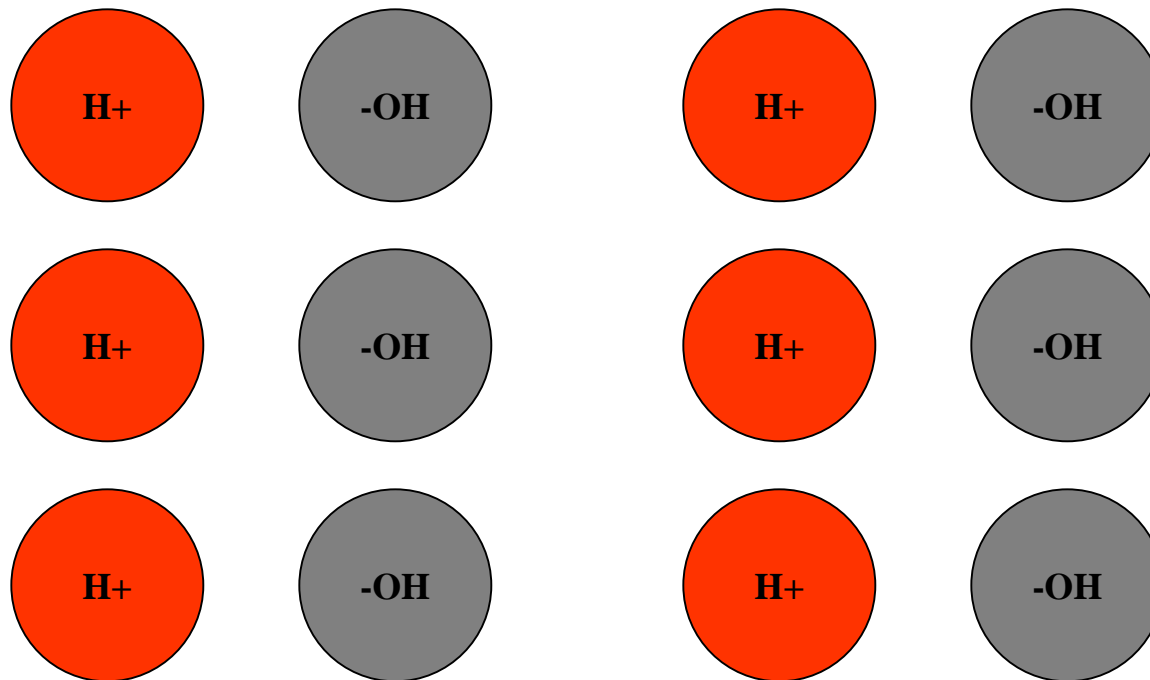


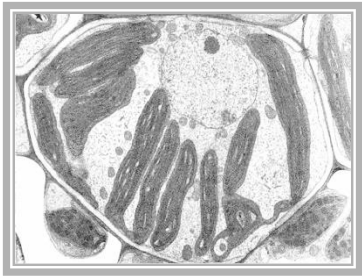
BUFFERS VITAL TO CELL METABOLISM



-OH

CELL pH TOO BASIC



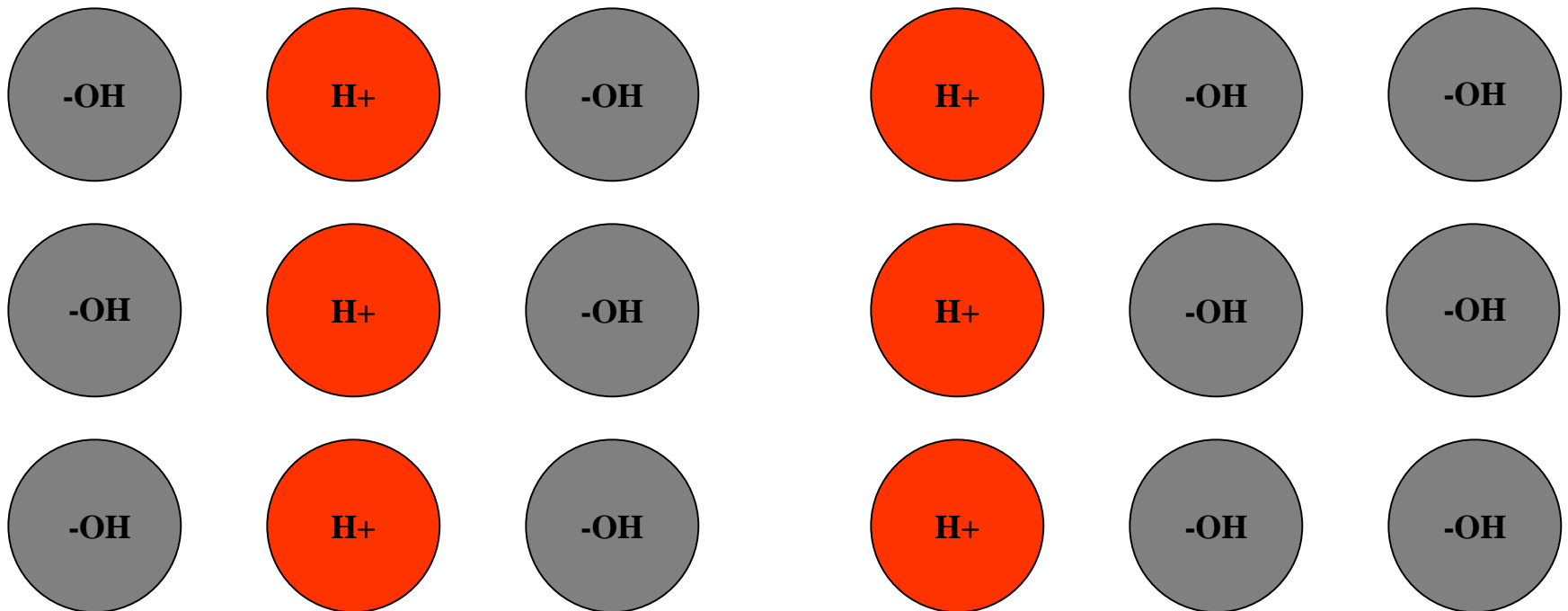


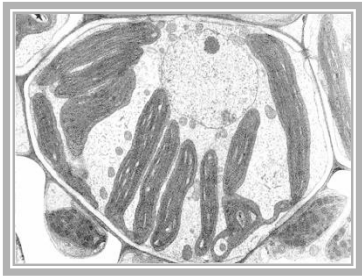
BUFFERS VITAL TO CELL METABOLISM



R

-OH CONCENTRATION TOO HIGH





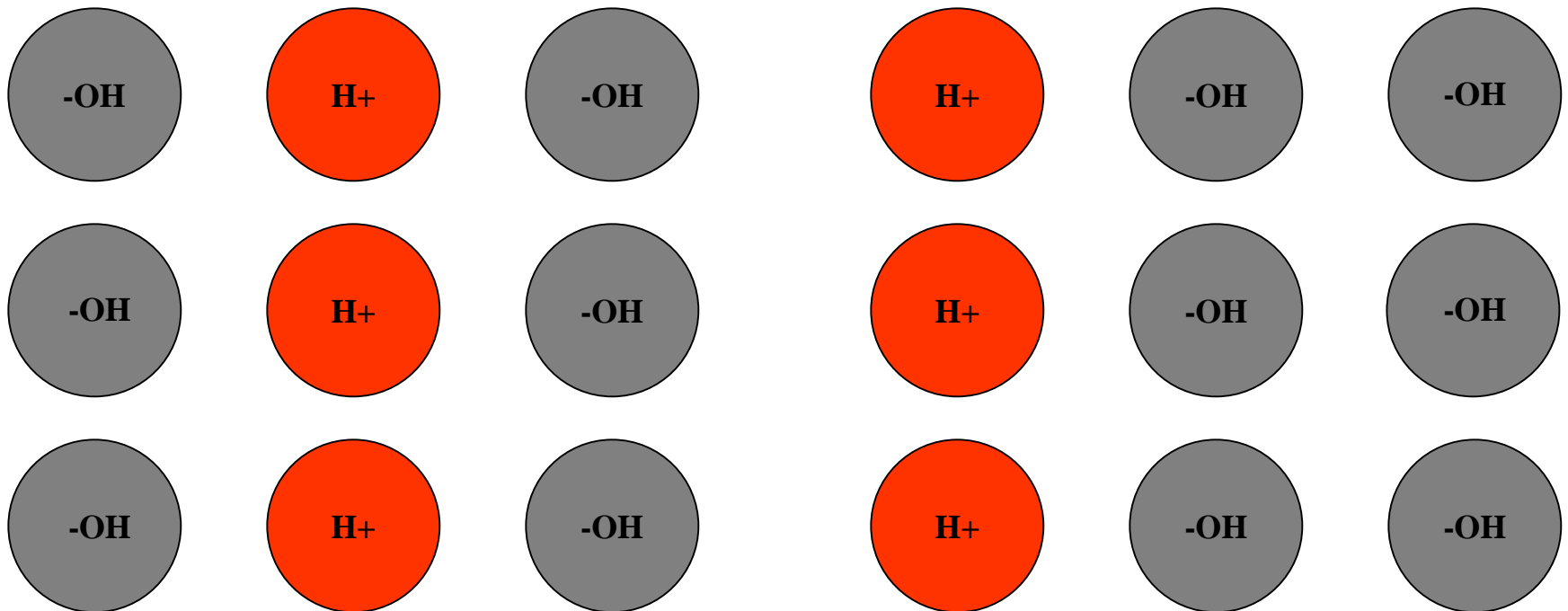
BUFFERS VITAL TO CELL METABOLISM

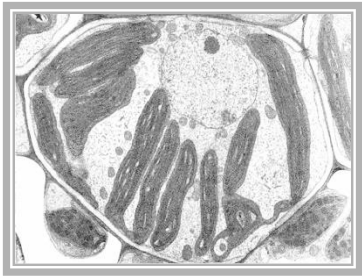


H^+

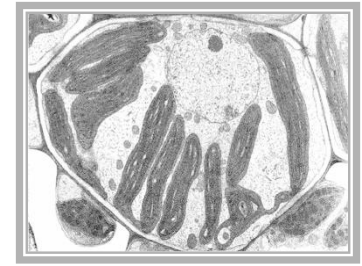


CELL BUFFERS RESPOND





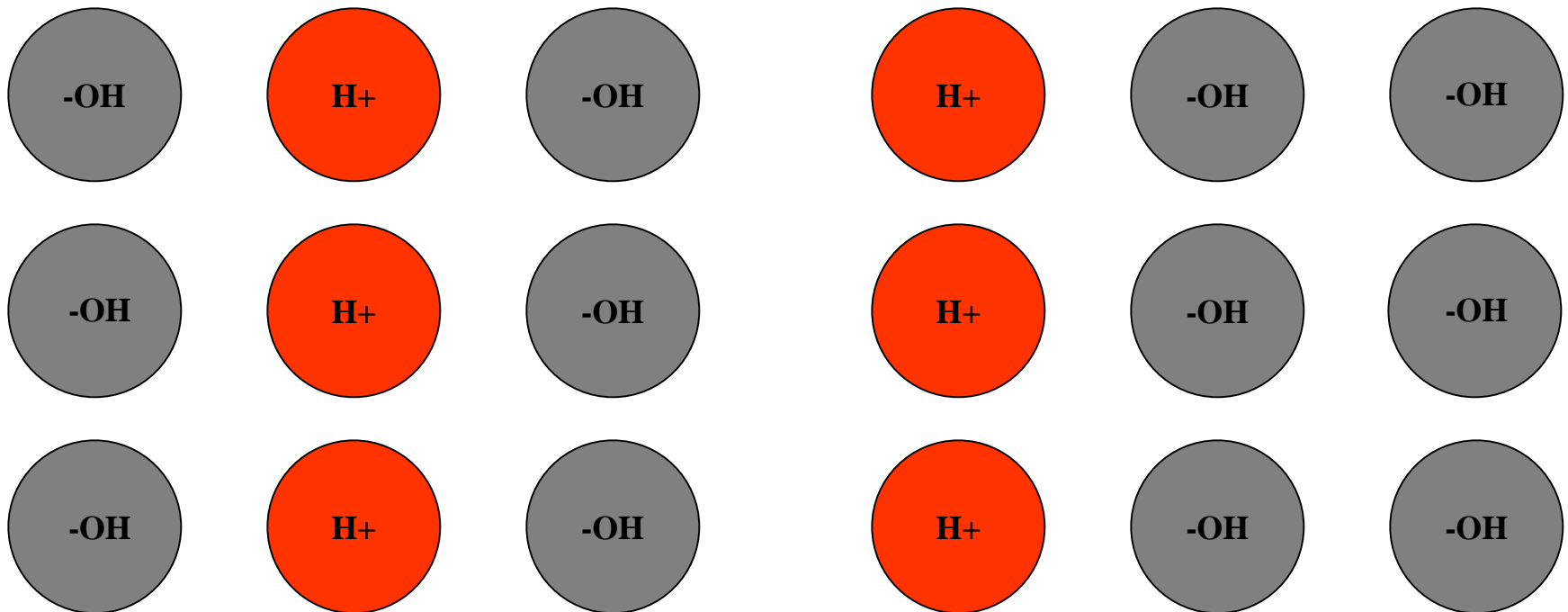
BUFFERS VITAL TO CELL METABOLISM

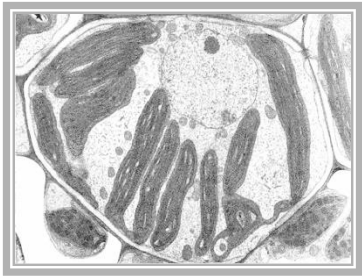


H⁺

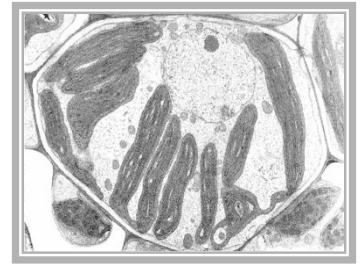


CELL BUFFERS ADD H⁺



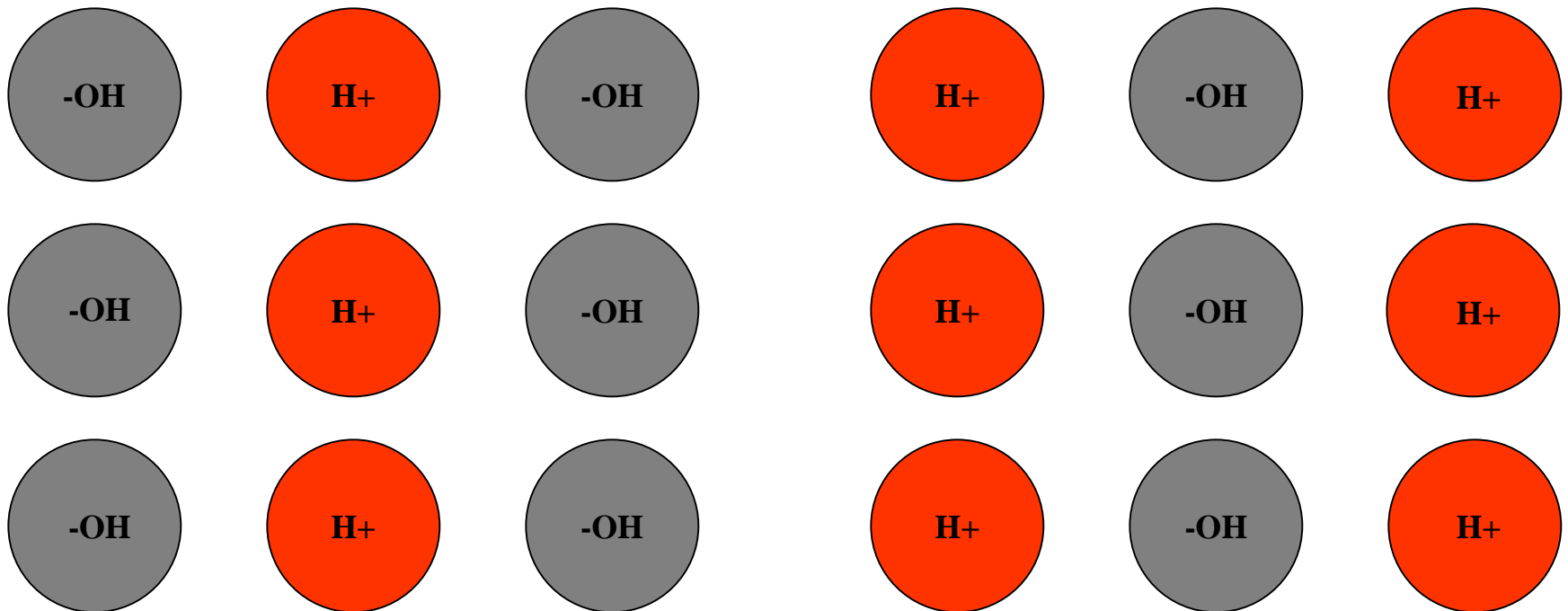


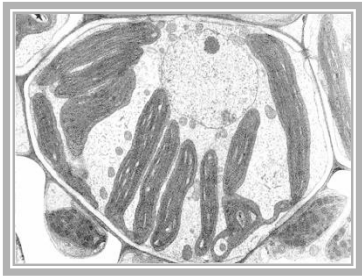
BUFFERS VITAL TO CELL METABOLISM



N

CELL BUFFERS ADD H^+



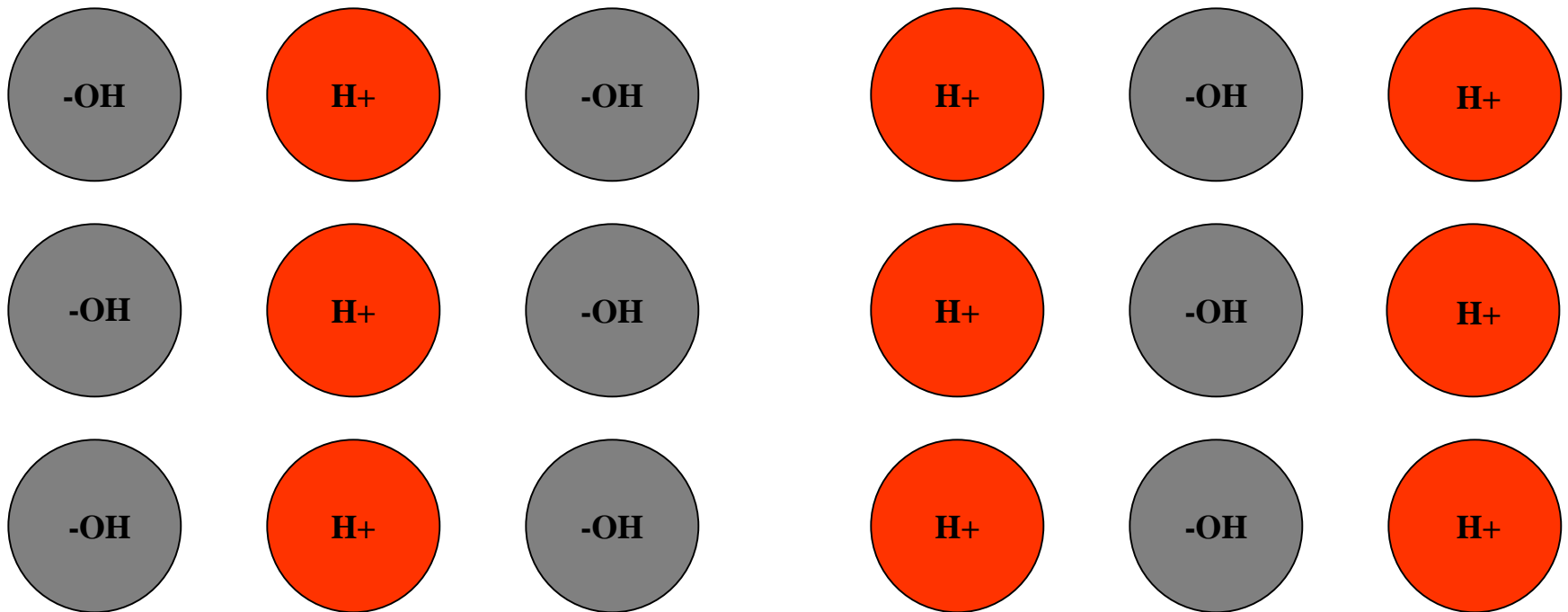


BUFFERS VITAL TO CELL METABOLISM



E

NORMAL STABILIZED pH RESTORED



***EFFICIENT
CELL
METABOLISM***

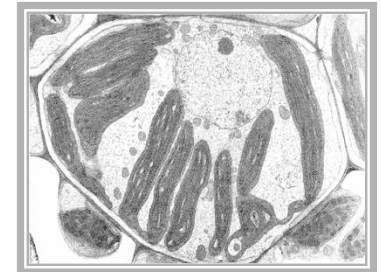


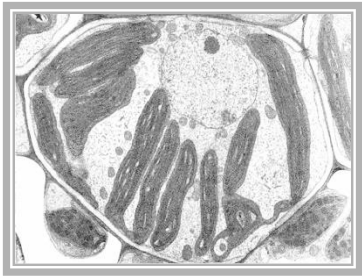
HOMEOSTASIS





CELL pH TOO ACIDIC



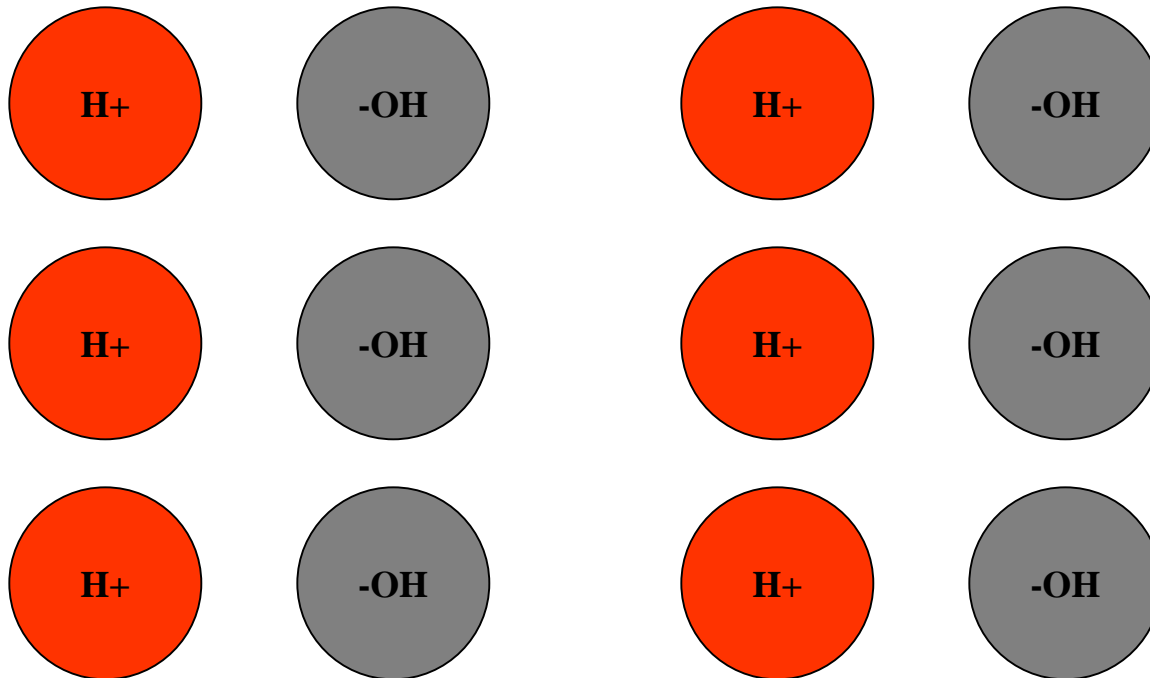


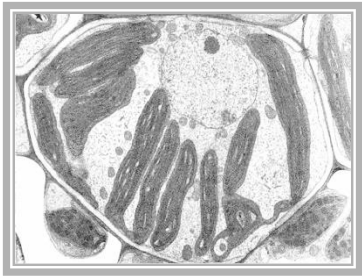
BUFFERS VITAL TO CELL METABOLISM



H^+

CELL pH TOO ACIDIC



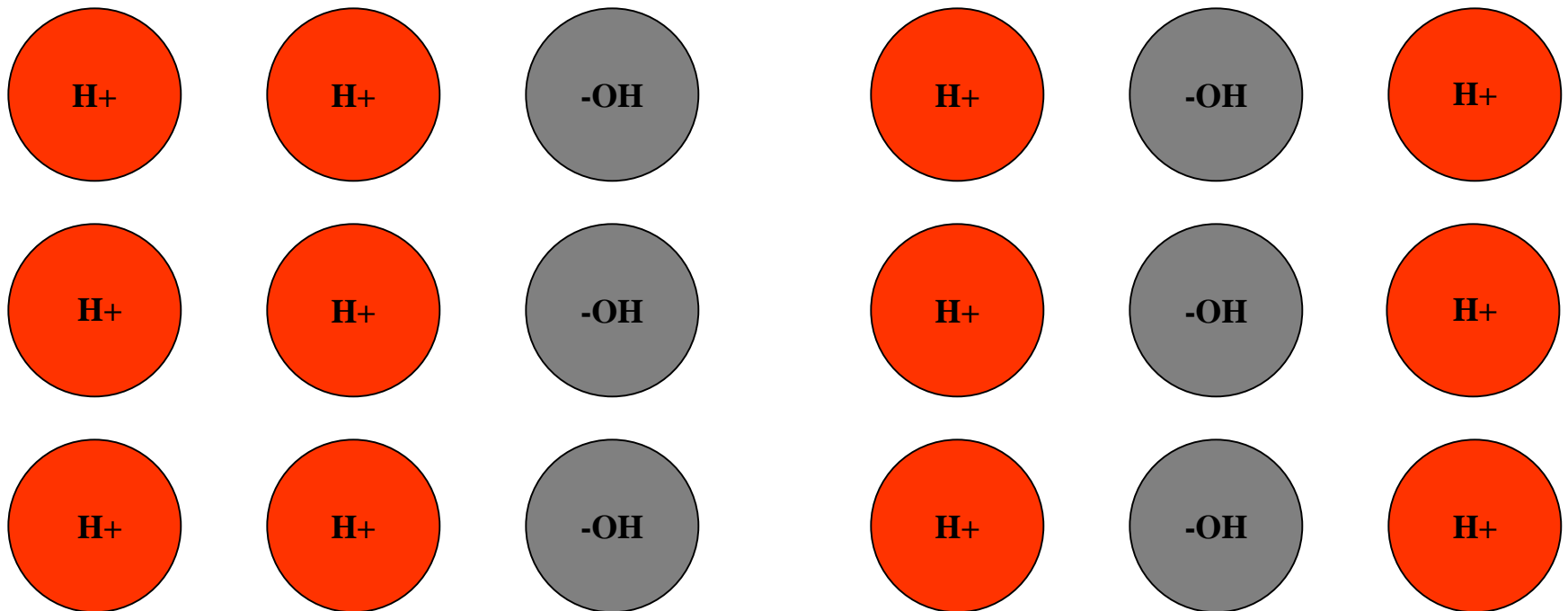


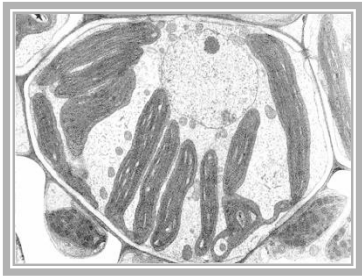
BUFFERS VITAL TO CELL METABOLISM



R

H⁺ CONCENTRATION TOO HIGH





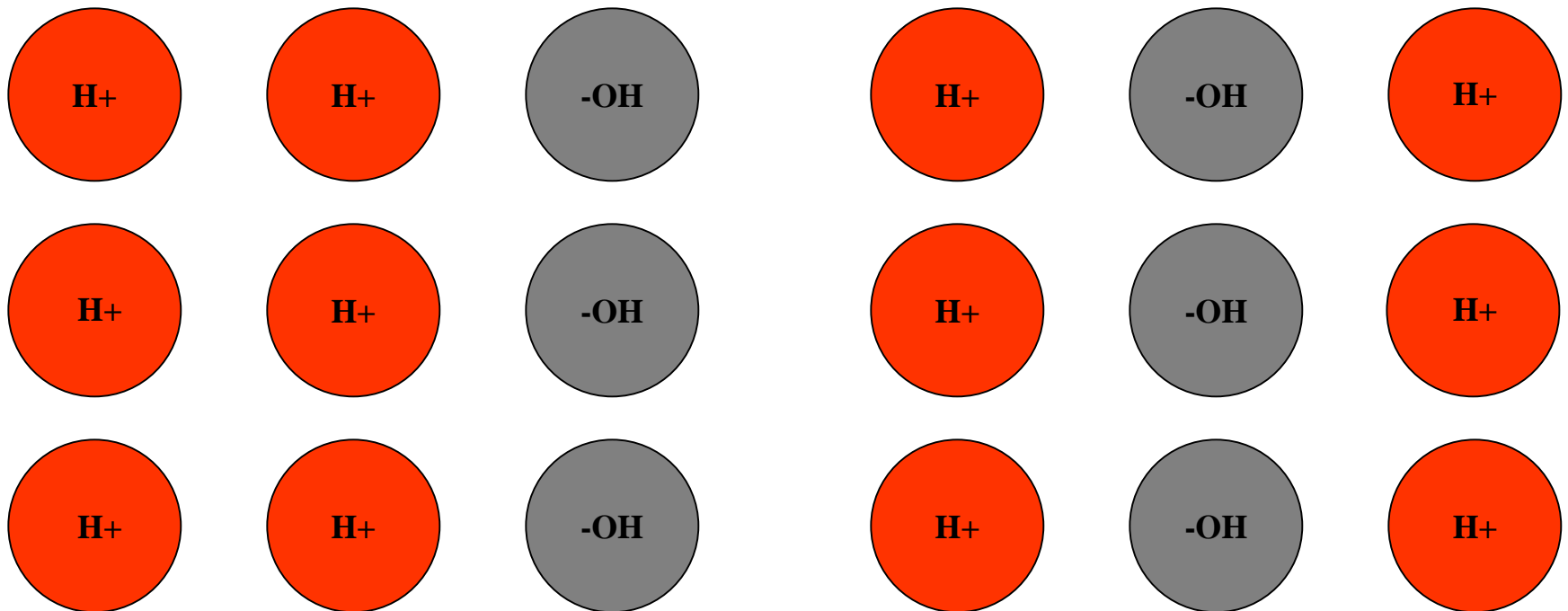
BUFFERS VITAL TO CELL METABOLISM

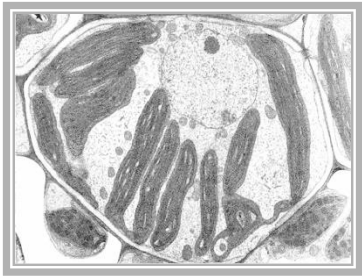


H^+

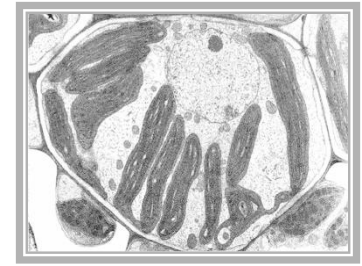


CELL BUFFERS RESPOND





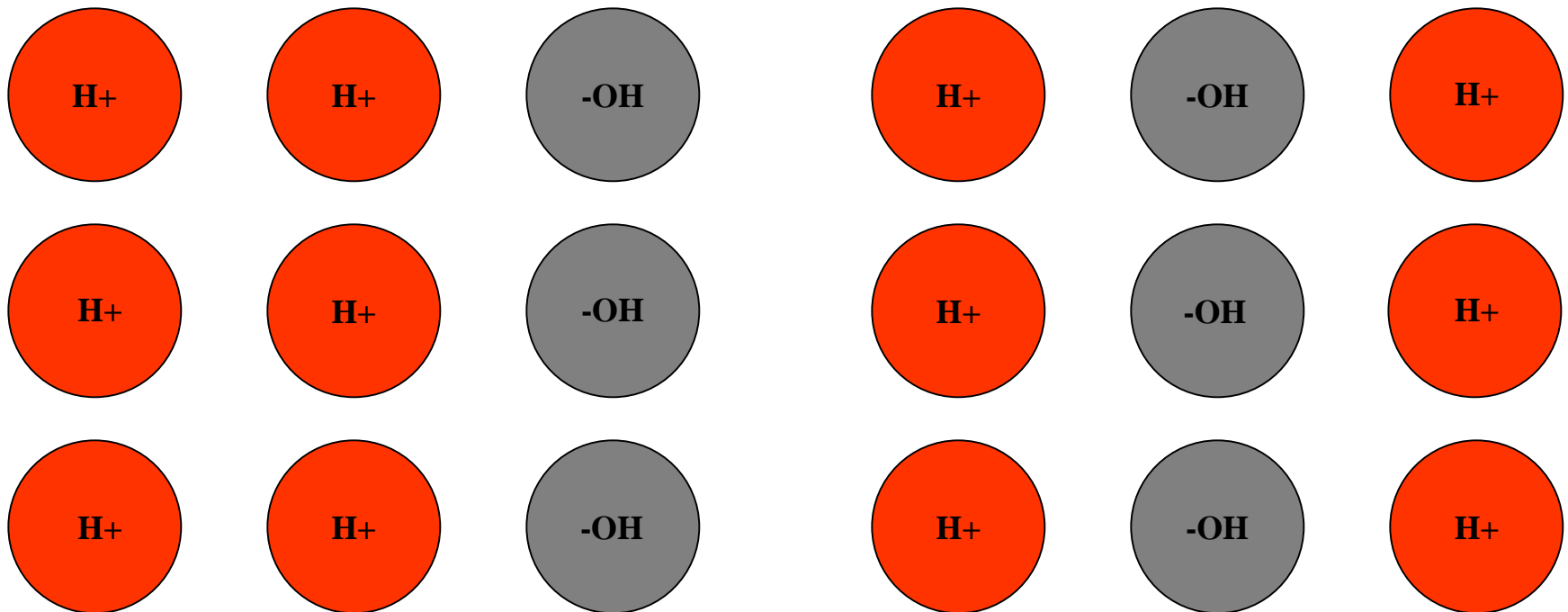
BUFFERS VITAL TO CELL METABOLISM

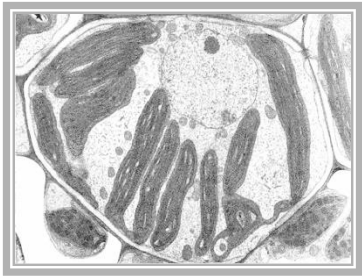


H⁺

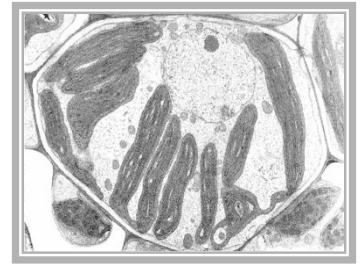


CELL BUFFERS REMOVE H⁺



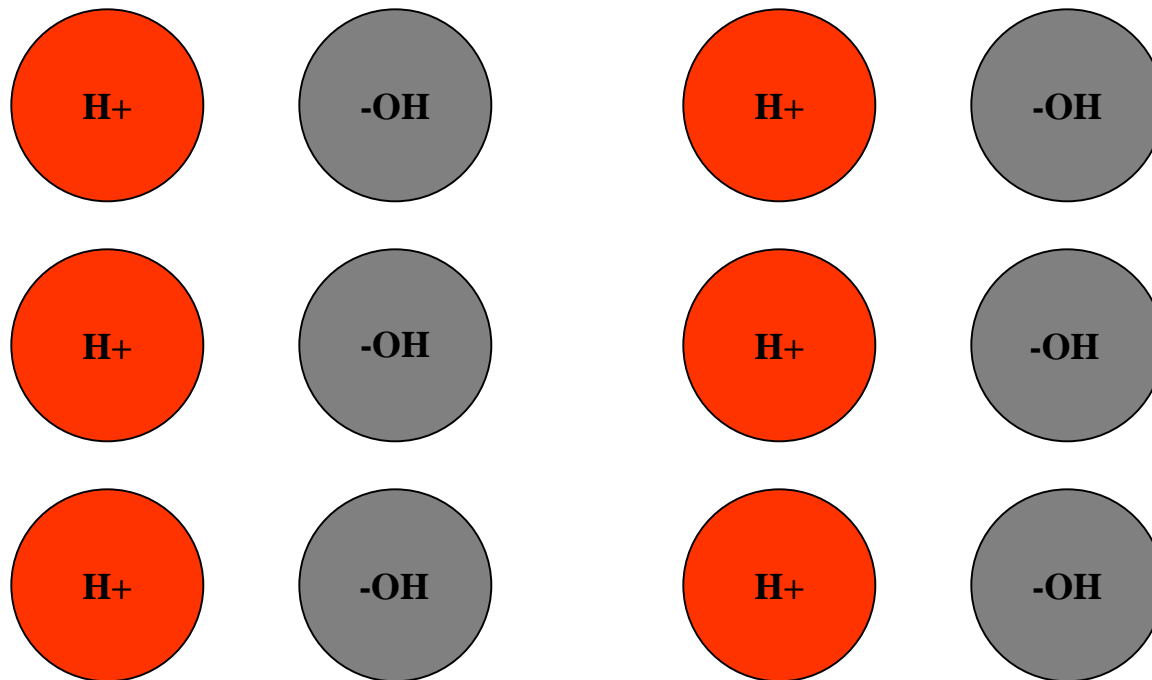


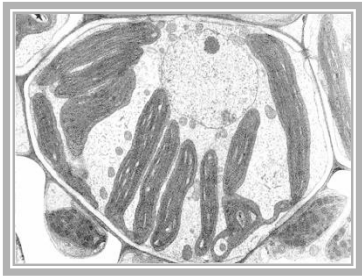
BUFFERS VITAL TO CELL METABOLISM



N

CELL BUFFERS REMOVE H^+



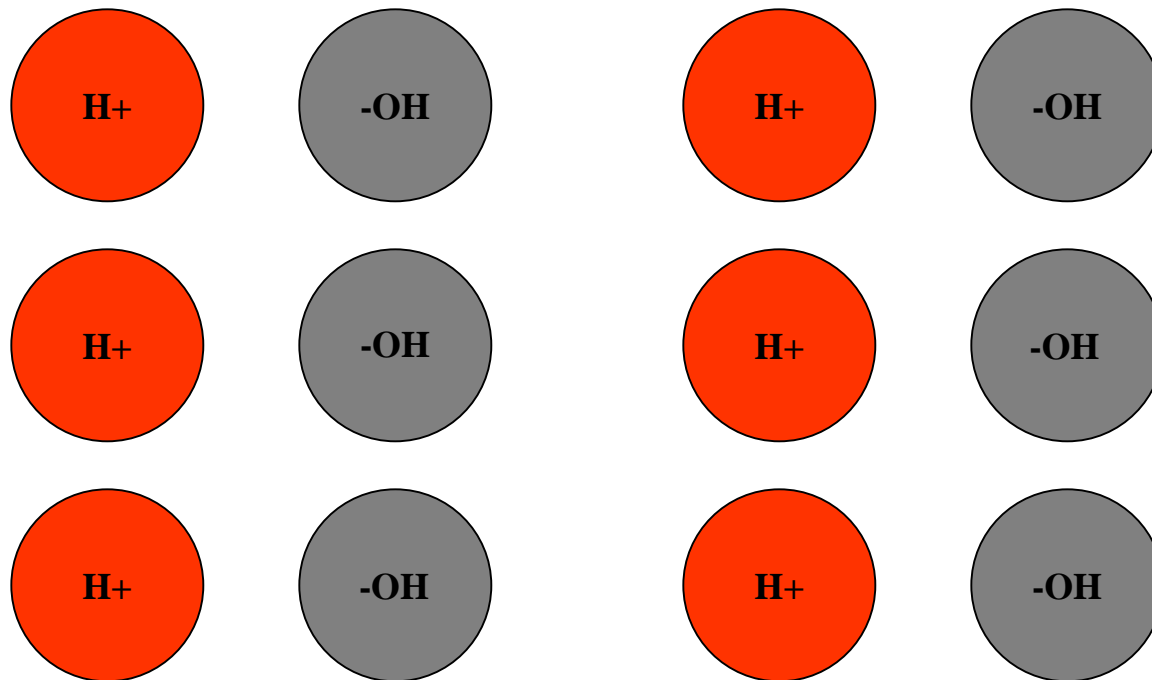


BUFFERS VITAL TO CELL METABOLISM



E

NORMAL STABILIZED pH RESTORED



***EFFICIENT
CELL
METABOLISM***



HOMEOSTASIS



ACID RAIN
WHY DON'T
CELL BUFFERS
RESPOND?

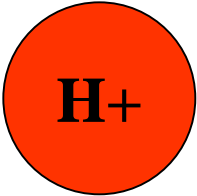
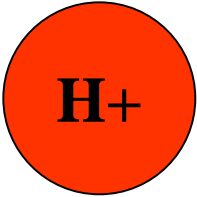
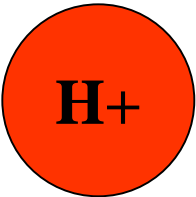
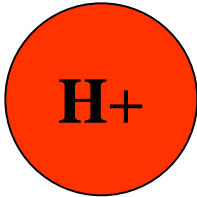
ACID RAIN



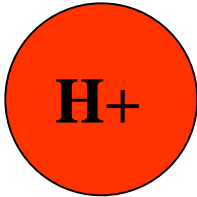
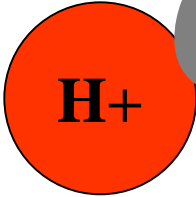
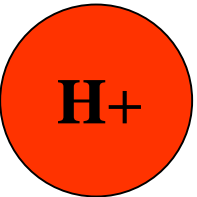
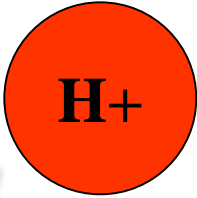
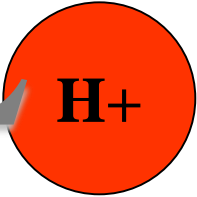


*CELL
BUFFERS
RESPOND*



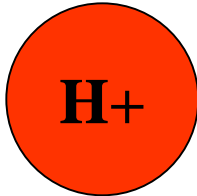
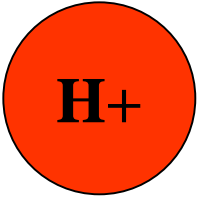
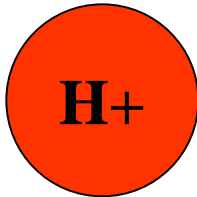
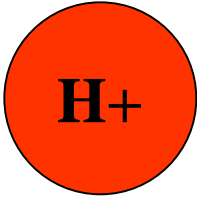
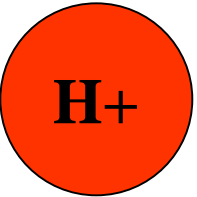
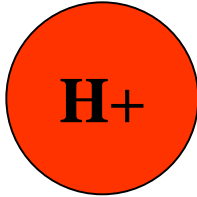
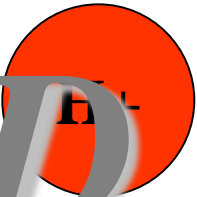
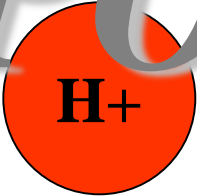
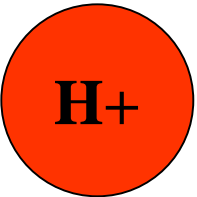
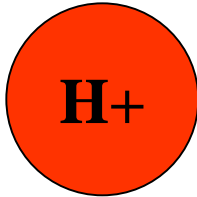


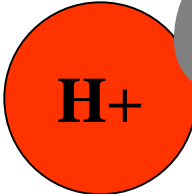
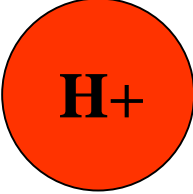
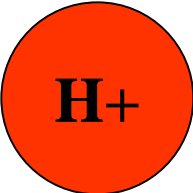
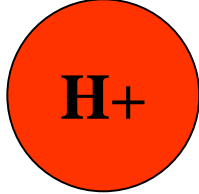
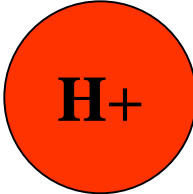
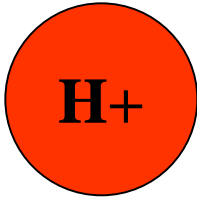
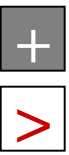
CELL



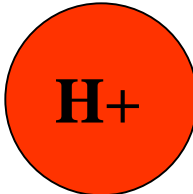
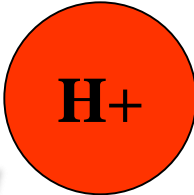
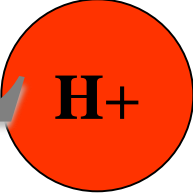
BUFFERS

RESPOND





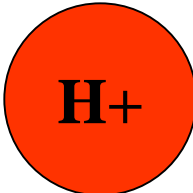
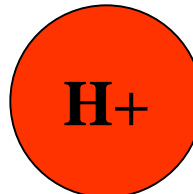
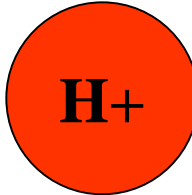
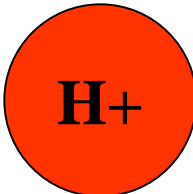
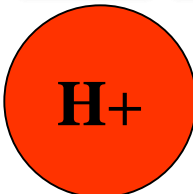
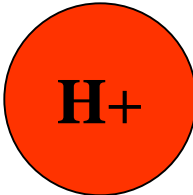
CELL



ENTRANCE
BUFFERS



OVERWHELMED





*ACID RAIN
OVERWHELMS
CELL BUFFERS*

ACID RAIN

ACID RAIN



FISH KILL



CHAPTER 04

CARBON'S CHEMICAL VERSITILITY



BIO-ESSENTIAL ELEMENTS

NATURAL ELEMENTS ?



25

NATURAL ELEMENTS 92

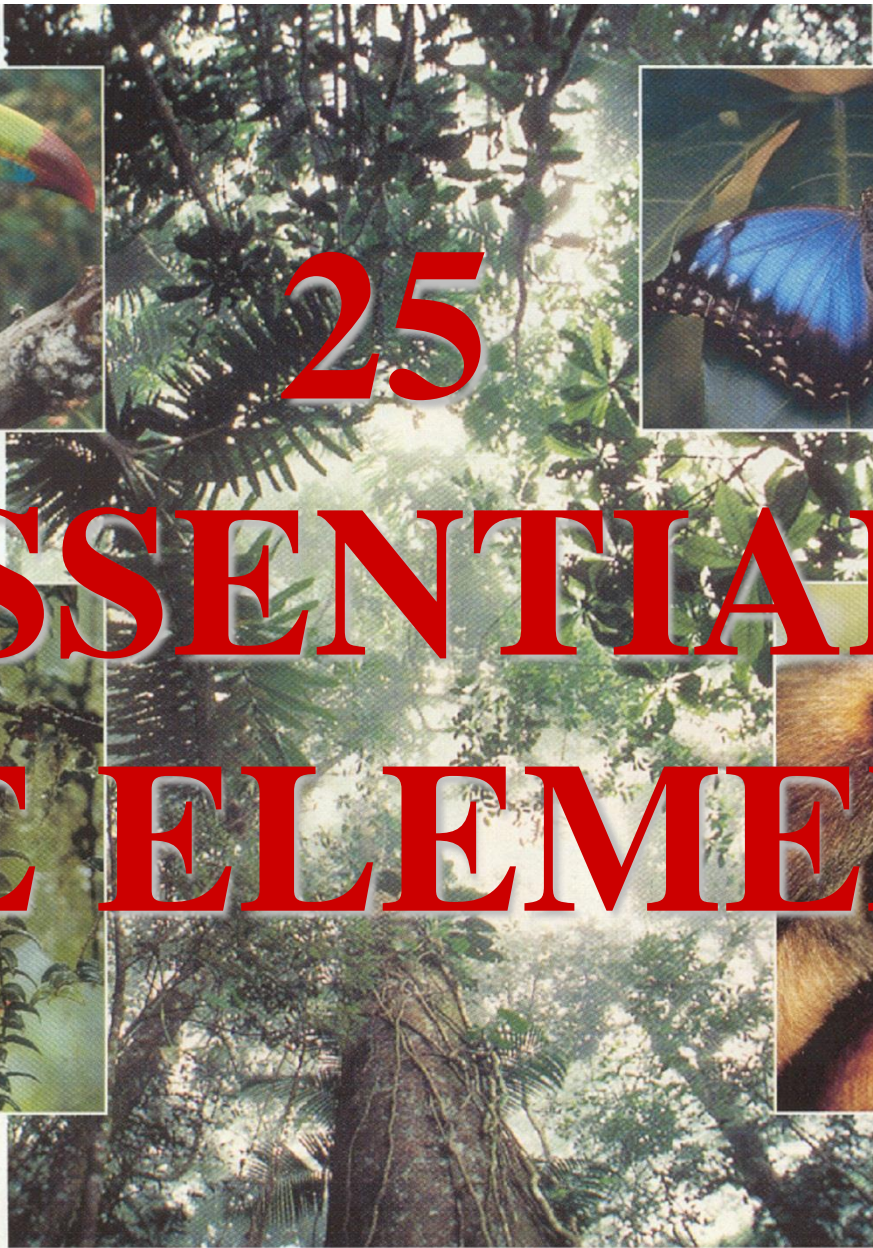
LIVING ORGANISMS



25

ESSENTIAL

LIFE ELEMENTS





**MAJOR
ELEMENTS
VS
TRACE
ELEMENTS**

MAJOR ELEMENTS

MAJOR ELEMENTS

LIVING ORGANISMS



8

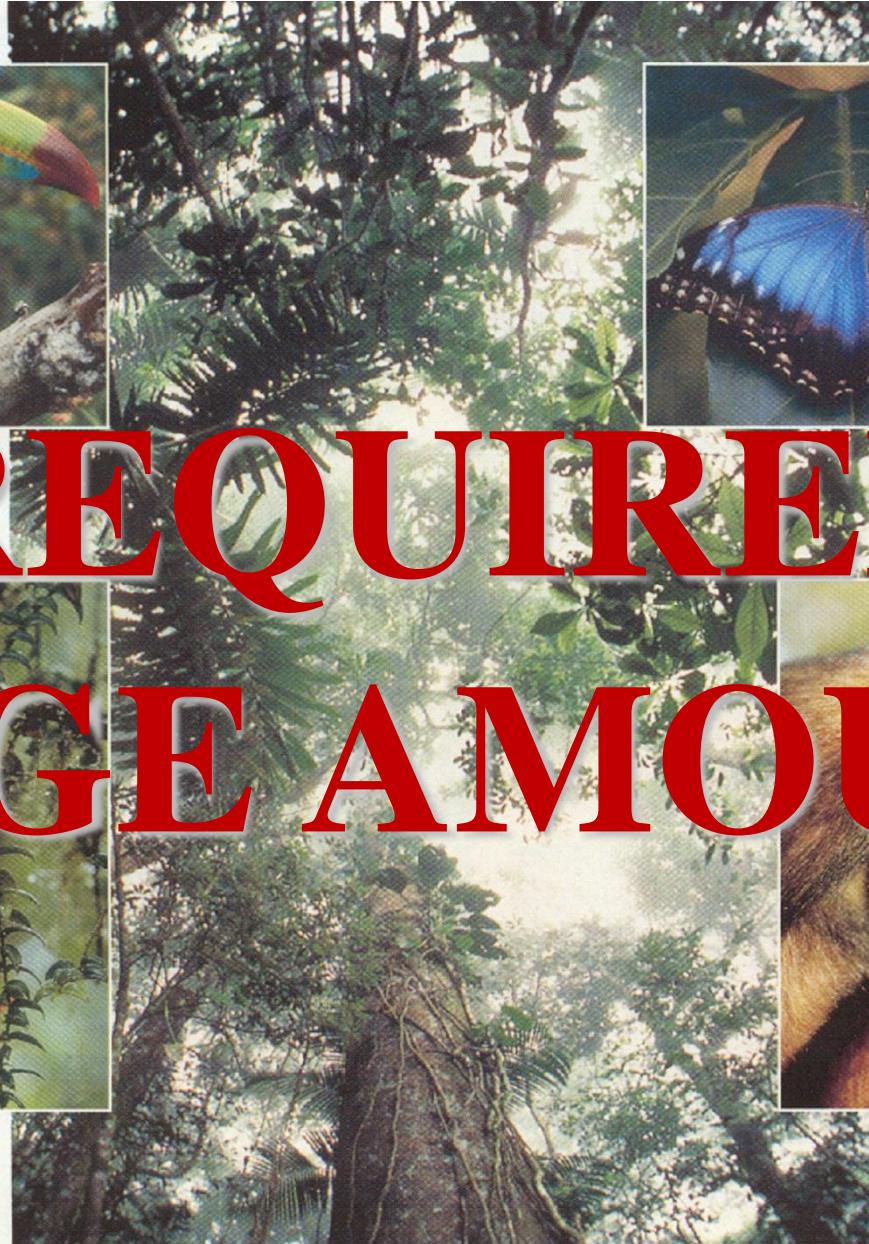


MAJOR
ELEMENTS



LIVING ORGANISMS

L



REQUIRED

LARGE AMOUNTS

MAJOR ELEMENTS

CARBON

MAJOR ELEMENTS

MAJOR ELEMENTS

**CARBON
HYDROGEN**

MAJOR ELEMENTS

MAJOR ELEMENTS

CARBON
HYDROGEN
OXYGEN

MAJOR ELEMENTS

MAJOR ELEMENTS

CARBON
HYDROGEN
OXYGEN
NITROGEN

MAJOR ELEMENTS

MAJOR ELEMENTS

**CARBON
HYDROGEN
OXYGEN
NITROGEN
PHOSPHOROUS**

MAJOR ELEMENTS

MAJOR ELEMENTS

CARBON
HYDROGEN
OXYGEN
NITROGEN
PHOSPHOROUS
SULFUR

MAJOR ELEMENTS

MAJOR ELEMENTS

**CARBON
HYDROGEN
OXYGEN
NITROGEN
PHOSPHOROUS
SULFUR
CALCIUM**

MAJOR ELEMENTS



MAJOR ELEMENTS

- CARBON
- HYDROGEN
- OXYGEN
- NITROGEN
- PHOSPHOROUS
- SULFUR
- CALCIUM
- POTASSIUM



EXAM #1 KNOW MAJOR ELEMENTS

MAJOR ELEMENTS

TRACE ELEMENTS

TRACE ELEMENTS

LIVING ORGANISMS



17

TRACE

ELEMENTS



LIVING ORGANISMS



EXAM #1 DO NOT KNOW TRACE ELEMENTS



REQUIRED



SMALL AMOUNTS

EXAM #1 DO NOT KNOW TRACE ELEMENTS



QUESTION

**WHAT ELEMENT IS
MOST ESSENTIAL
TO LIFE?**

QUESTION