KINETIC ENERGY

CMP-A + CMP-B → CMP-C

KINETIC ENERGY
ENERGY IN MOTION/USE

KINETIC ENERGY

RE
?

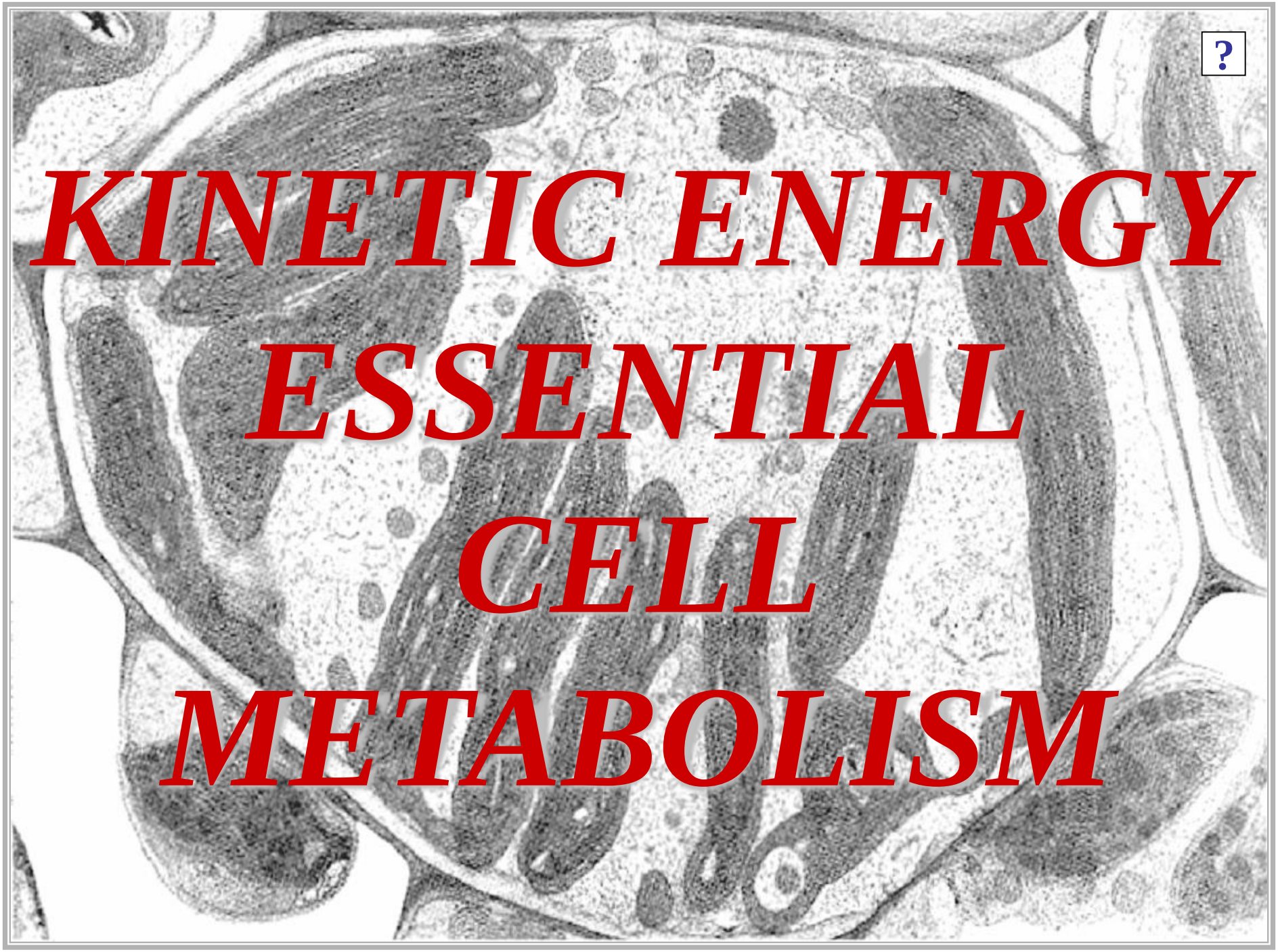
CMP-A + CMP-B → CMP-C

KINETIC ENERGY DRIVES BIOCHEMICAL REACTIONS

QUESTION

WHAT ENERGY STATE IS ESSENTIAL TO CELL METABOLISM?

QUESTION



KINETIC ENERGY ESSENTIAL CELL METABOLISM

QUESTION

WHAT ENERGY FORM IS ESSENTIAL TO CELL METABOLISM?

QUESTION

ENERGY FORMS

ENERGY FORMS

LIGHT ENERGY

ENERGY FROMS

ENERGY FORMS

LIGHT ENERGY

HEAT ENERGY

ENERGY FROMS

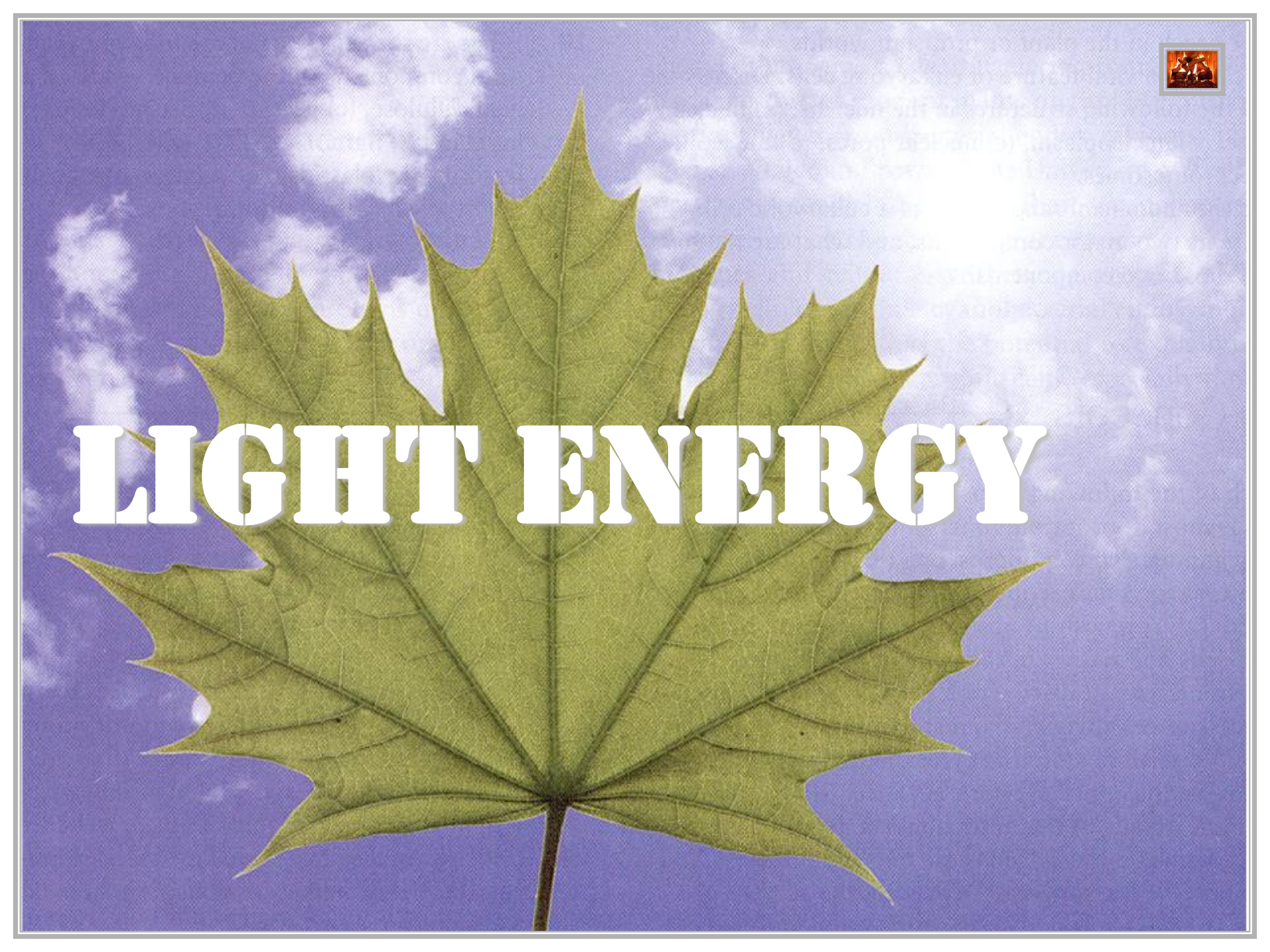
ENERGY FORMS

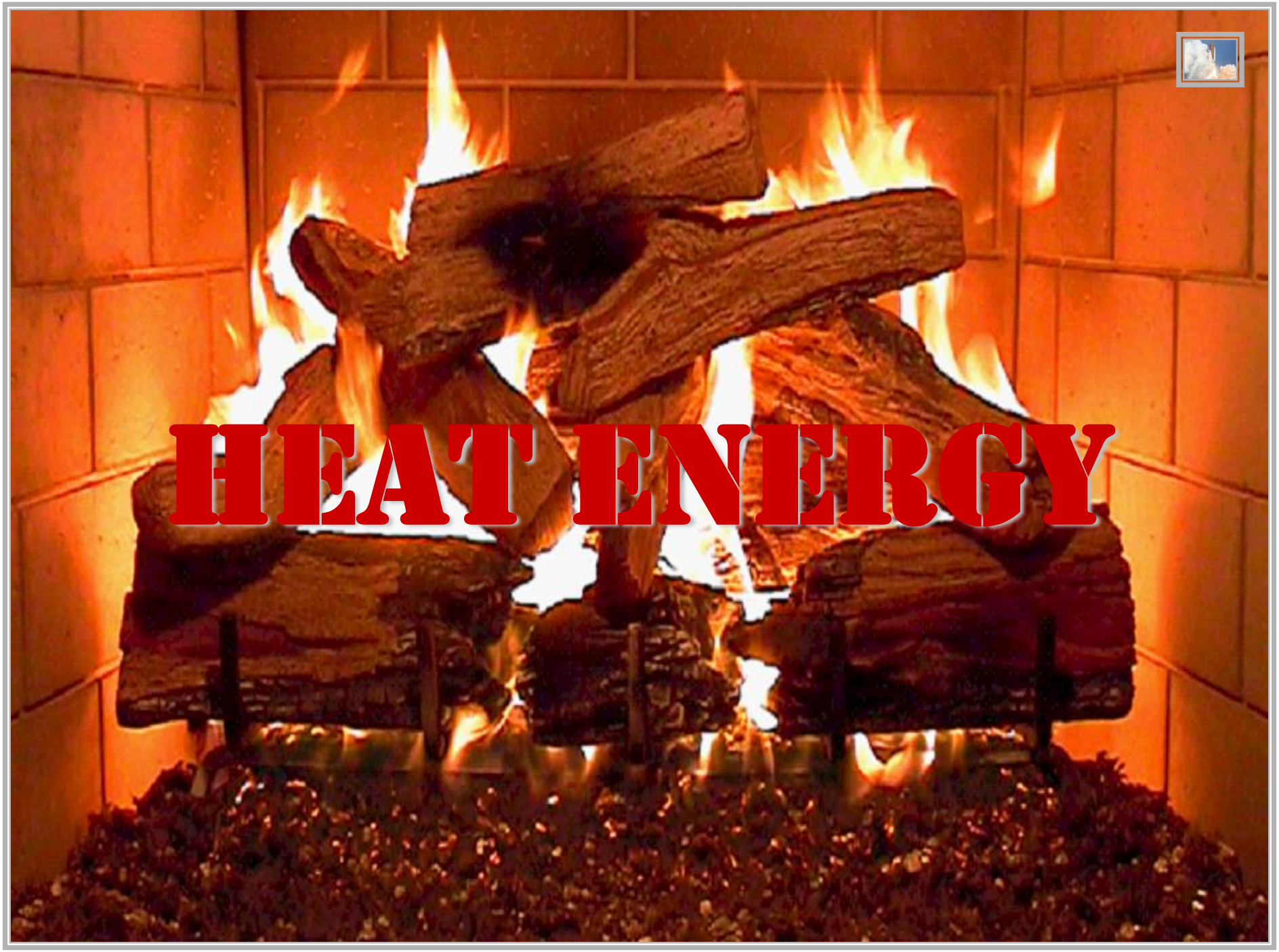
LIGHT ENERGY

HEAT ENERGY

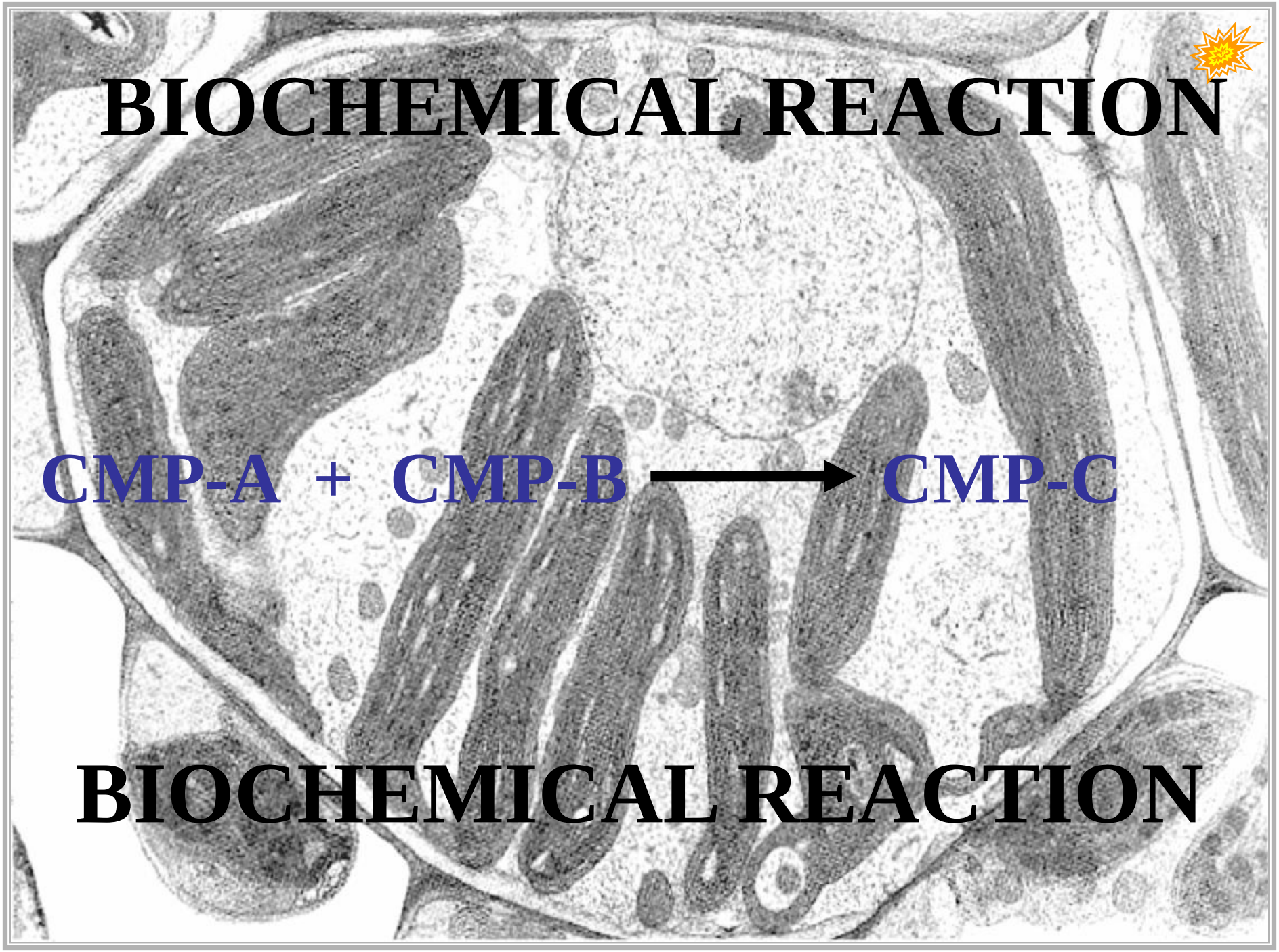
CHEMICAL ENERGY

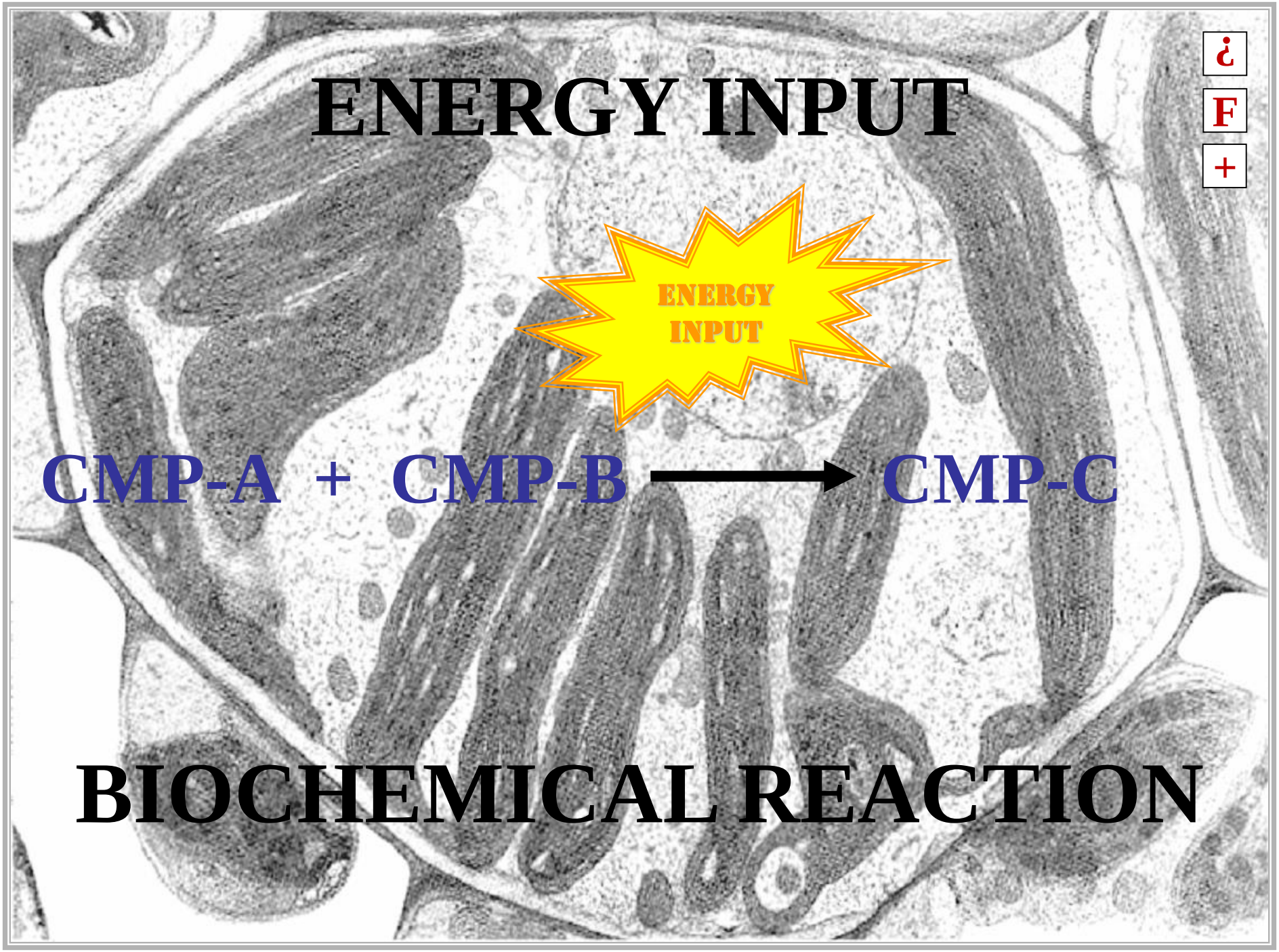
ENERGY FROMS


LIGHT ENERGY


HEAT ENERGY

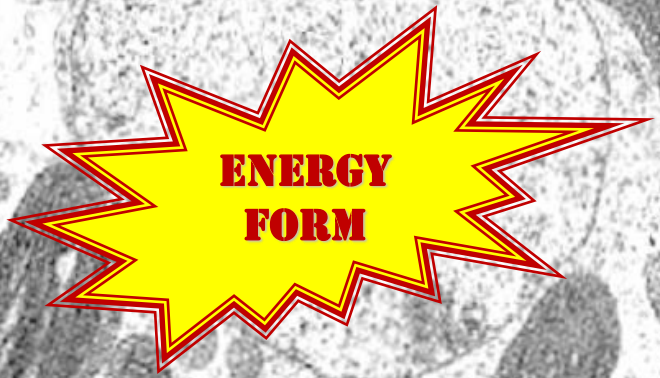
CHEMICAL ENERGY


BIOCHEMICAL REACTION
CMP-A + CMP-B → CMP-C
BIOCHEMICAL REACTION


¿
F
+
ENERGY INPUT
ENERGY INPUT
CMP-A + CMP-B
CMP-C
BIOCHEMICAL REACTION

C

ENERGY INPUT



CMP-A + CMP-B → CMP-C

BIOCHEMICAL REACTION

CHEMICAL ENERGY

CMP-A + CMP-B → CMP-C

BIOCHEMICAL REACTION

CHEMICAL ENERGY

RE
?

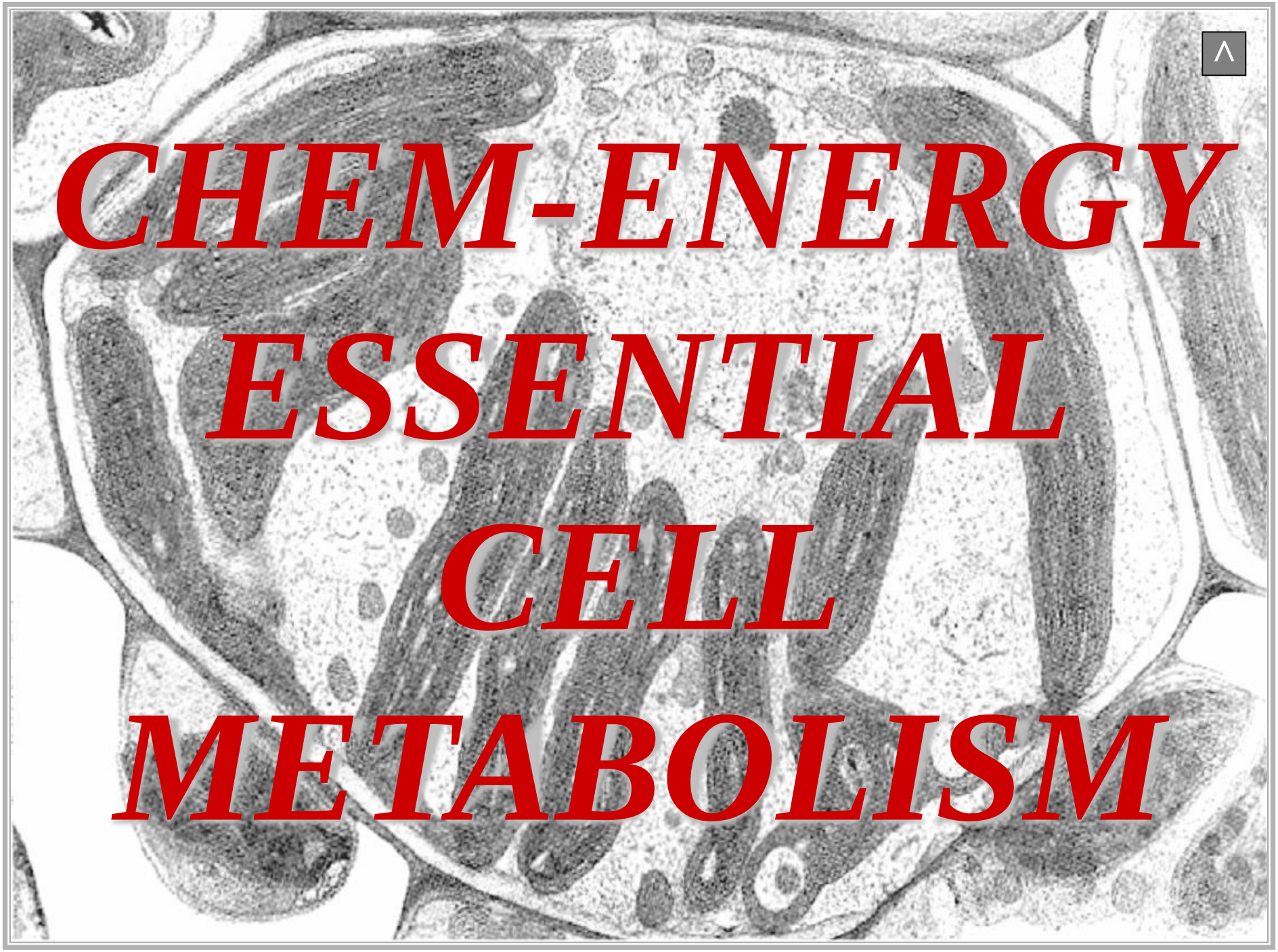
CMP-A + CMP-B → CMP-C

CHEMICAL ENERGY DRIVES BIOCHEMICAL REACTIONS

QUESTION

WHAT ENERGY FORM IS ESSENTIAL TO CELL METABOLISM?

QUESTION



CHEM-ENERGY ESSENTIAL CELL METABOLISM

ENERGY: SUMMARY

ENERGY

ABSTRACT

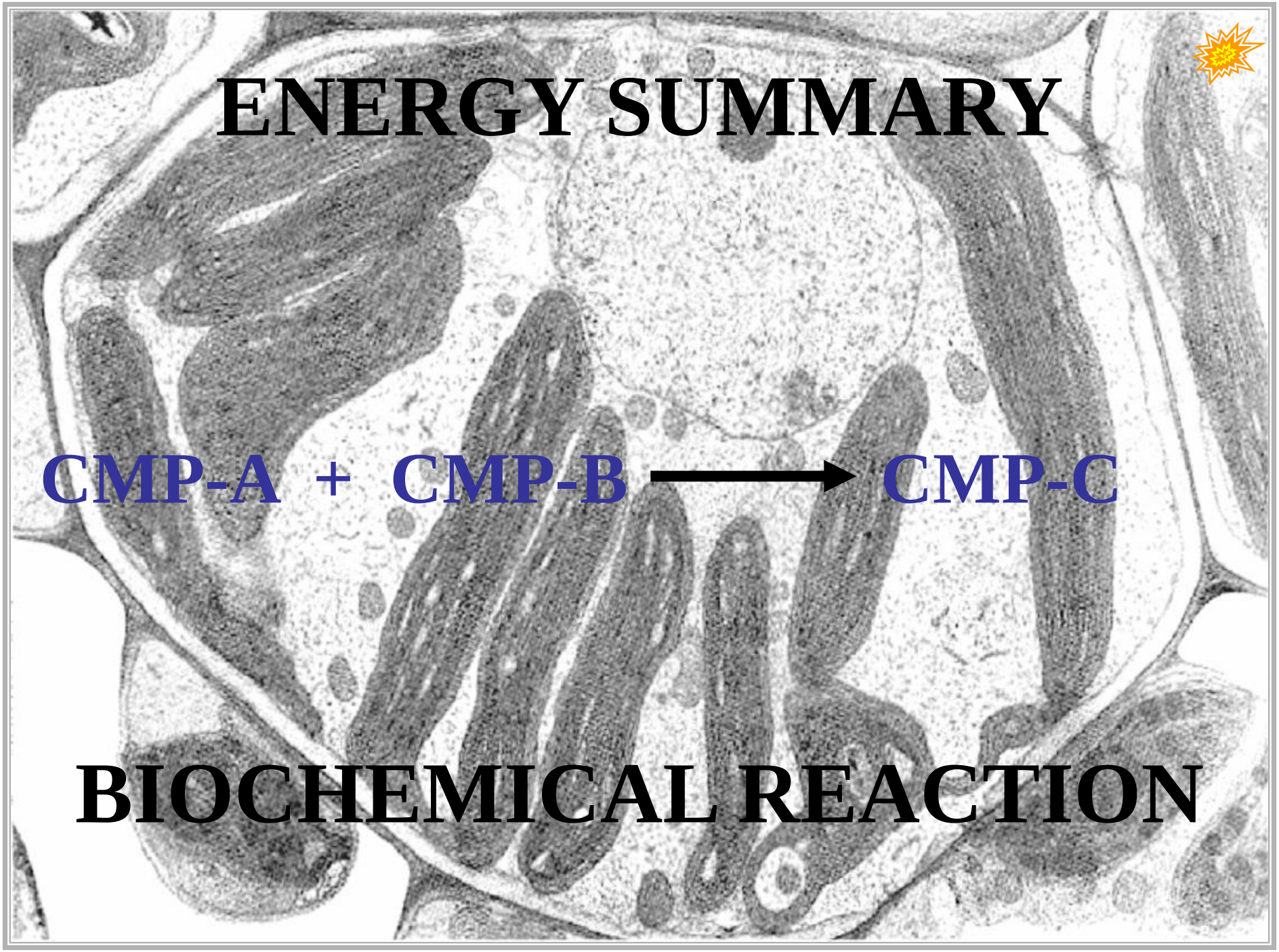
DIFFICULT TO DEFINE

ENERGY

ABILITY TO DO WORK

ENERGY

ABILITY TO DRIVE BIO-CHEM RXTS

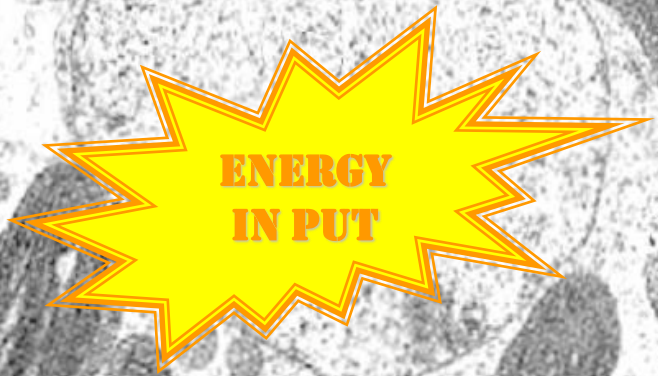


ENERGY SUMMARY

CMP-A + CMP-B → CMP-C

BIOCHEMICAL REACTION

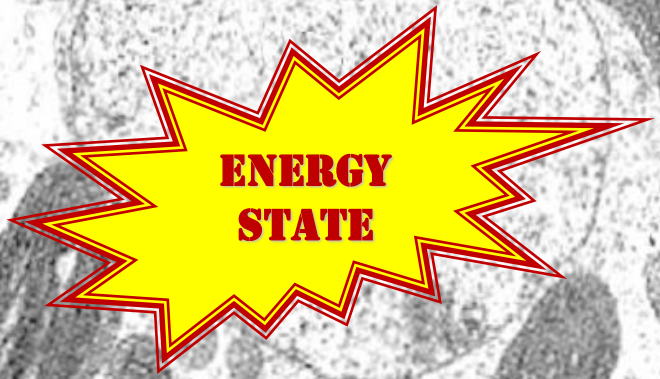
ENERGY SUMMARY



CMP-A + CMP-B → CMP-C

ENERGY INPUT DRIVES BIOCHEMICAL REACTIONS

ENERGY SUMMARY



CMP-A + CMP-B → CMP-C

WHAT ENERGY STATE DRIVES BIOCHEMICAL REACTIONS?

ENERGY SUMMARY

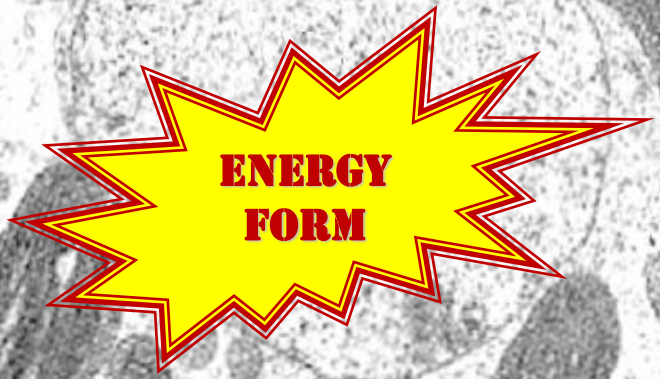
¿ F +

CMP-A + CMP-B → CMP-C

KINETIC ENERGY DRIVES BIOCHEMICAL REACTIONS

C

ENERGY SUMMARY



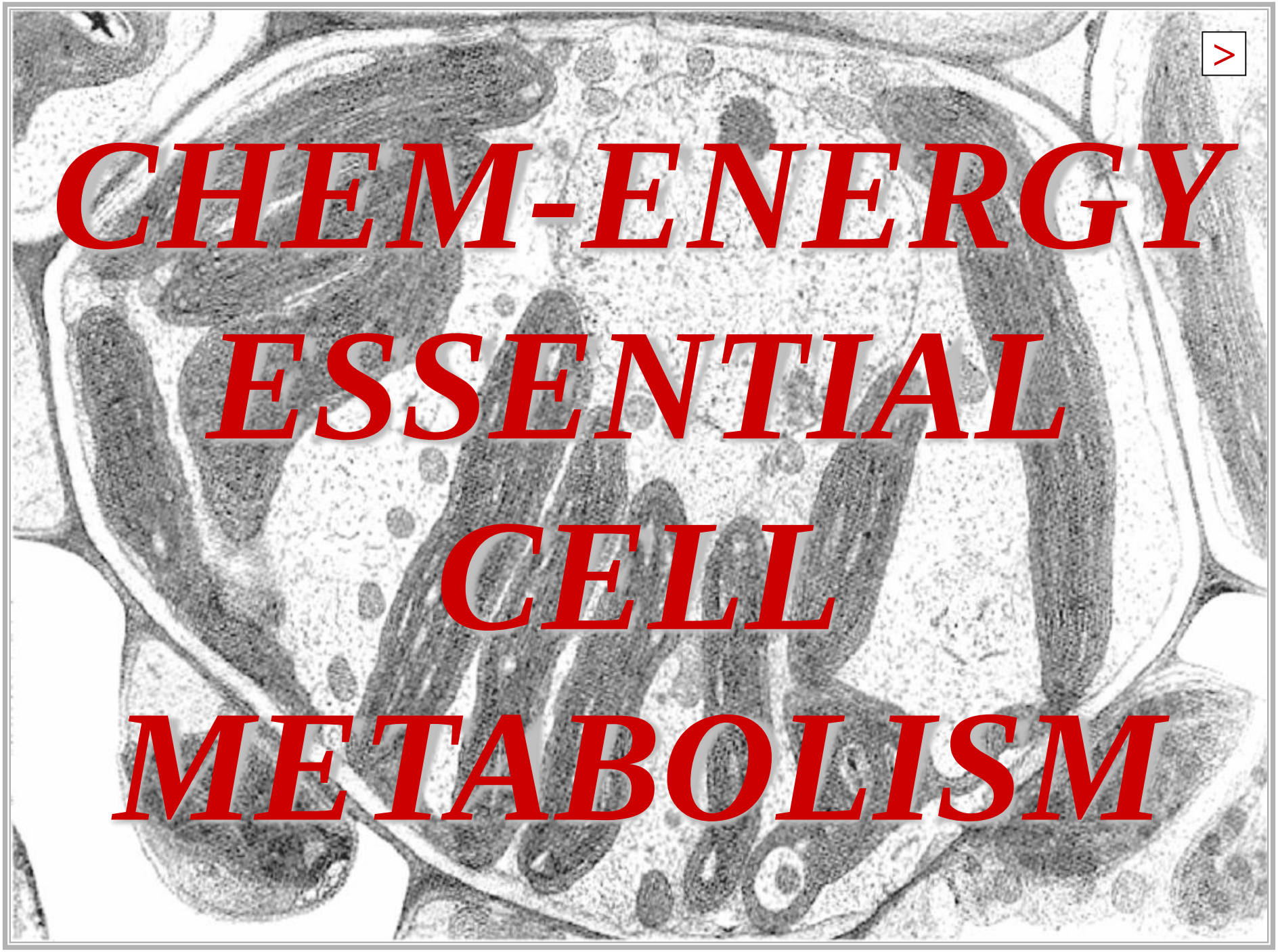
CMP-A + CMP-B → CMP-C

WHAT ENERGY FORM DRIVES BIOCHEMICAL REACTIONS?

ENERGY SUMMARY

CMP-A + CMP-B → CMP-C

CHEMICAL ENERGY DRIVES BIOCHEMICAL REACTIONS



CHEM-ENERGY ESSENTIAL CELL METABOLISM

LIVING ORGANISMS EXPEND CHEM-ENERGY VIA THERMODYNAMIC LAWS

THERMODYNAMIC LAWS

THERMODYNAMICS

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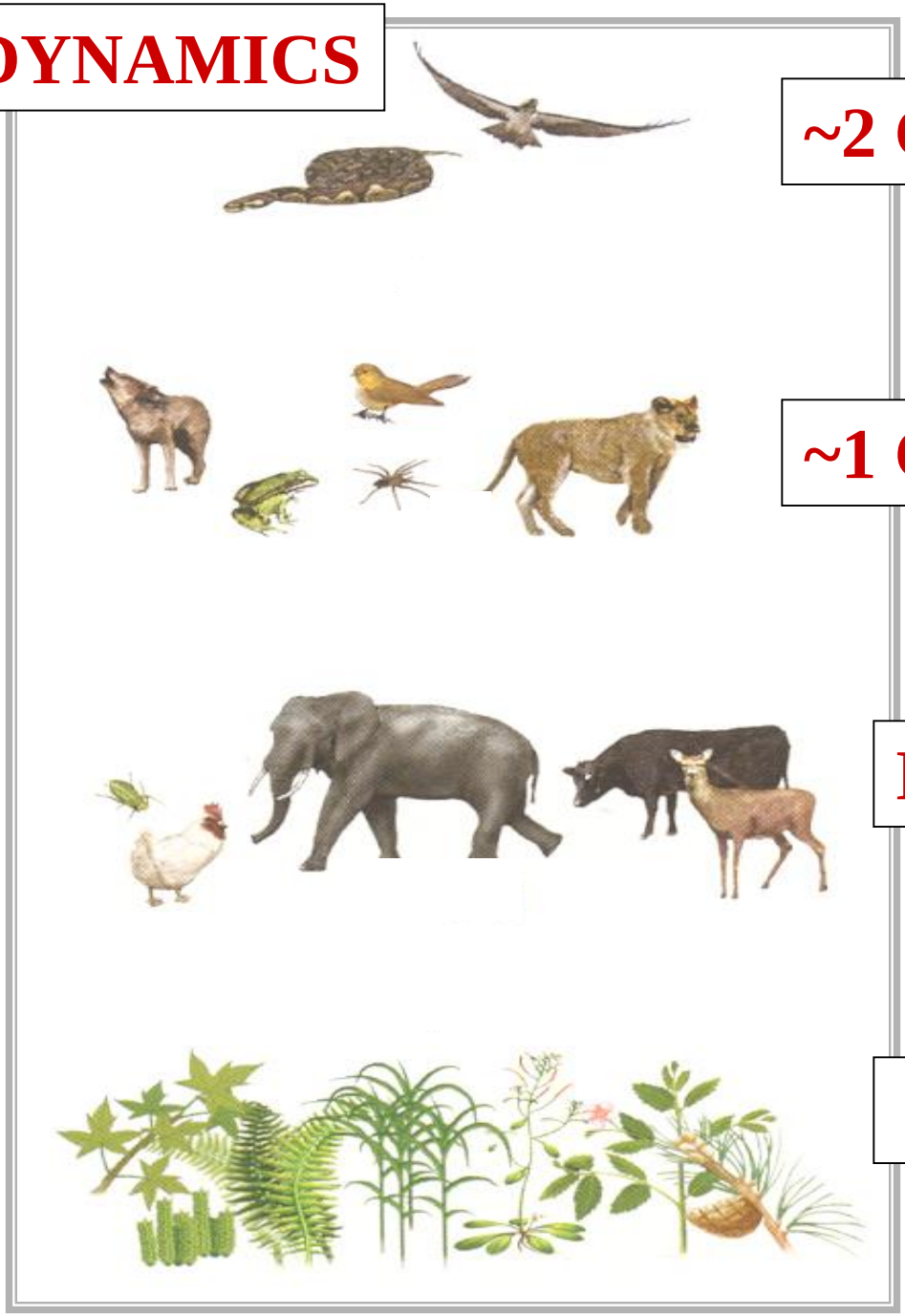
THERMODYNAMICS

STUDY ENERGY TRANSFORMATION & TRANSFER

THERMODYNAMICS

THERMODYNAMICS

FOOD CHAIN



~2 CARNIVORES

~1 CARNIVORES

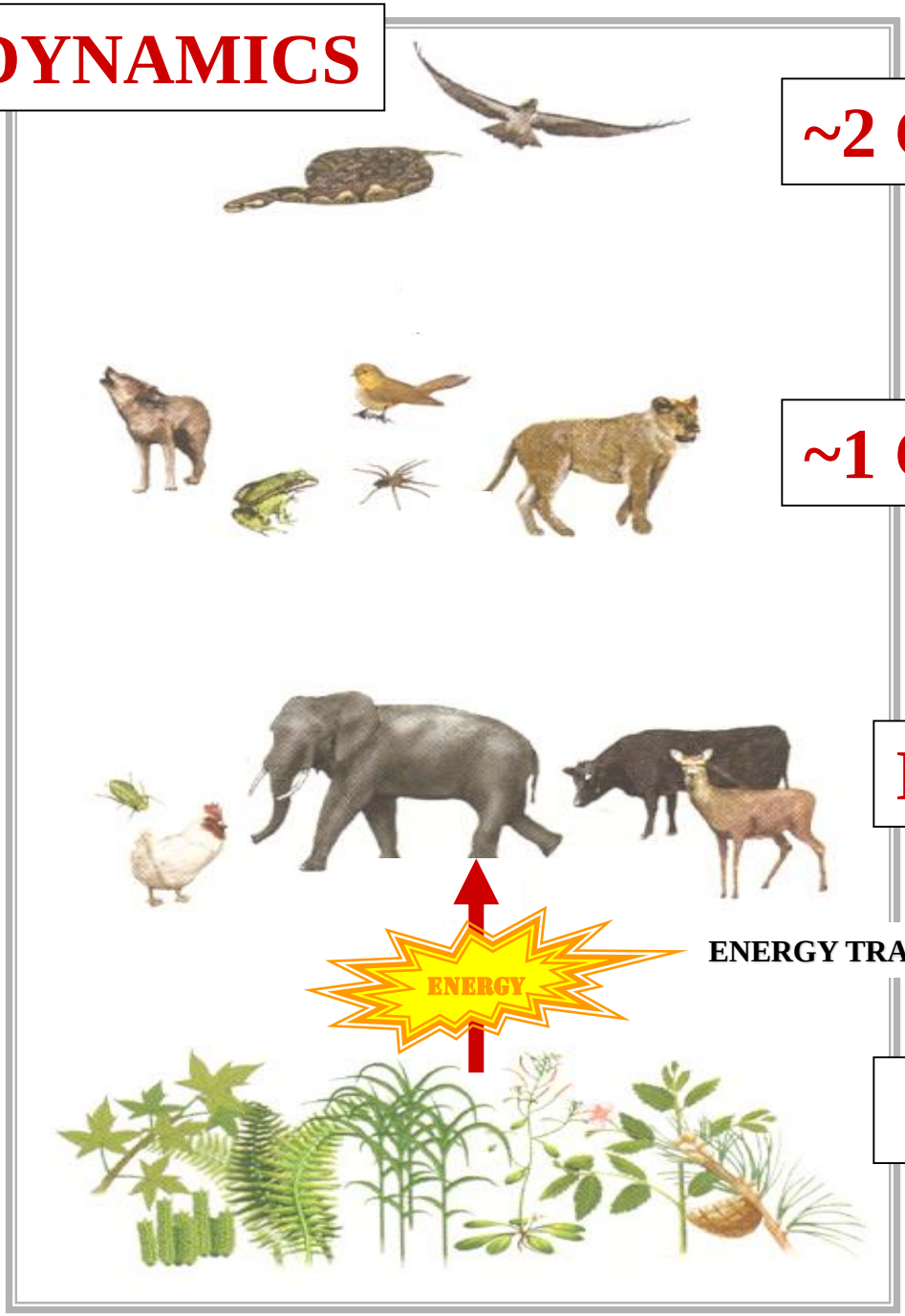
HERBIVORES

PRODUCERS

= CHEMICAL ENERGY

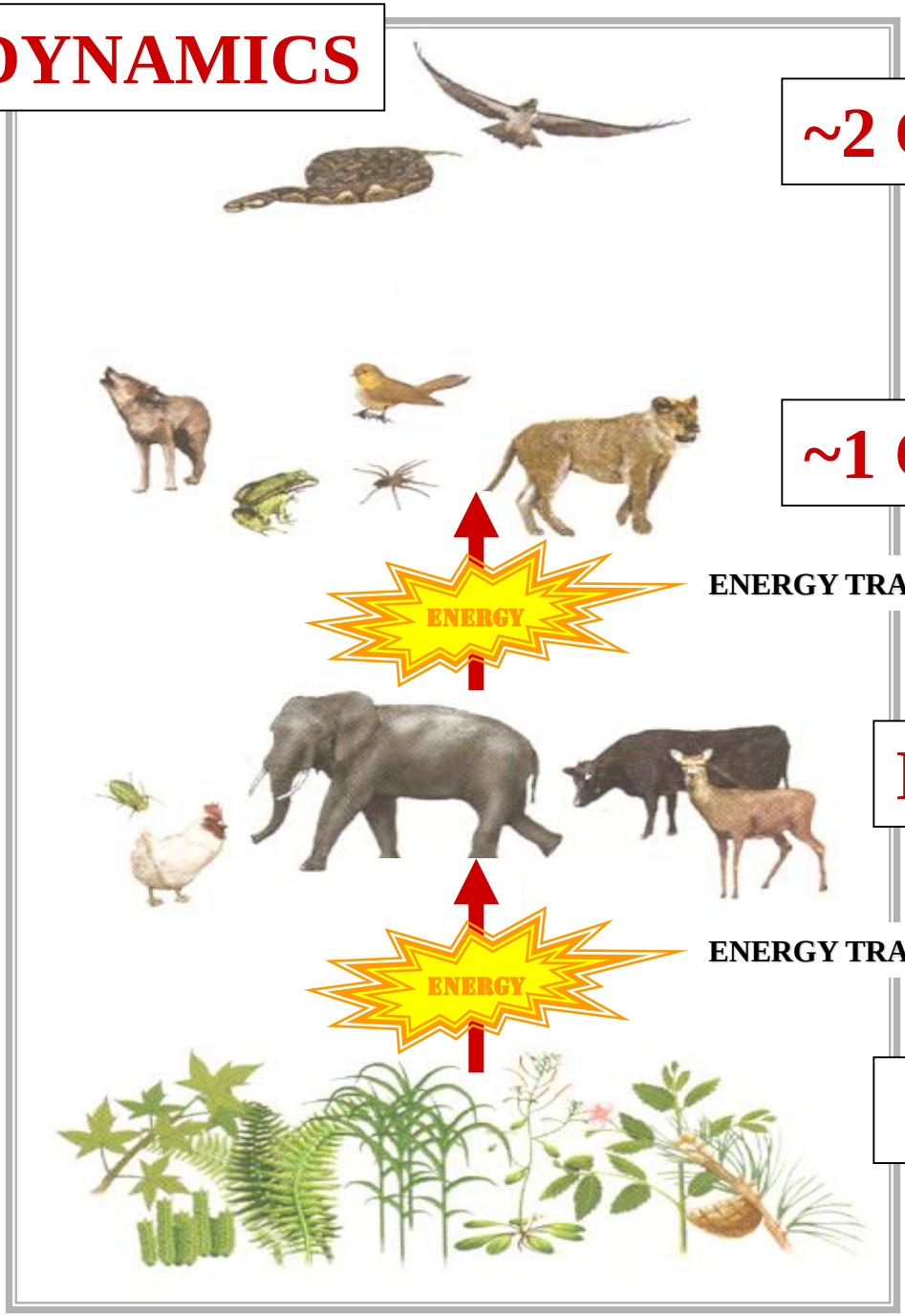
THERMODYNAMICS

FOOD CHAIN



THERMODYNAMICS

FOOD CHAIN



~2 CARNIVORES

~1 CARNIVORES

ENERGY TRANSFORMATION & TRANSFER

HERBIVORES

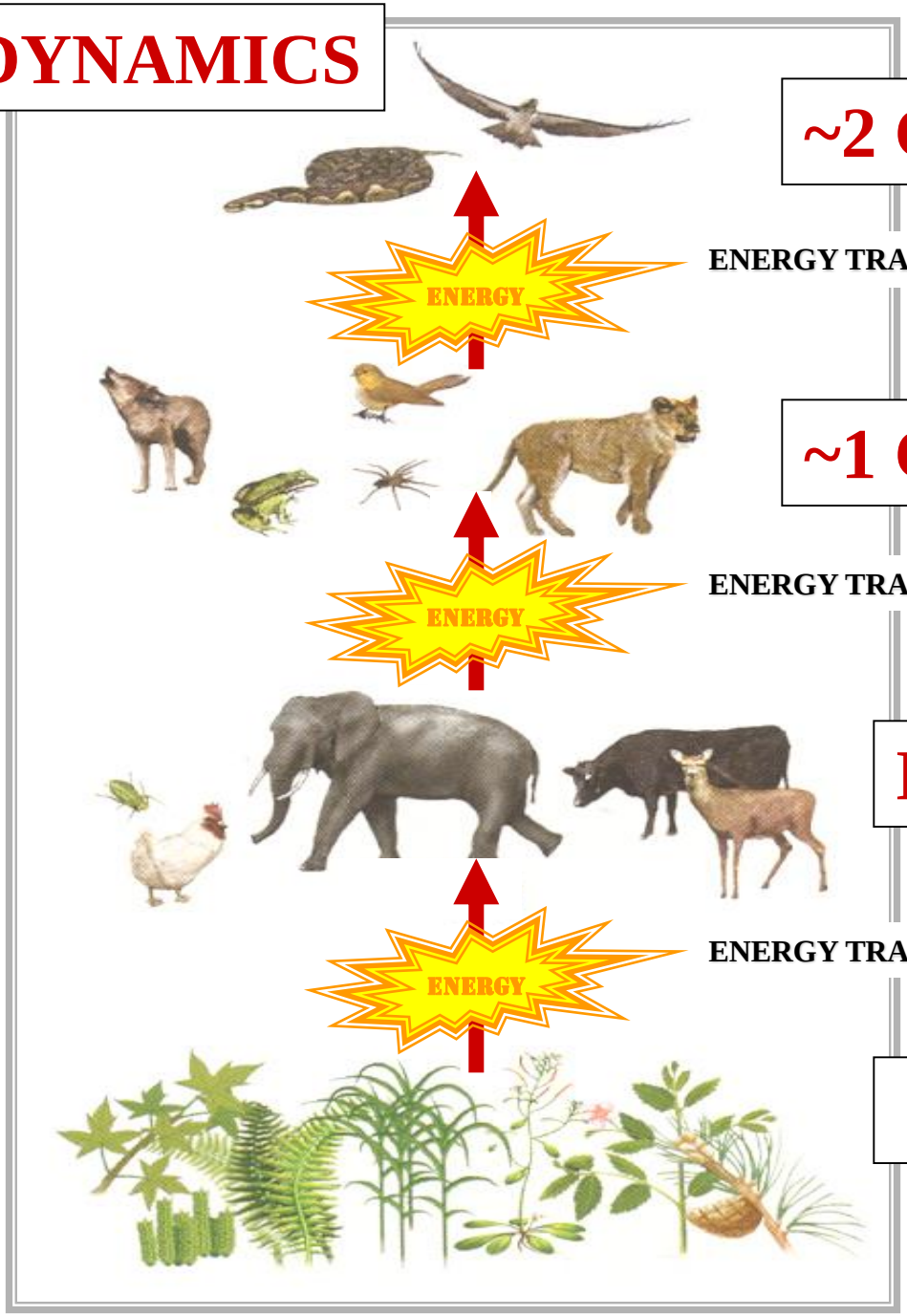
ENERGY TRANSFORMATION & TRANSFER

PRODUCERS

= CHEMICAL ENERGY

THERMODYNAMICS

FOOD CHAIN



~2 CARNIVORES

ENERGY TRANSFORMATION & TRANSFER

~1 CARNIVORES

ENERGY TRANSFORMATION & TRANSFER

HERBIVORES

ENERGY TRANSFORMATION & TRANSFER

PRODUCERS

= CHEMICAL ENERGY

F

FIRST THERMODYNAMIC LAW

FIRST THERMODYNAMIC LAW

1ST THERMODYNAMIC LAW

ENERGY CANNOT BE CREATED OR DESTROYED

1ST THERMODYNAMIC LAW

EG

1ST THERMODYNAMIC LAW

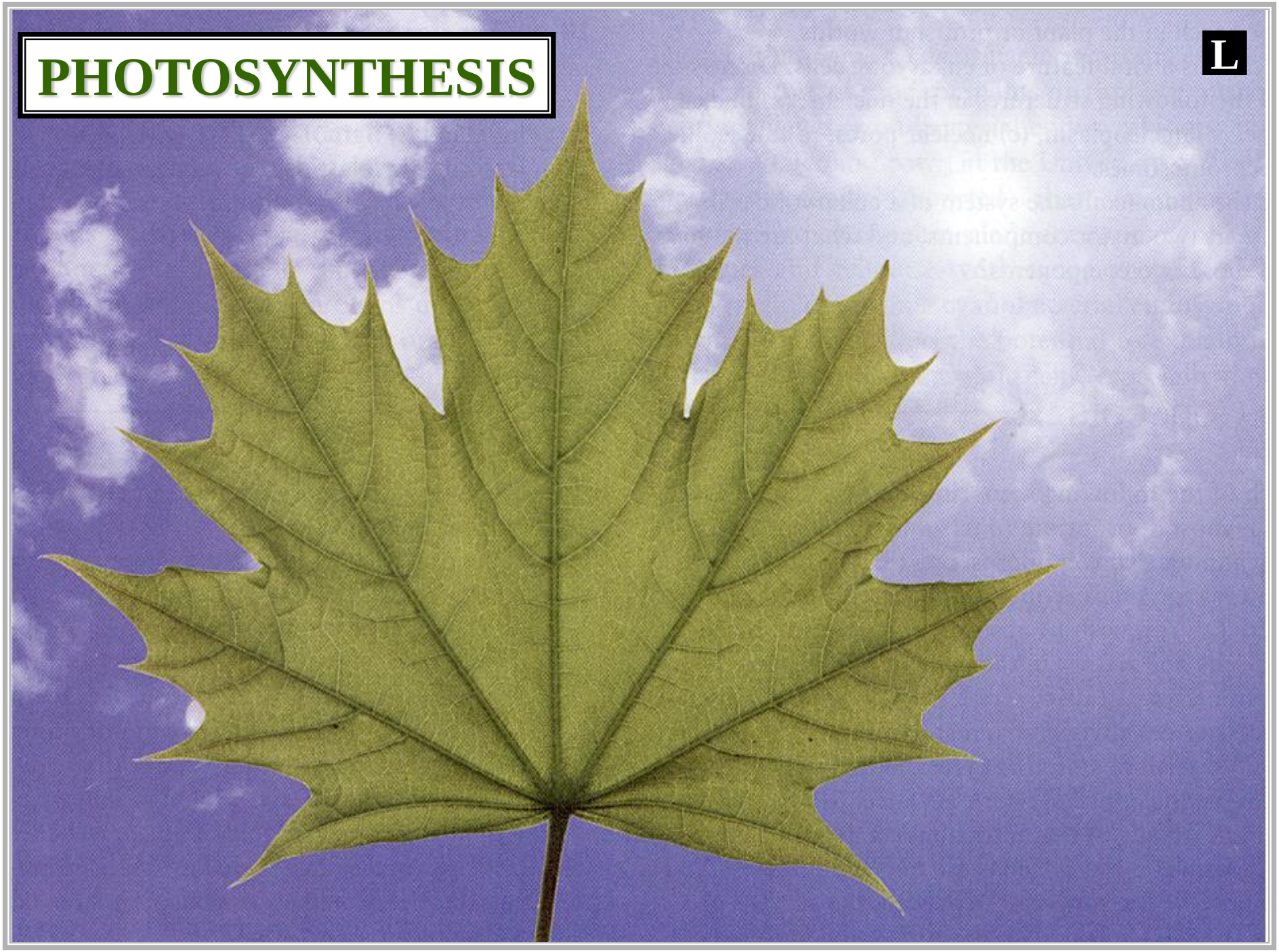
ENERGY CANNOT BE CREATED OR DESTROYED

ENERGY CAN CHANGE FORM

1ST THERMODYNAMIC LAW

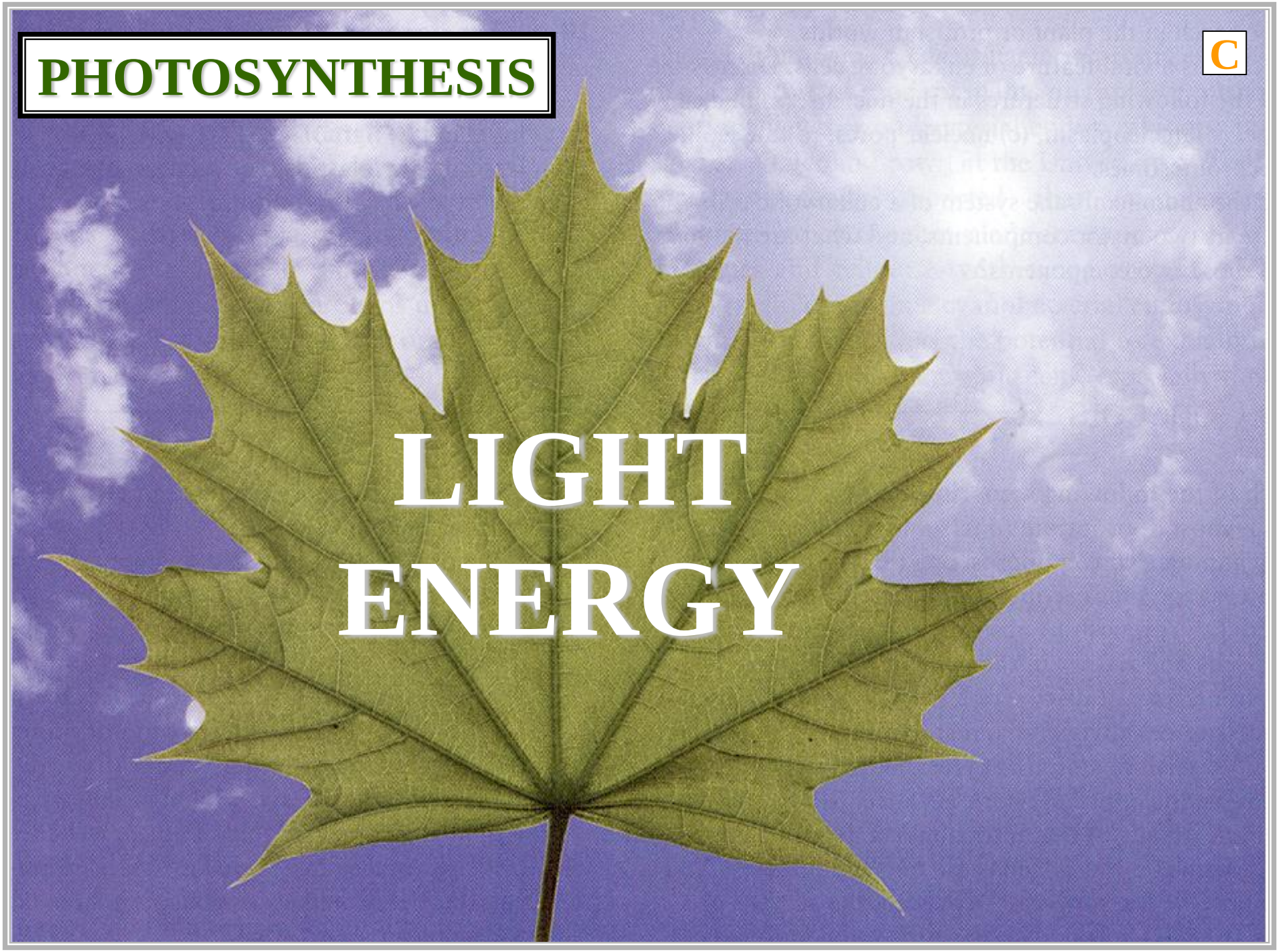
FIRST THERMODYNAMIC LAW EXAMPLE

PHOTOSYNTHESIS



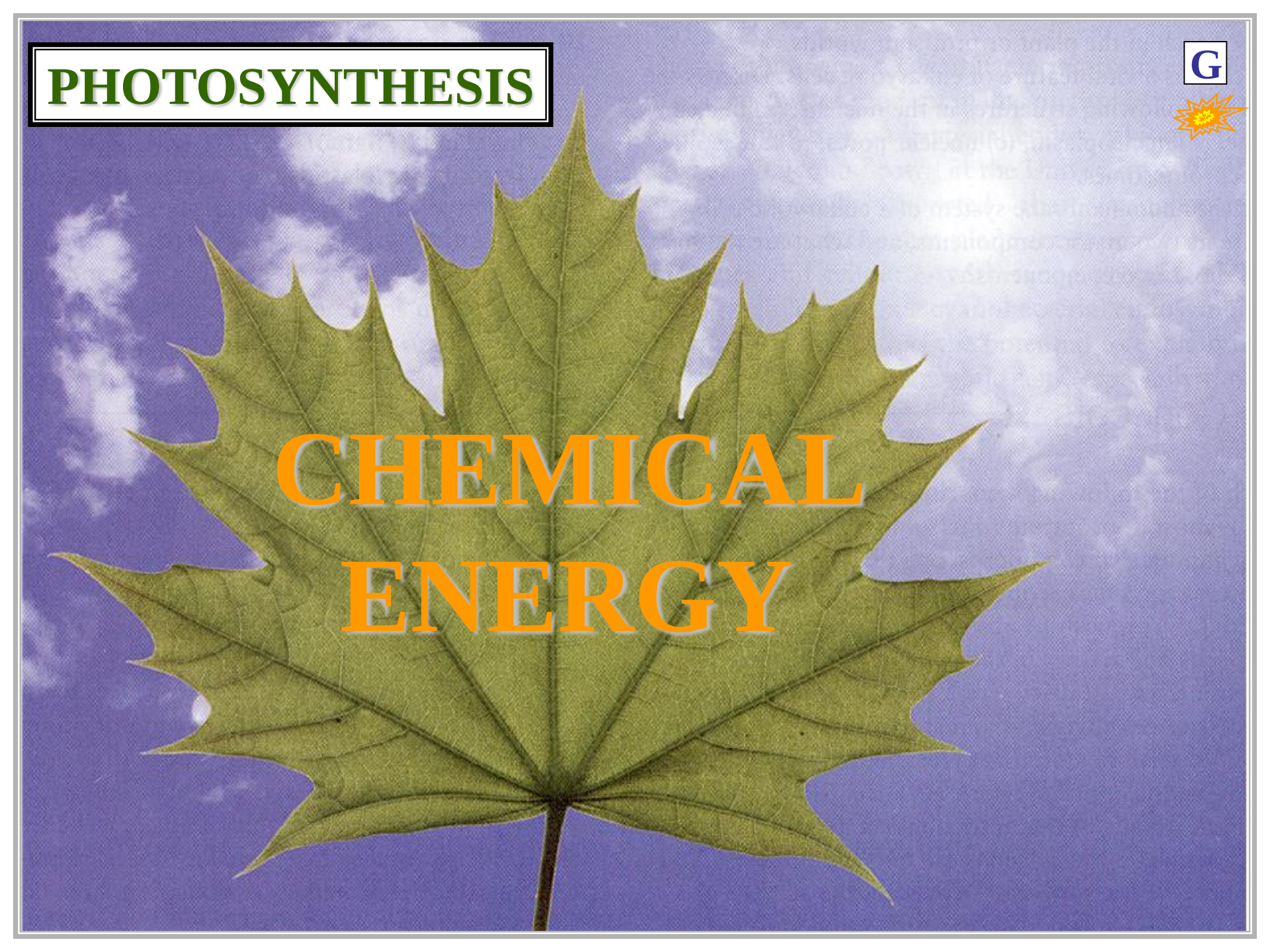
PHOTOSYNTHESIS

C



PHOTOSYNTHESIS

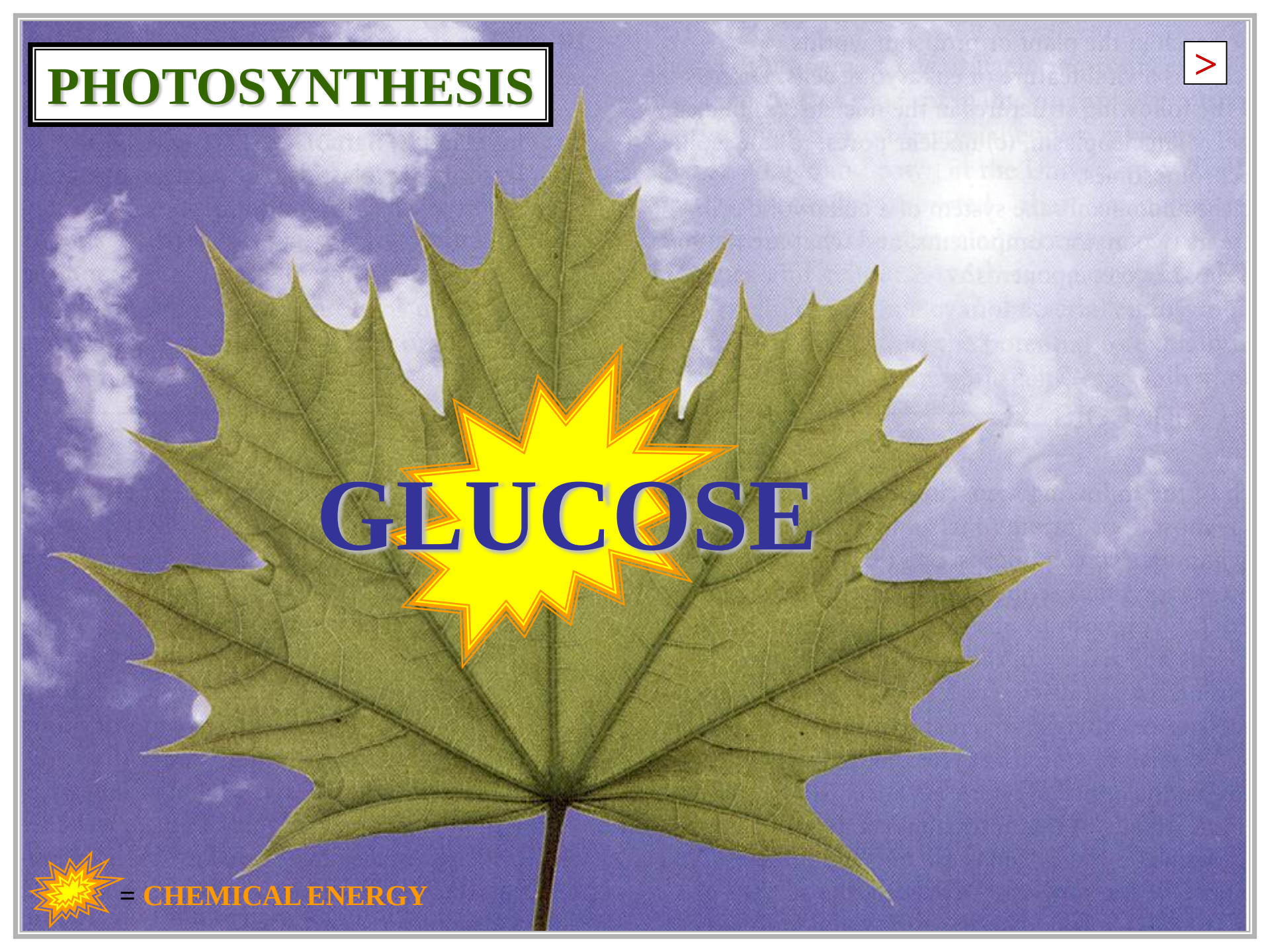
G



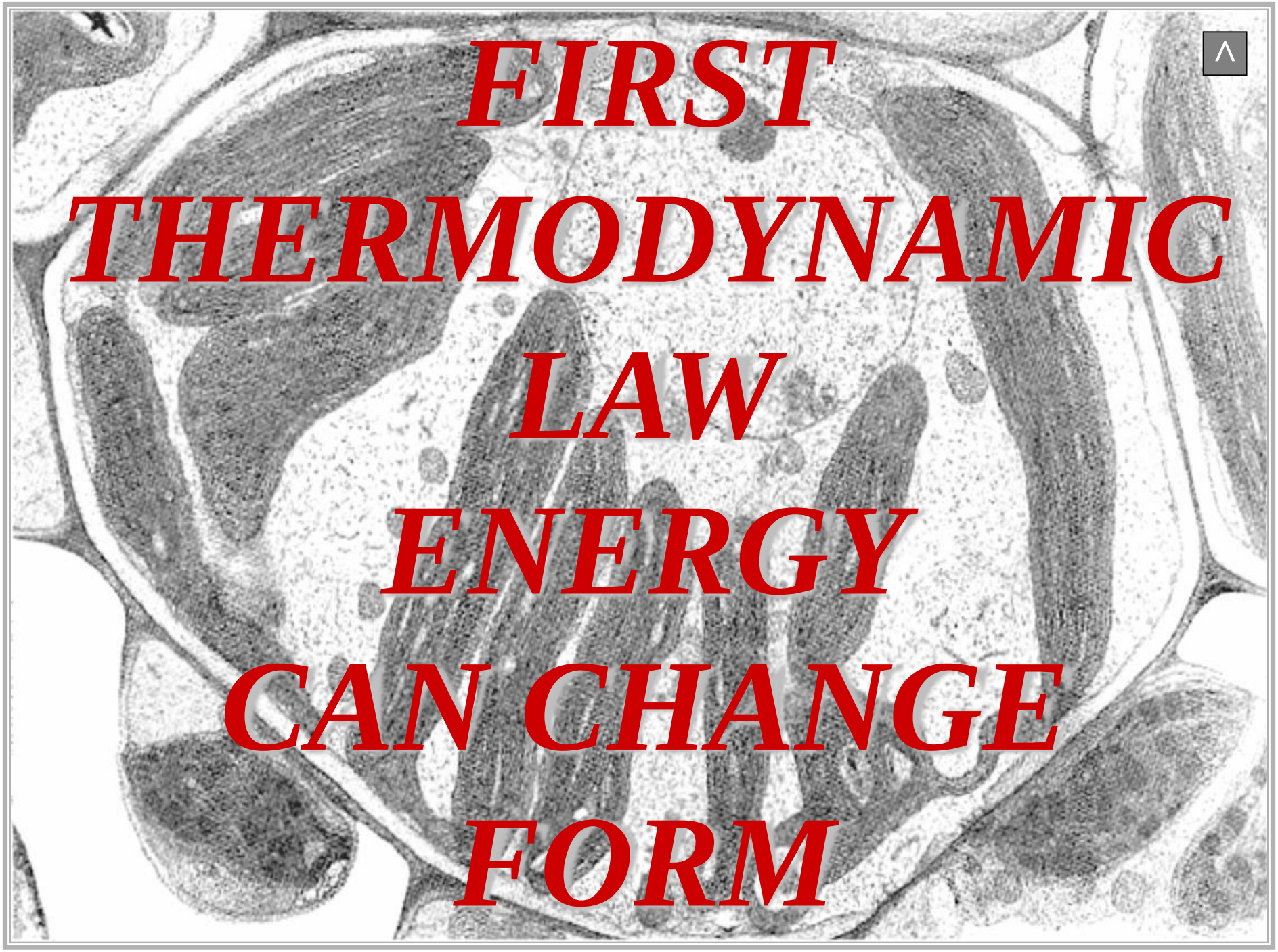
CHEMICAL ENERGY

PHOTOSYNTHESIS

>



= CHEMICAL ENERGY


FIRST
THERMODYNAMIC
LAW
ENERGY
CAN CHANGE
FORM

S

SECOND THERMODYNAMIC LAW

SECOND THERMODYNAMIC LAW

2ND THERMODYNAMIC LAW

ENERGY CAN BE TRANSFERED

2ND THERMODYNAMIC LAW

EG

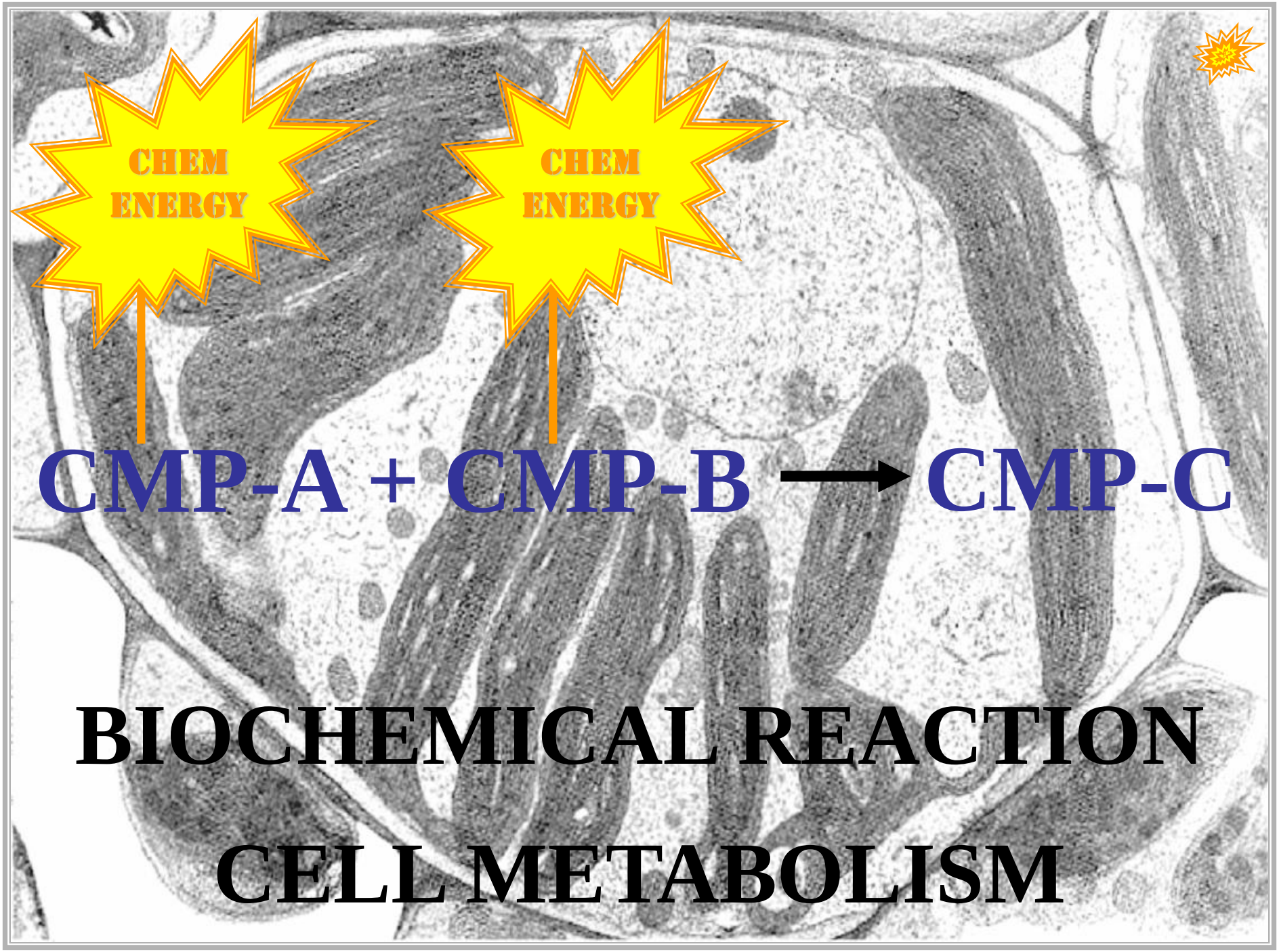
2ND THERMODYNAMIC LAW

ENERGY CAN BE TRANSFERRED

ENERGY DISSIPATES TO ENVIRONMENT AS HEAT

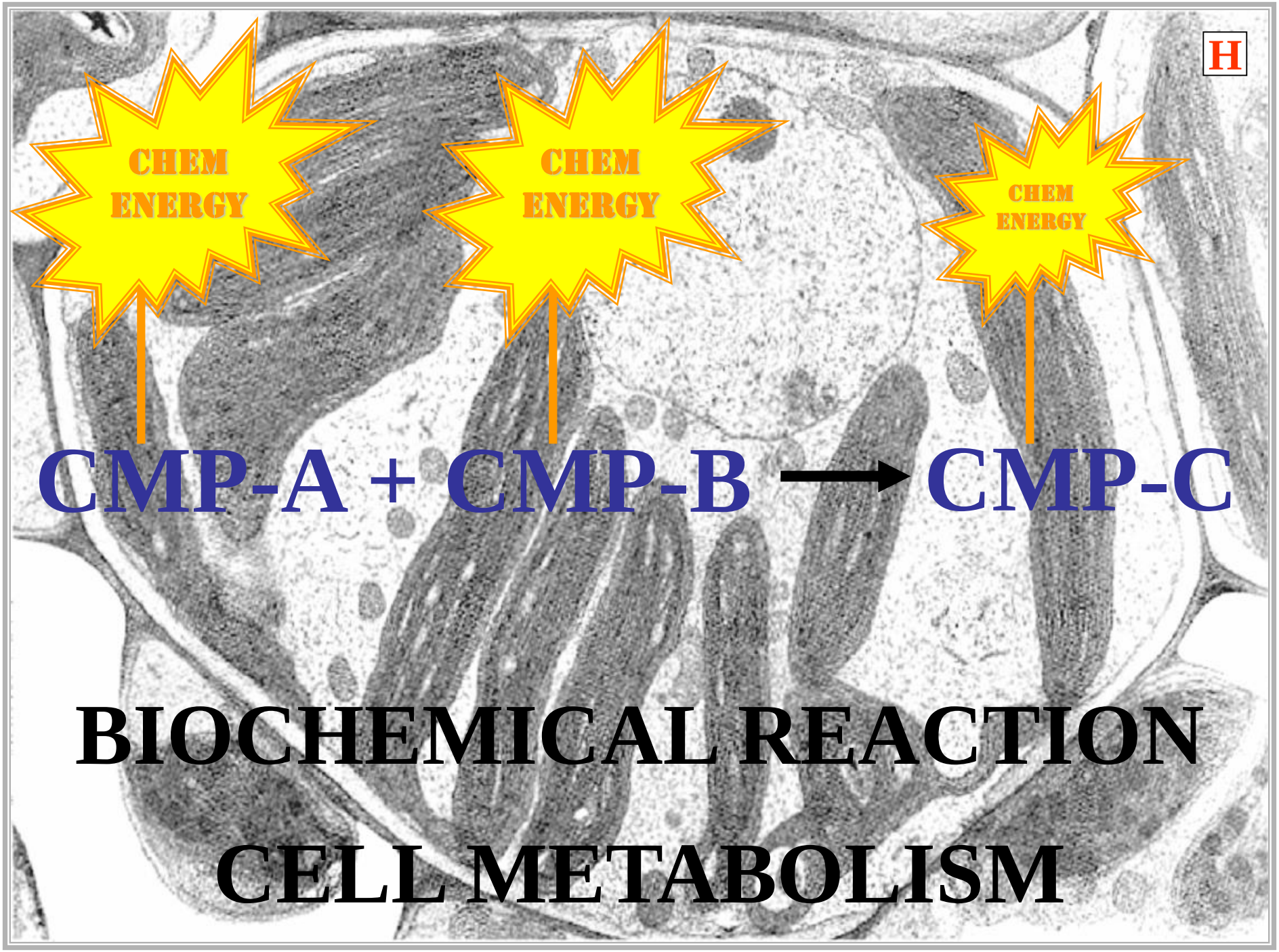
2ND THERMODYNAMIC LAW

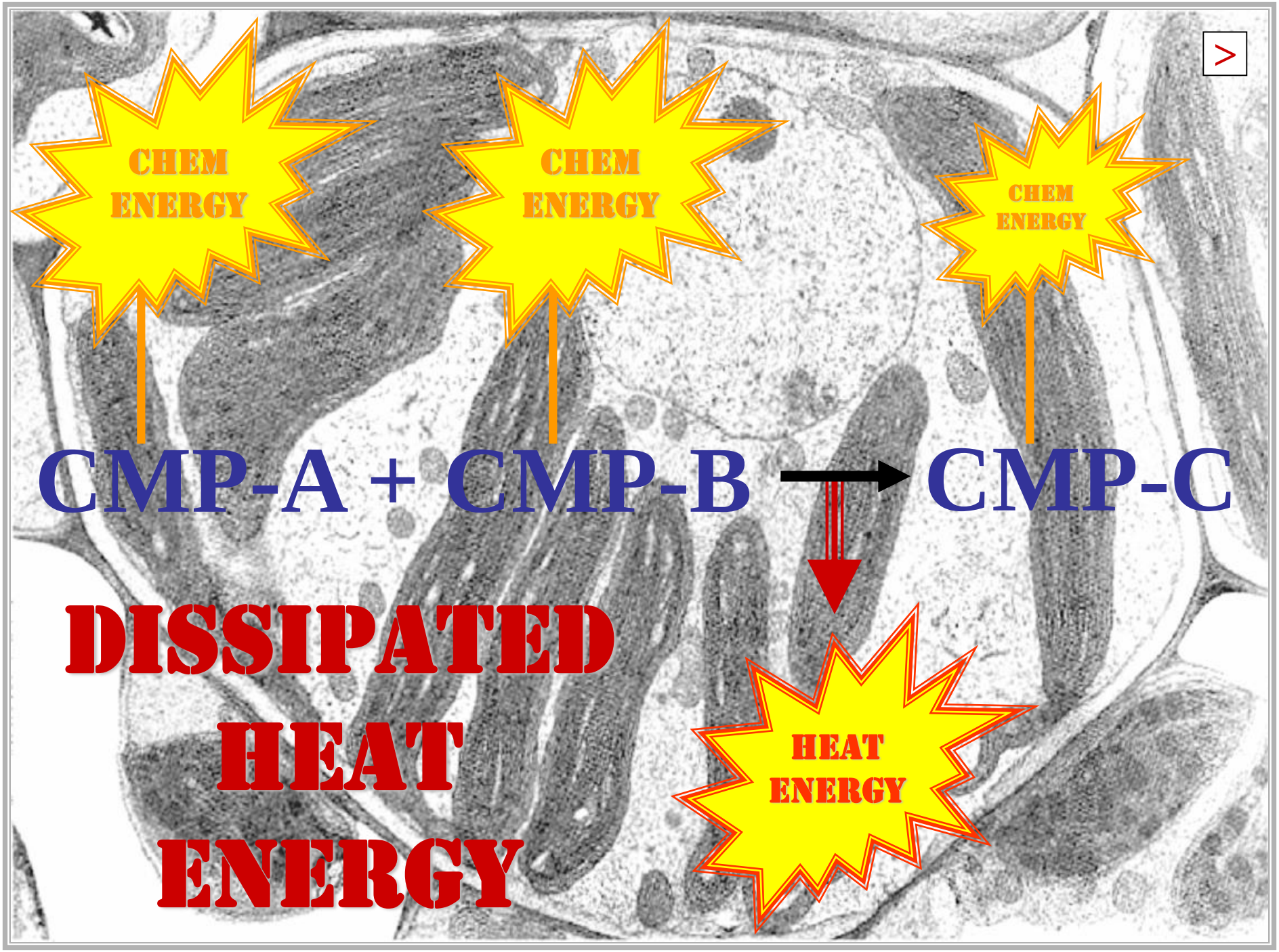
SECOND THERMODYNAMIC LAW EXAMPLE

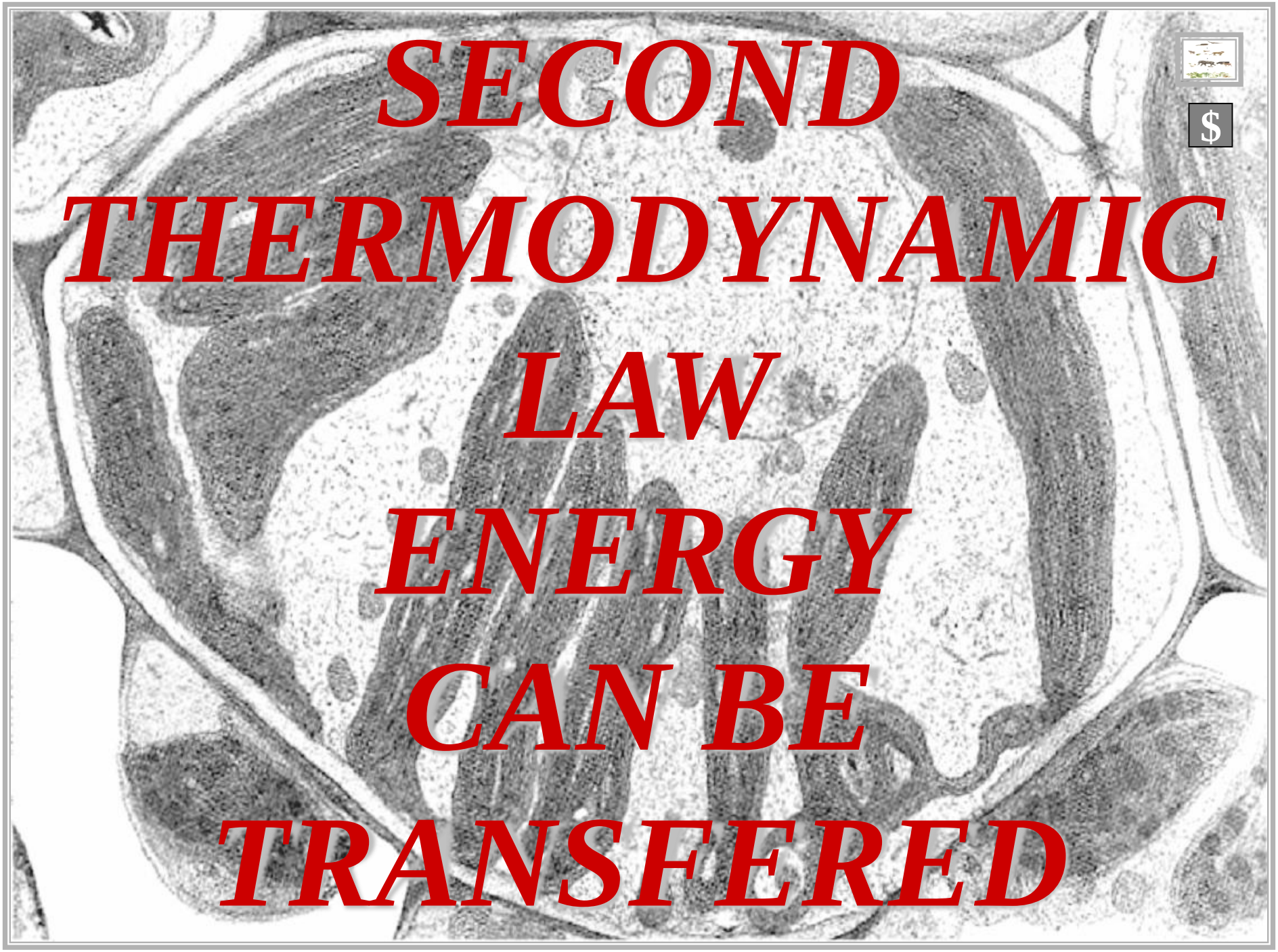


BIOCHEMICAL REACTION

CELL METABOLISM


CHEM ENERGY
CHEM ENERGY
CHEM ENERGY
CMP-A + CMP-B → CMP-C
BIOCHEMICAL REACTION
CELL METABOLISM


CHEM ENERGY
CHEM ENERGY
CHEM ENERGY
CMP-A + CMP-B → CMP-C
DISSIPATED HEAT ENERGY
HEAT ENERGY


SECOND
THERMODYNAMIC
LAW
ENERGY
CAN BE
TRANSFERED

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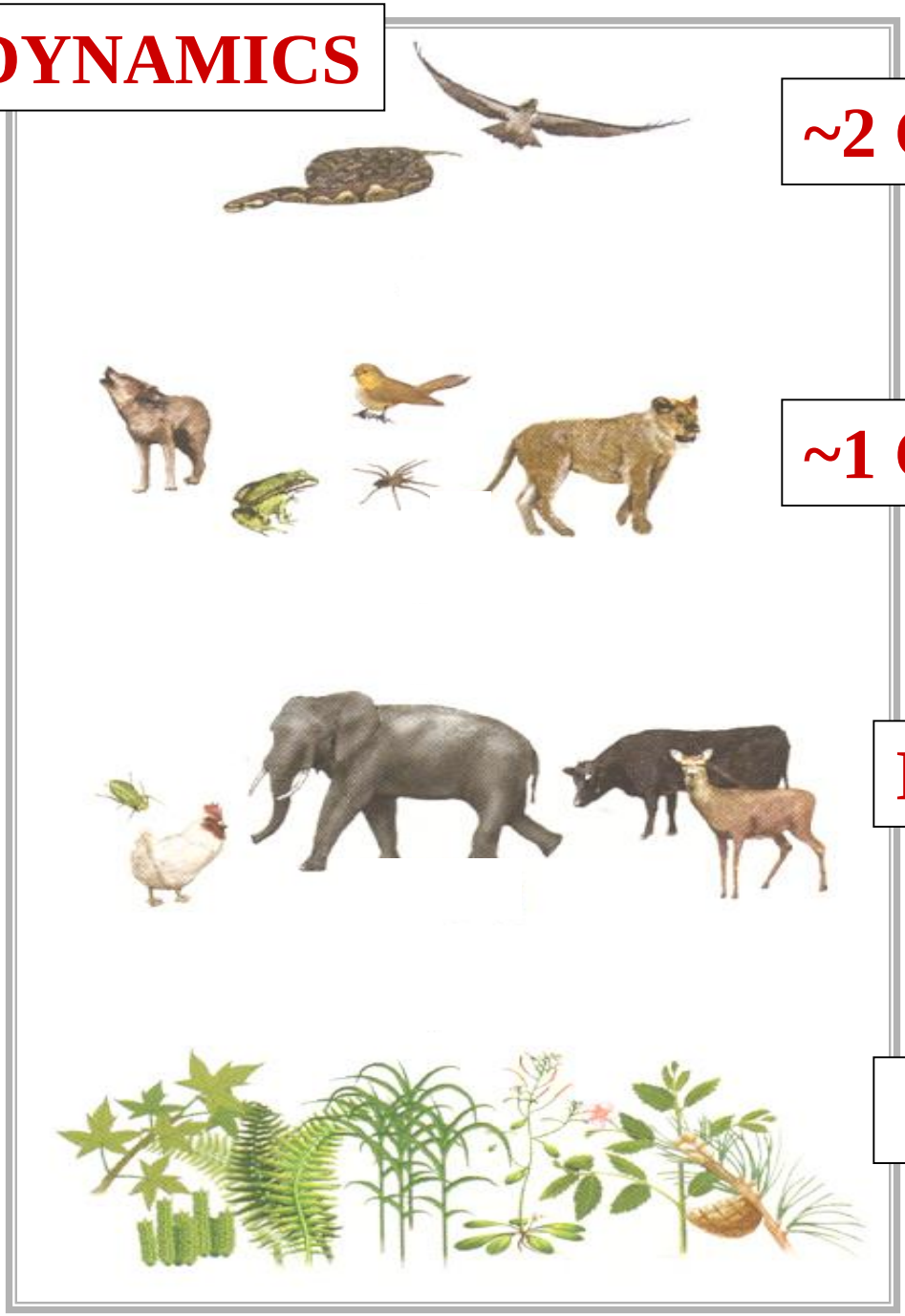
THERMODYNAMIC LAWS SUMMARY

THERMODYNAMICS

FOOD CHAIN



~2 CARNIVORES

~1 CARNIVORES

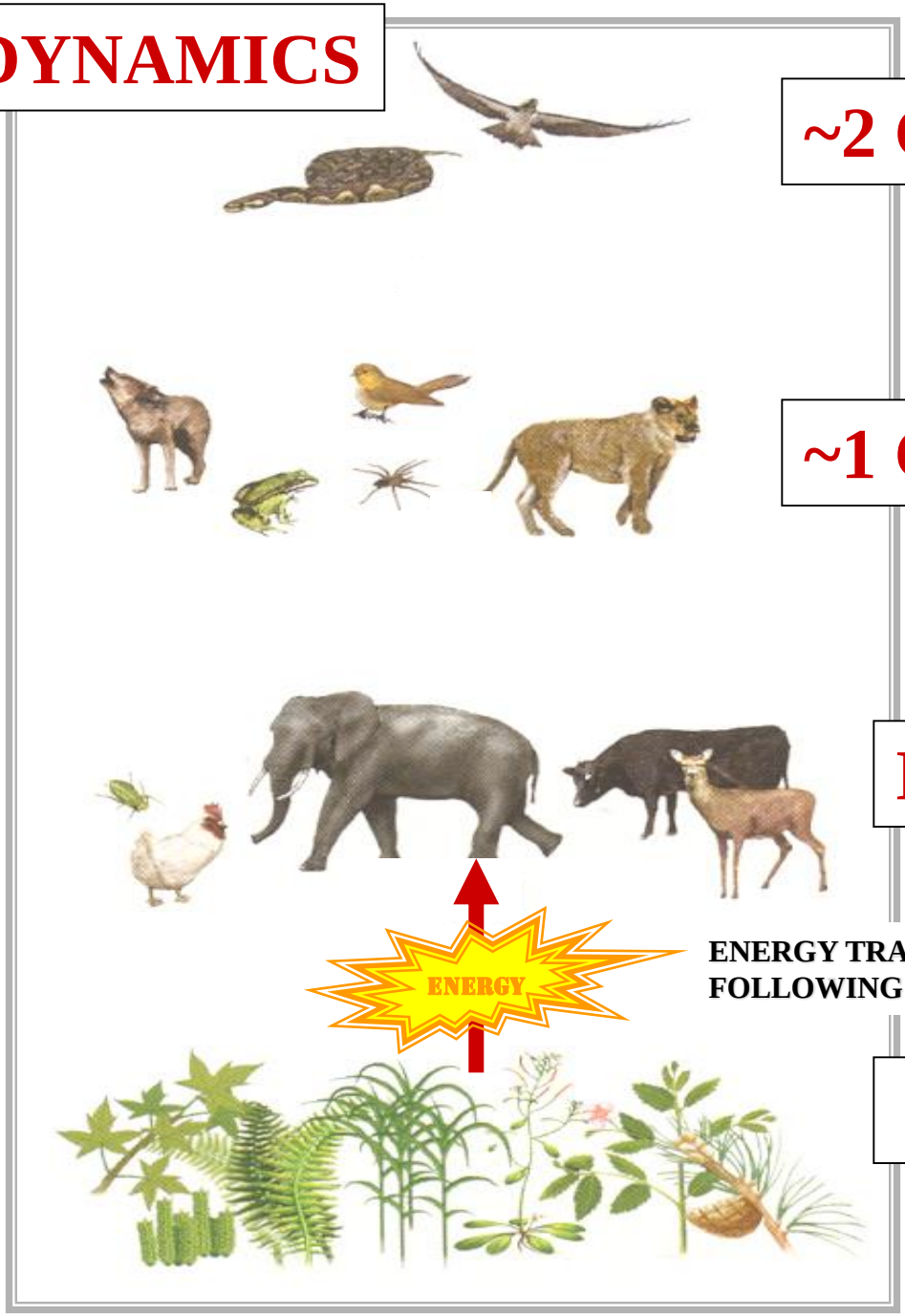
HERBIVORES

PRODUCERS

= CHEMICAL ENERGY

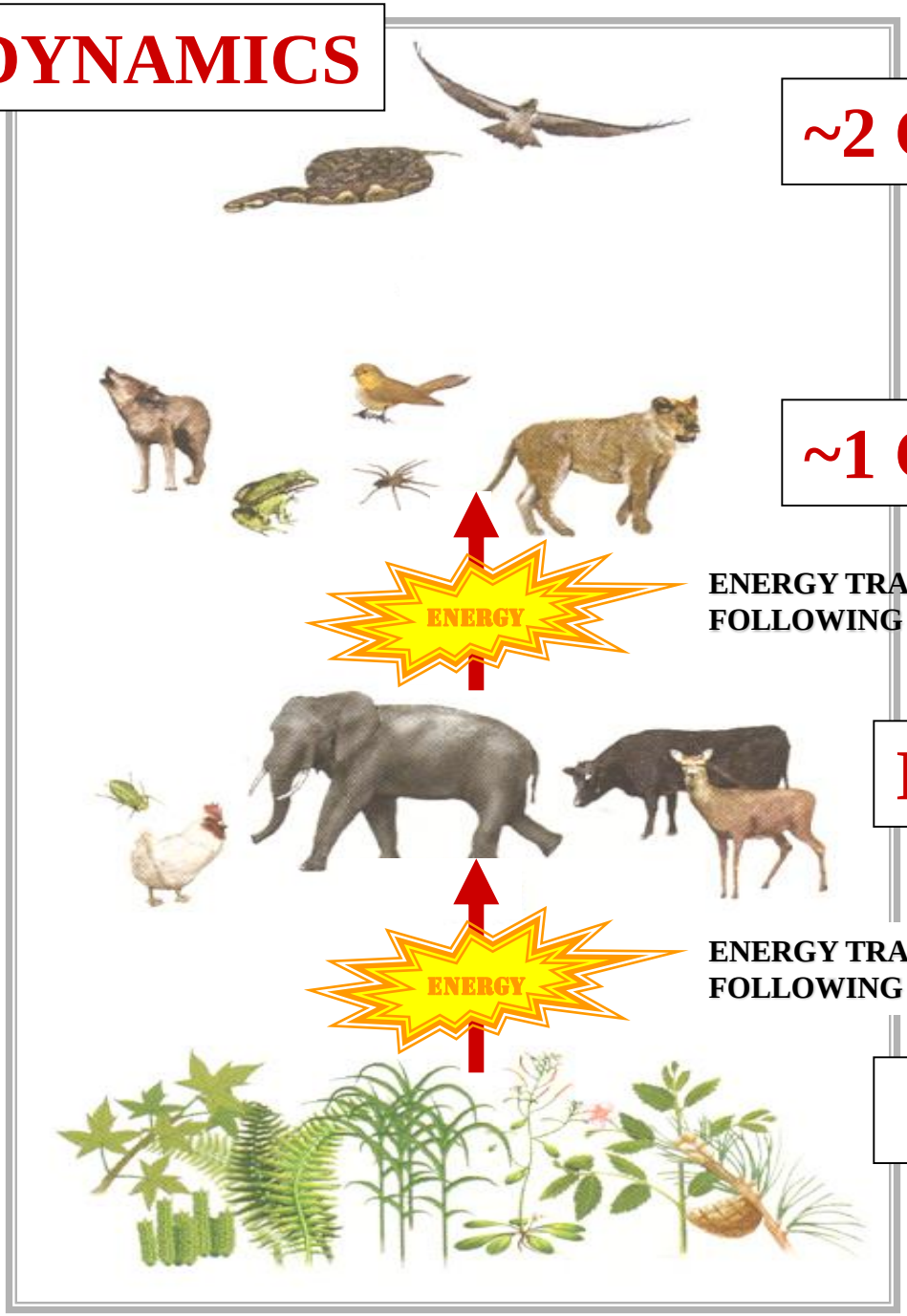
THERMODYNAMICS

FOOD CHAIN



THERMODYNAMICS

FOOD CHAIN



~2 CARNIVORES

~1 CARNIVORES

ENERGY TRANSFORMATION & TRANSFER FOLLOWING THERMODYNAMIC LAWS

HERBIVORES

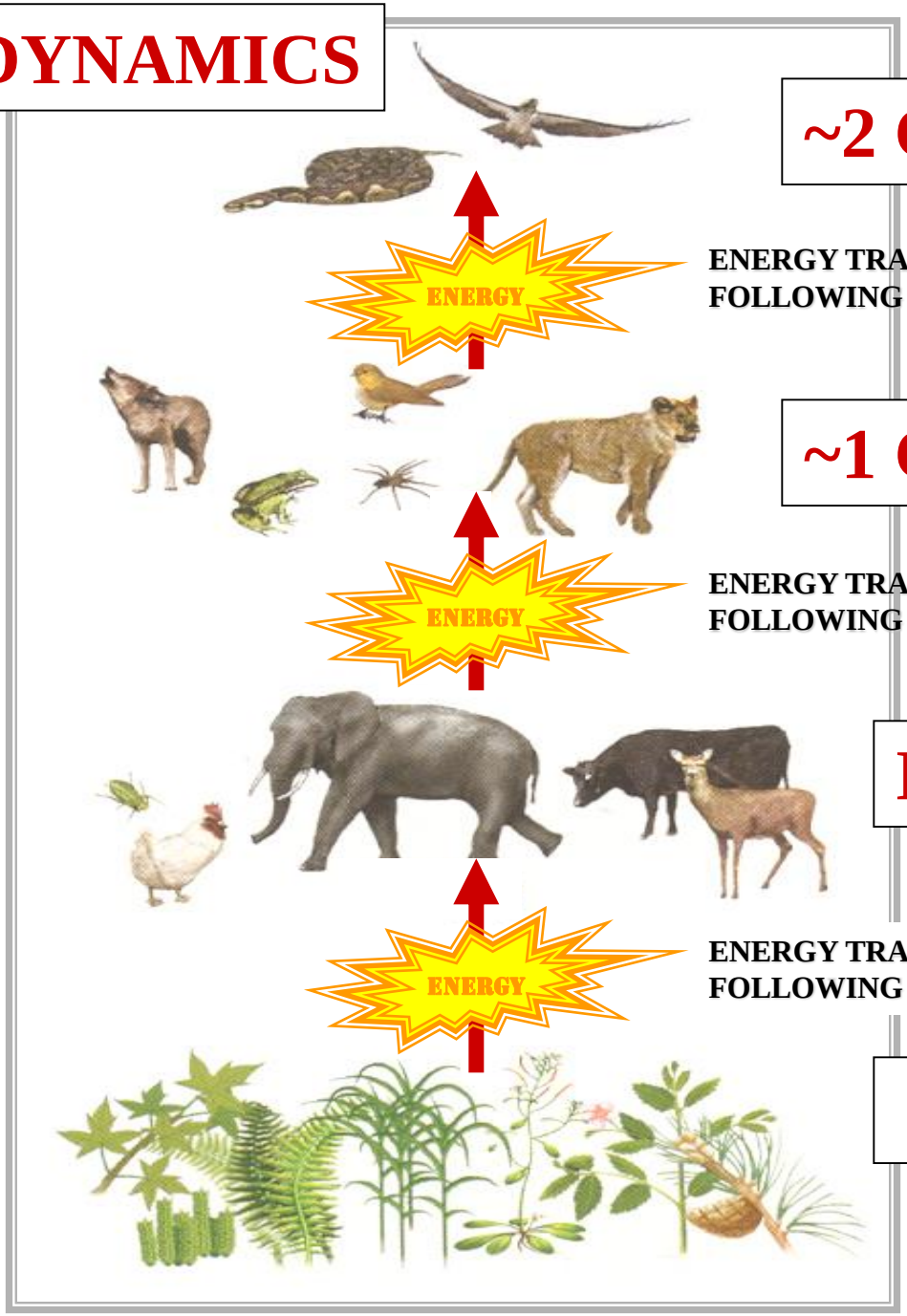
ENERGY TRANSFORMATION & TRANSFER FOLLOWING THERMODYNAMIC LAWS

PRODUCERS

= CHEMICAL ENERGY

THERMODYNAMICS

FOOD CHAIN



~2 CARNIVORES

ENERGY TRANSFORMATION & TRANSFER FOLLOWING THERMODYNAMIC LAWS

~1 CARNIVORES

ENERGY TRANSFORMATION & TRANSFER FOLLOWING THERMODYNAMIC LAWS

HERBIVORES

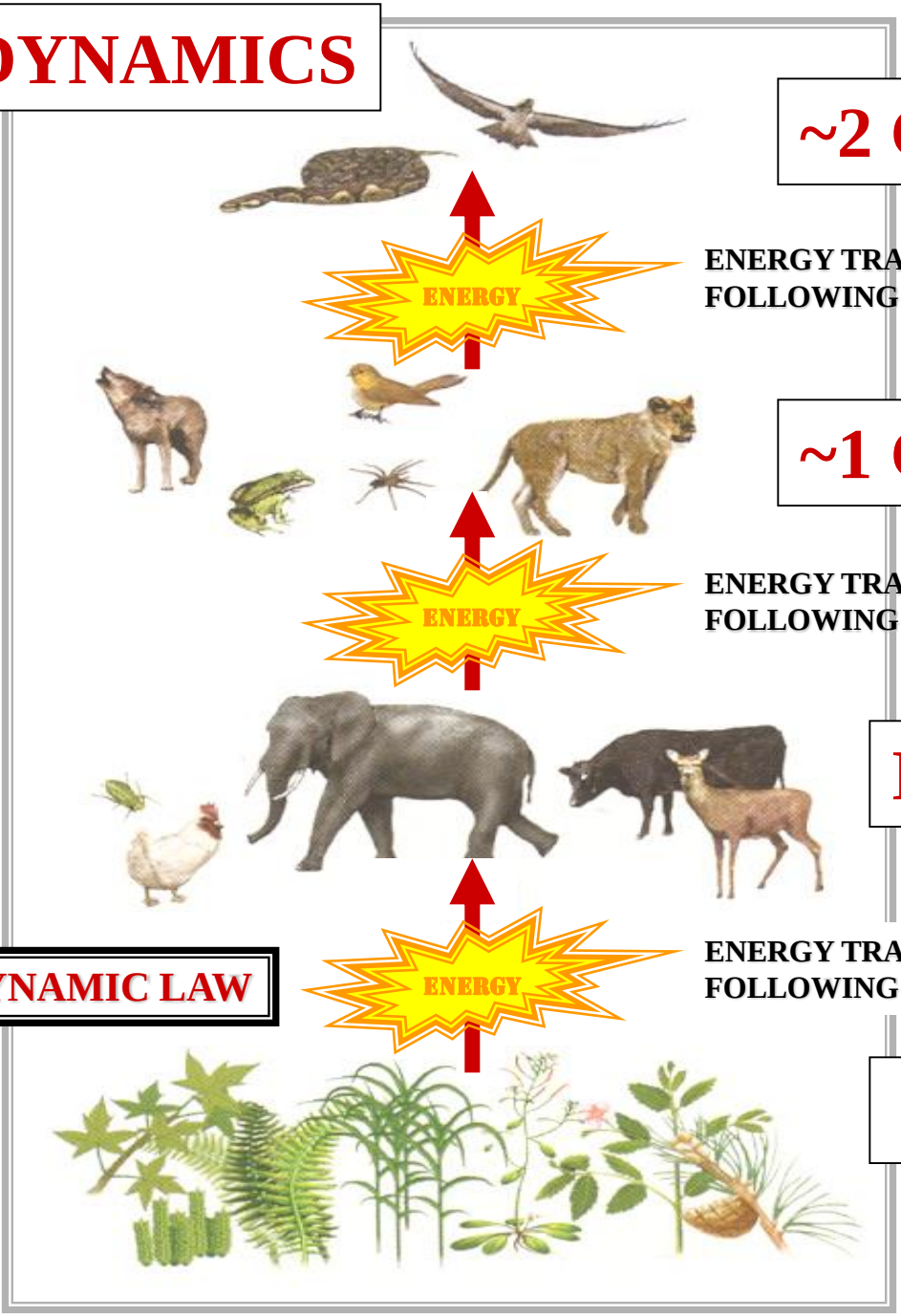
ENERGY TRANSFORMATION & TRANSFER FOLLOWING THERMODYNAMIC LAWS

PRODUCERS

= CHEMICAL ENERGY

THERMODYNAMICS

FOOD CHAIN



~2 CARNIVORES

ENERGY TRANSFORMATION & TRANSFER FOLLOWING THERMODYNAMIC LAWS

~1 CARNIVORES

ENERGY TRANSFORMATION & TRANSFER FOLLOWING THERMODYNAMIC LAWS

HERBIVORES

ENERGY TRANSFORMATION & TRANSFER FOLLOWING THERMODYNAMIC LAWS

PRODUCERS

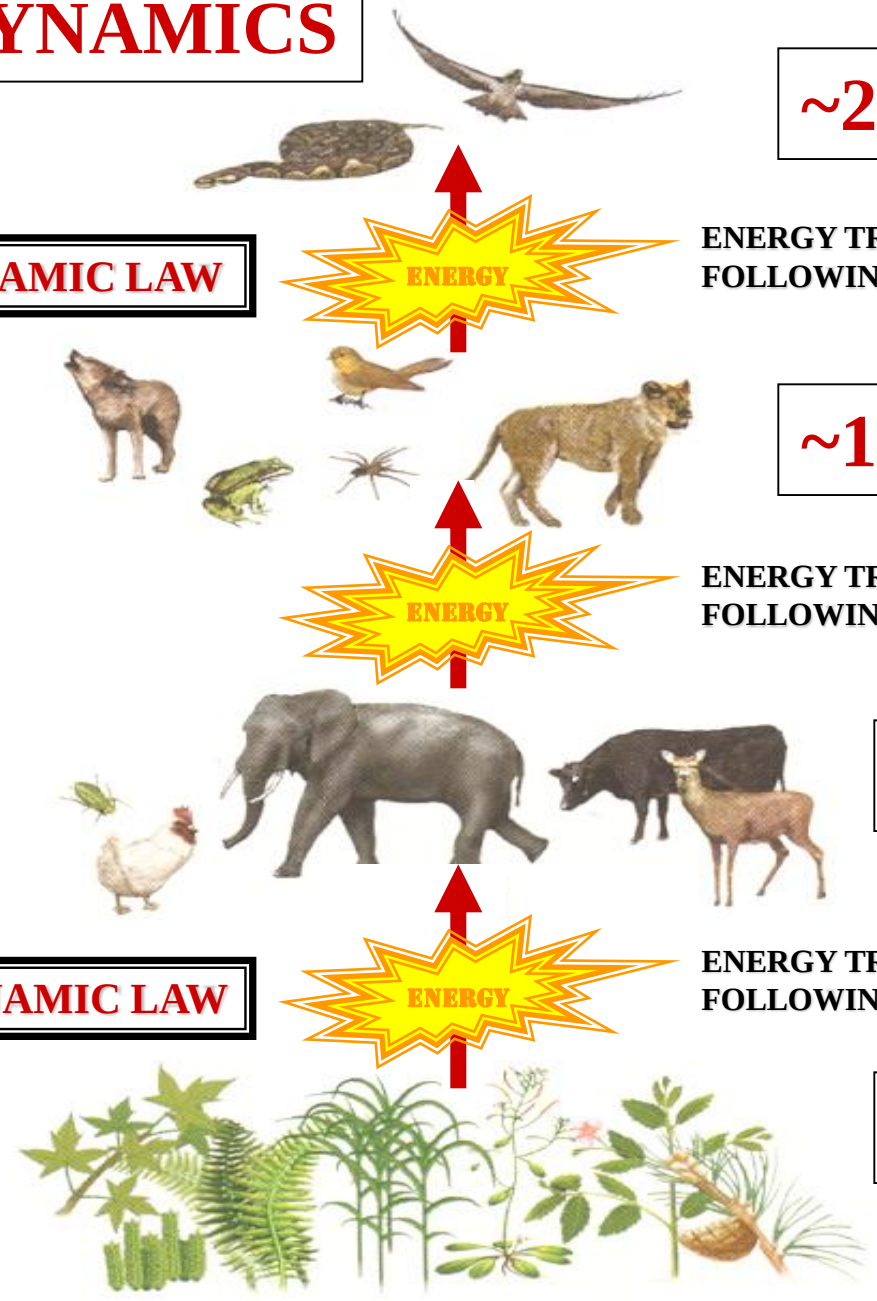
1ST THERMODYNAMIC LAW

= CHEMICAL ENERGY

THERMODYNAMICS

>

FOOD CHAIN



~2 CARNIVORES

~1 CARNIVORES

HERBIVORES

PRODUCERS

2ND THERMODYNAMIC LAW

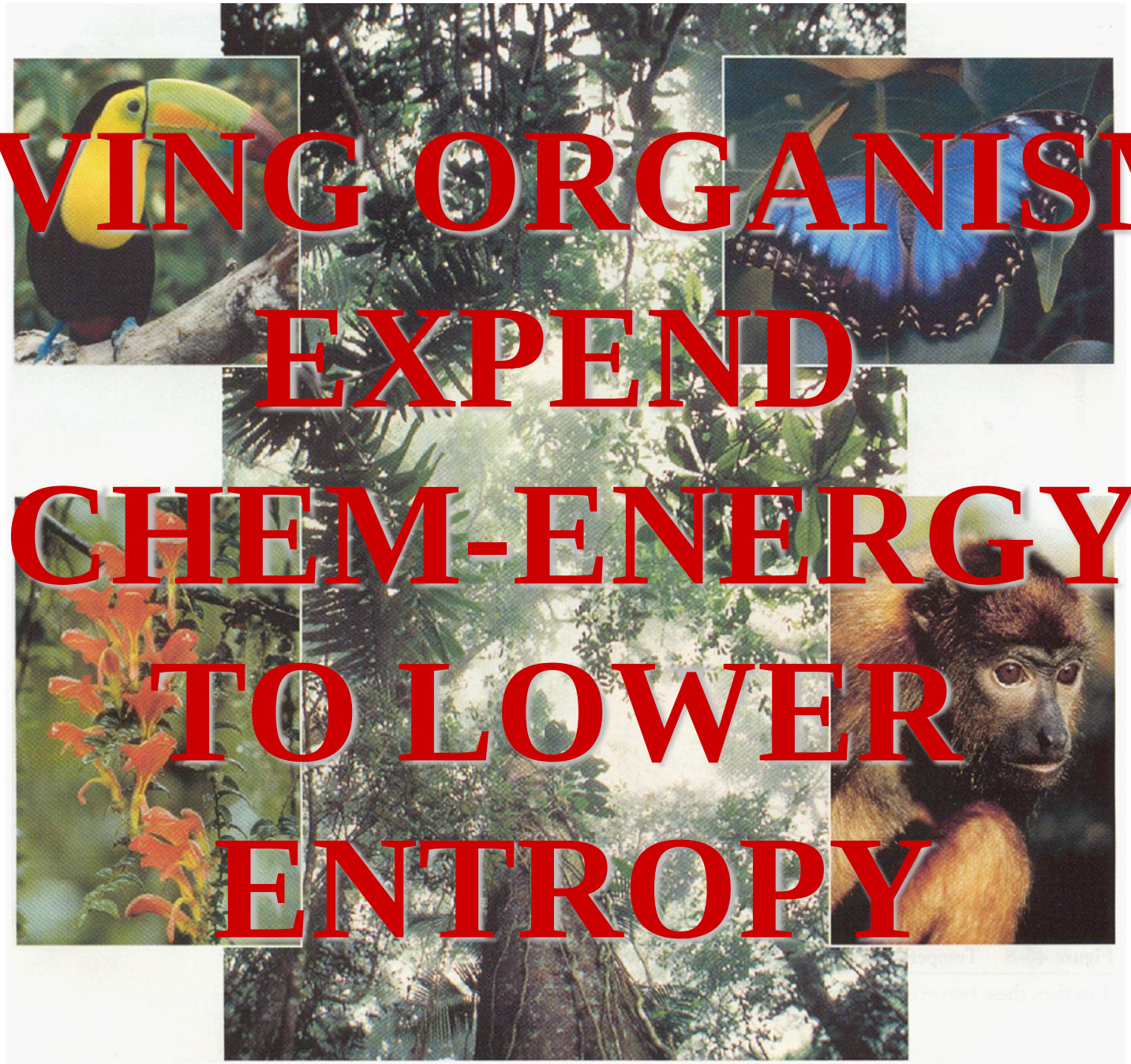
ENERGY TRANSFORMATION & TRANSFER FOLLOWING THERMODYNAMIC LAWS

ENERGY TRANSFORMATION & TRANSFER FOLLOWING THERMODYNAMIC LAWS

1ST THERMODYNAMIC LAW

ENERGY TRANSFORMATION & TRANSFER FOLLOWING THERMODYNAMIC LAWS

= CHEMICAL ENERGY



LIVING ORGANISMS EXPEND CHEM-ENERGY TO LOWER ENTROPY

E

ENTROPY

ENTROPY

ENTROPY

ORGANIZATION MEASURE

ENTROPY

ENTROPY

ORGANIZATION MEASURE

HIGH ORGANIZATION = LOW ENTROPY

ENTROPY

ENTROPY

ORGANIZATION MEASURE

HIGH ORGANIZATION = LOW ENTROPY

LOW ORGANIZATION = HIGH ENTROPY

ENTROPY

ENTROPY: APPLIED


CHEETAH
DISPATCHES
IMPALA

I

DEAD ORGANISM

IMPALA

IMPALA

IMPALA

POLYMER

POLYMER

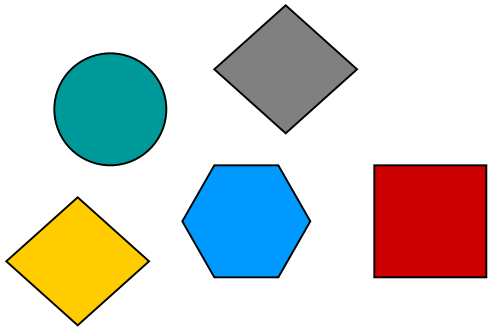
CATABOLIC METABOLISM

ENERGY IN PUT

ANABOLIC METABOLISM

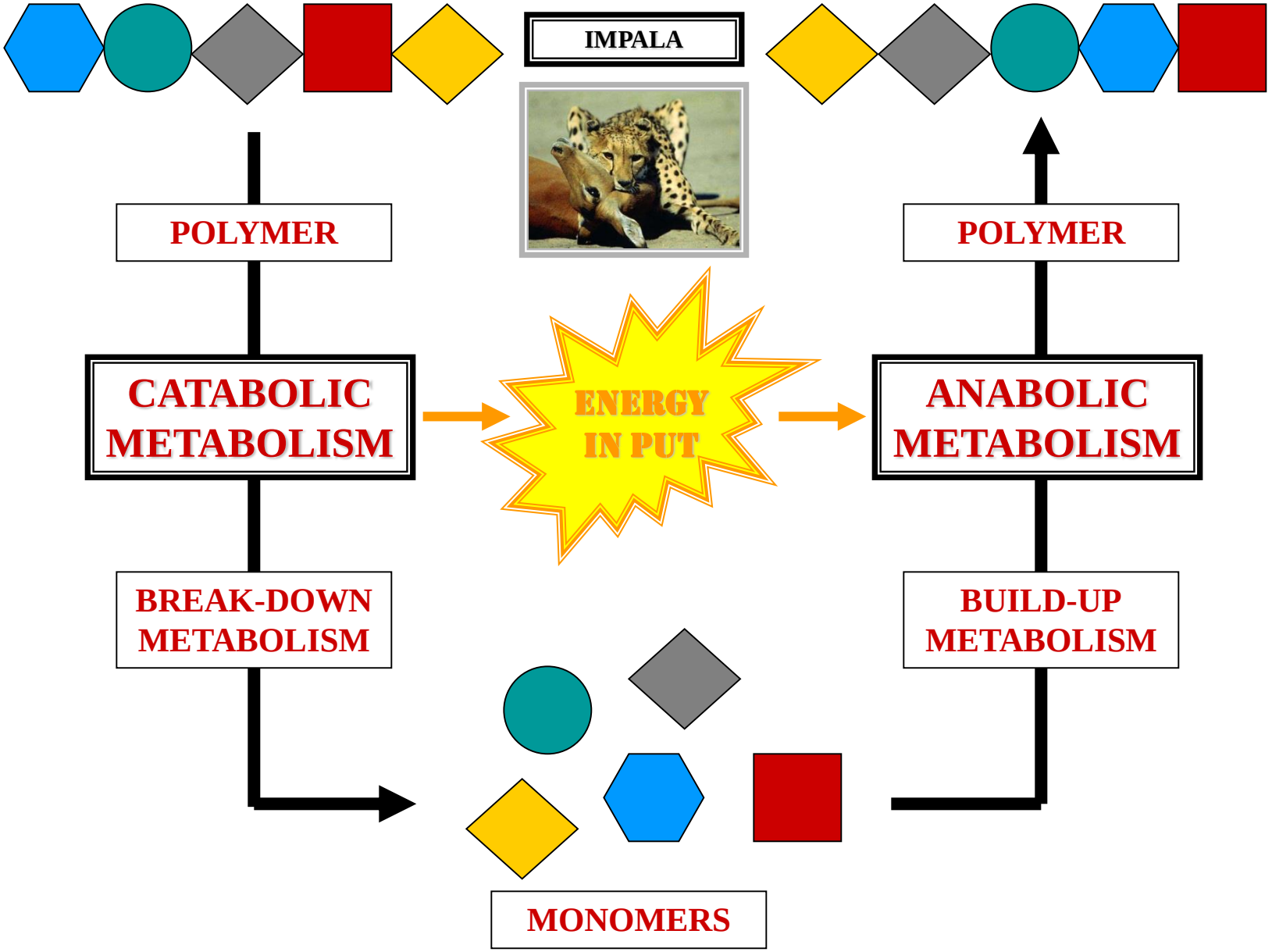
BREAK-DOWN METABOLISM

BUILD-UP METABOLISM



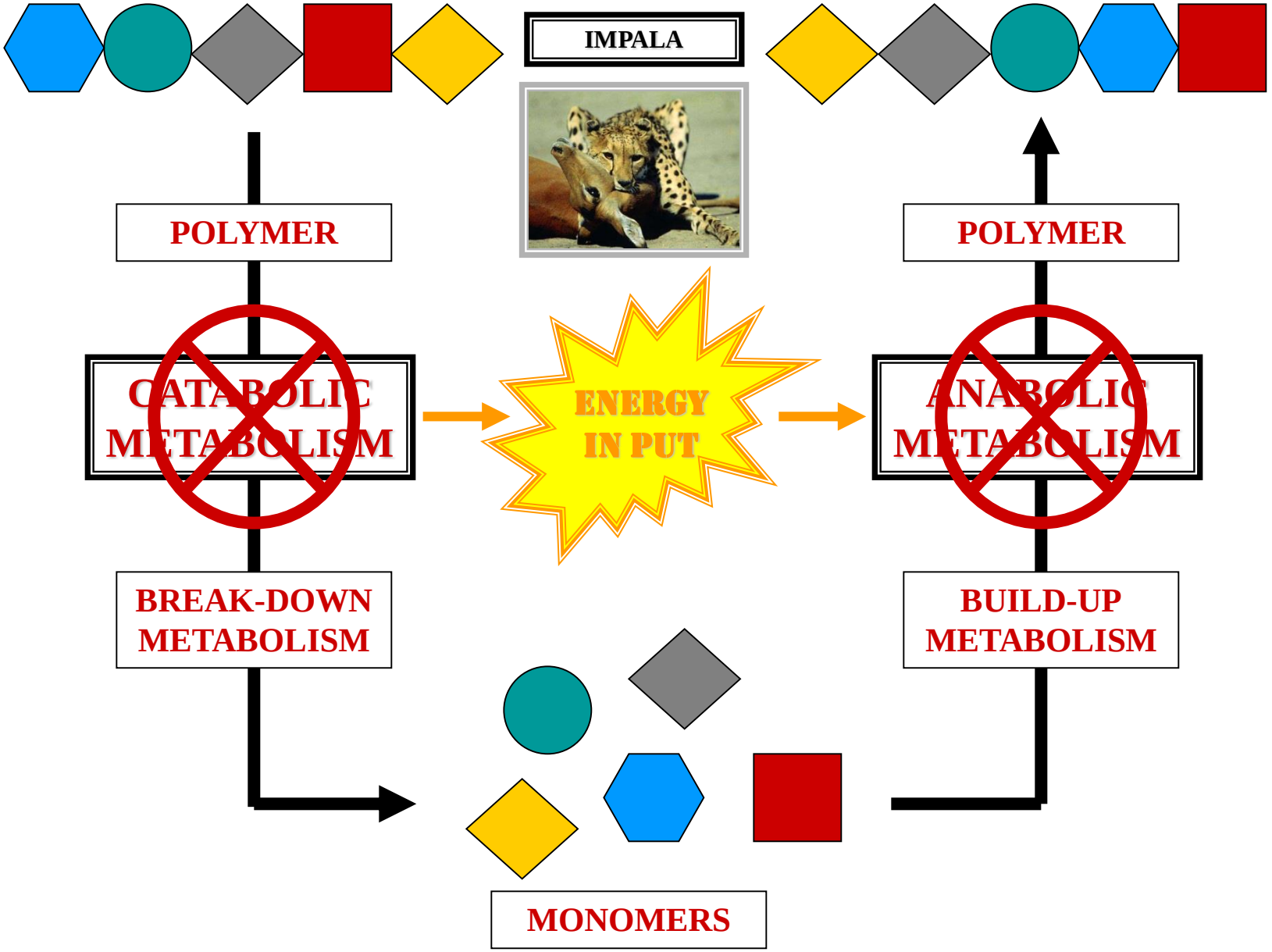
MONOMERS

METABOLISM

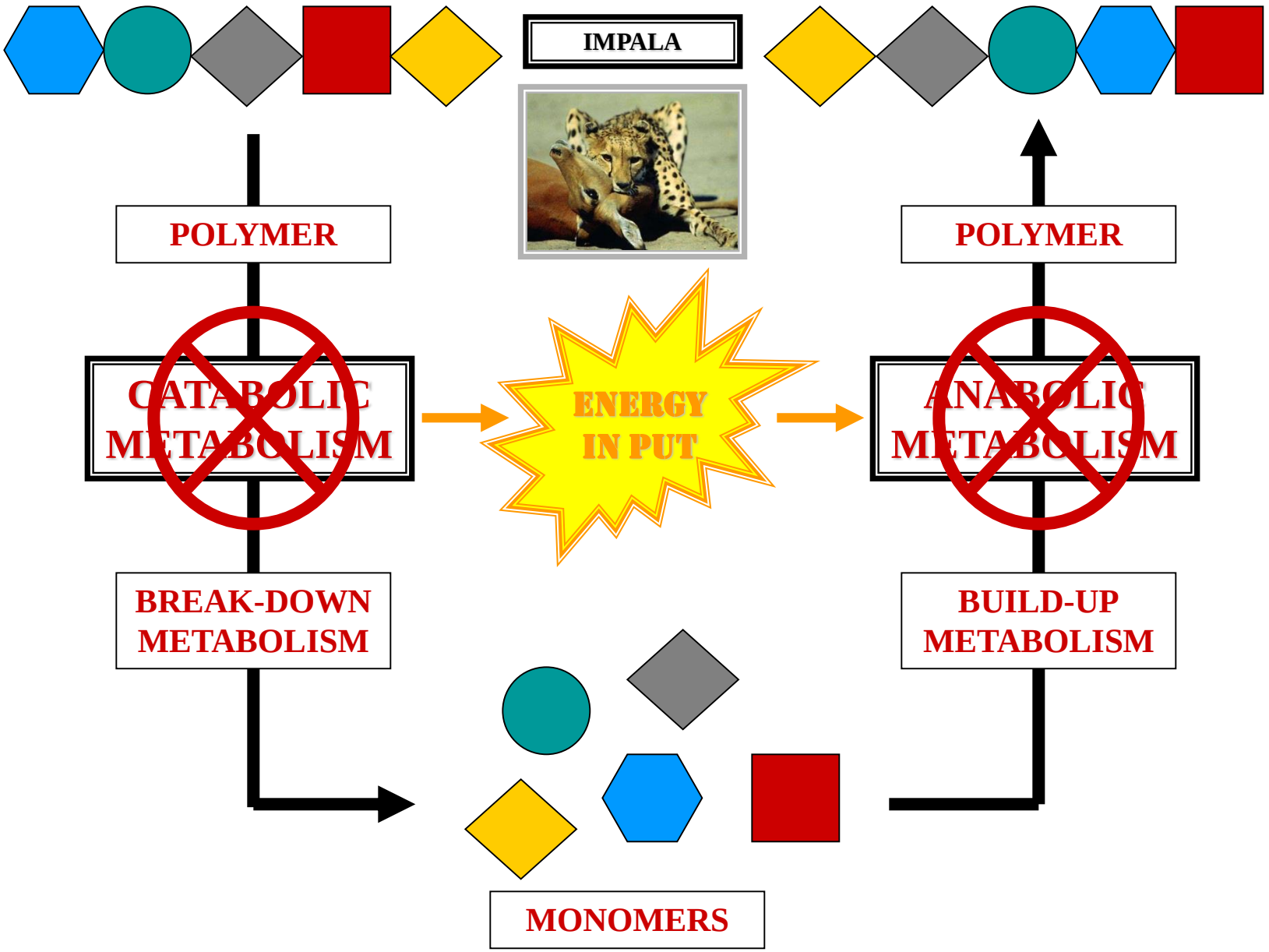

IMPALA
POLYMER
POLYMER
CATABOLIC METABOLISM
ENERGY IN PUT
ANABOLIC METABOLISM
BREAK-DOWN METABOLISM
BUILD-UP METABOLISM
MONOMERS

NO METABOLISM

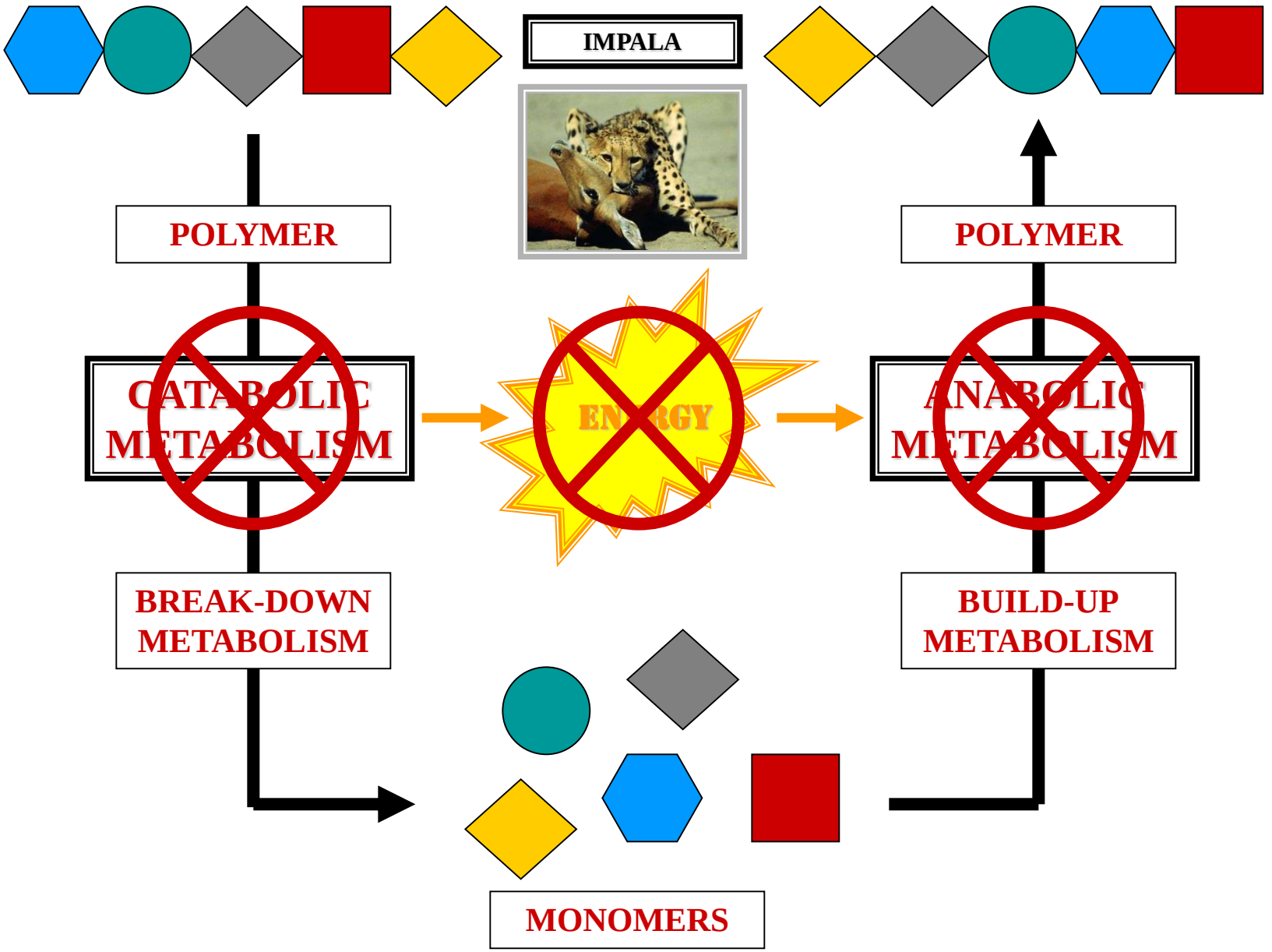
E



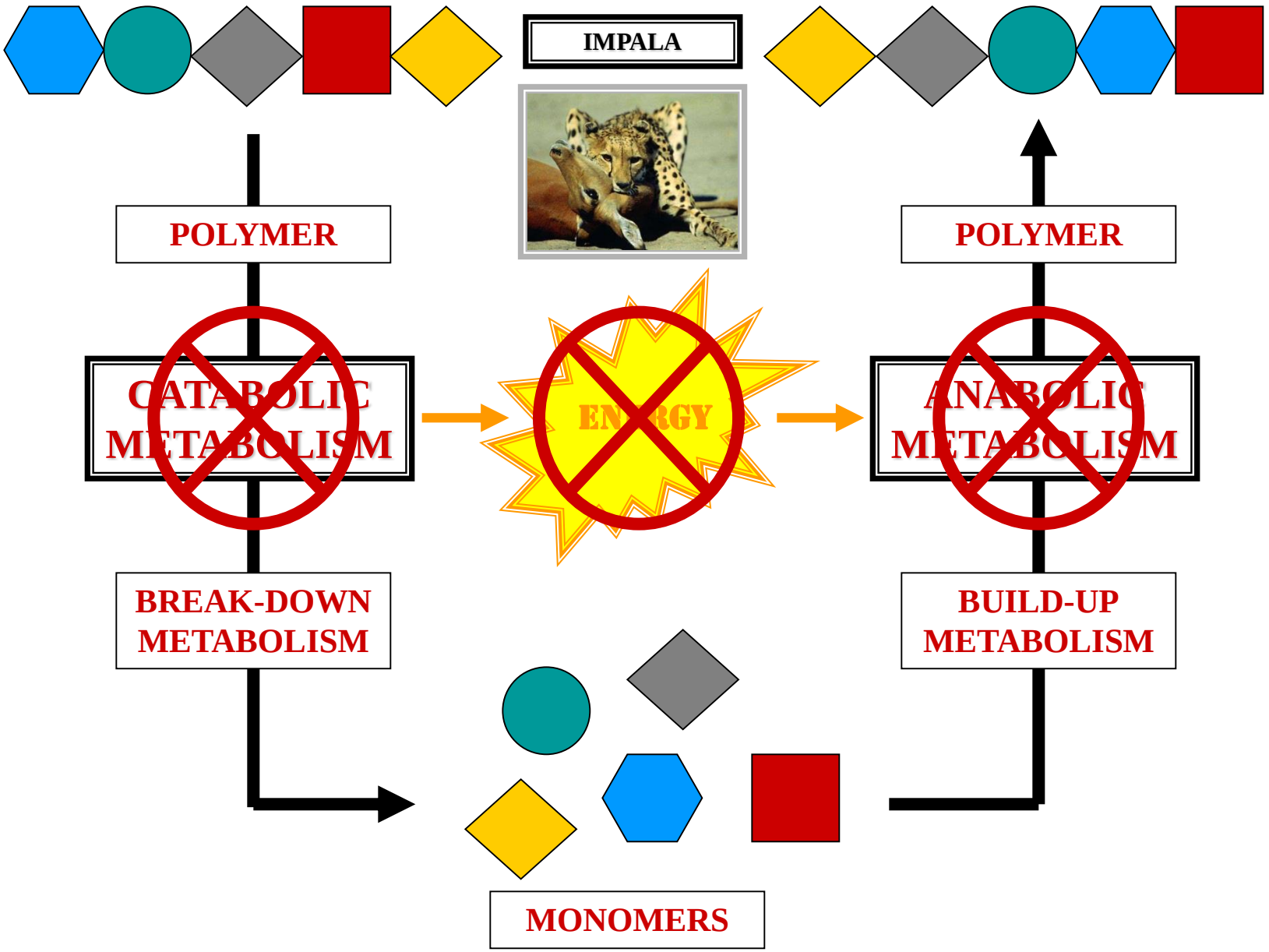
ENERGY


IMPALA
POLYMER
POLYMER
CATABOLIC METABOLISM
ENERGY IN PUT
ANABOLIC METABOLISM
BREAK-DOWN METABOLISM
BUILD-UP METABOLISM
MONOMERS

NO ENERGY INPUT

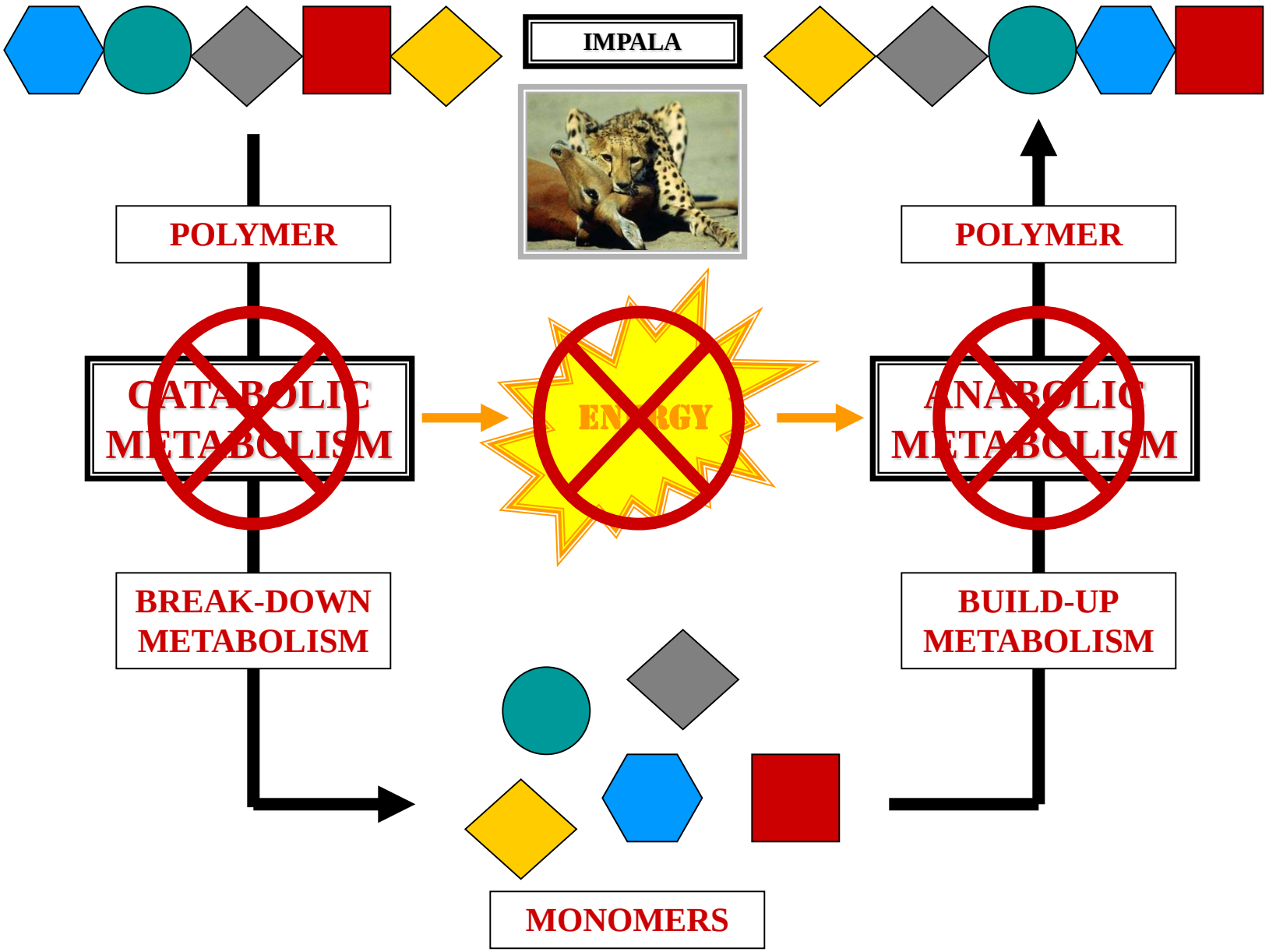


ORGANIZATION

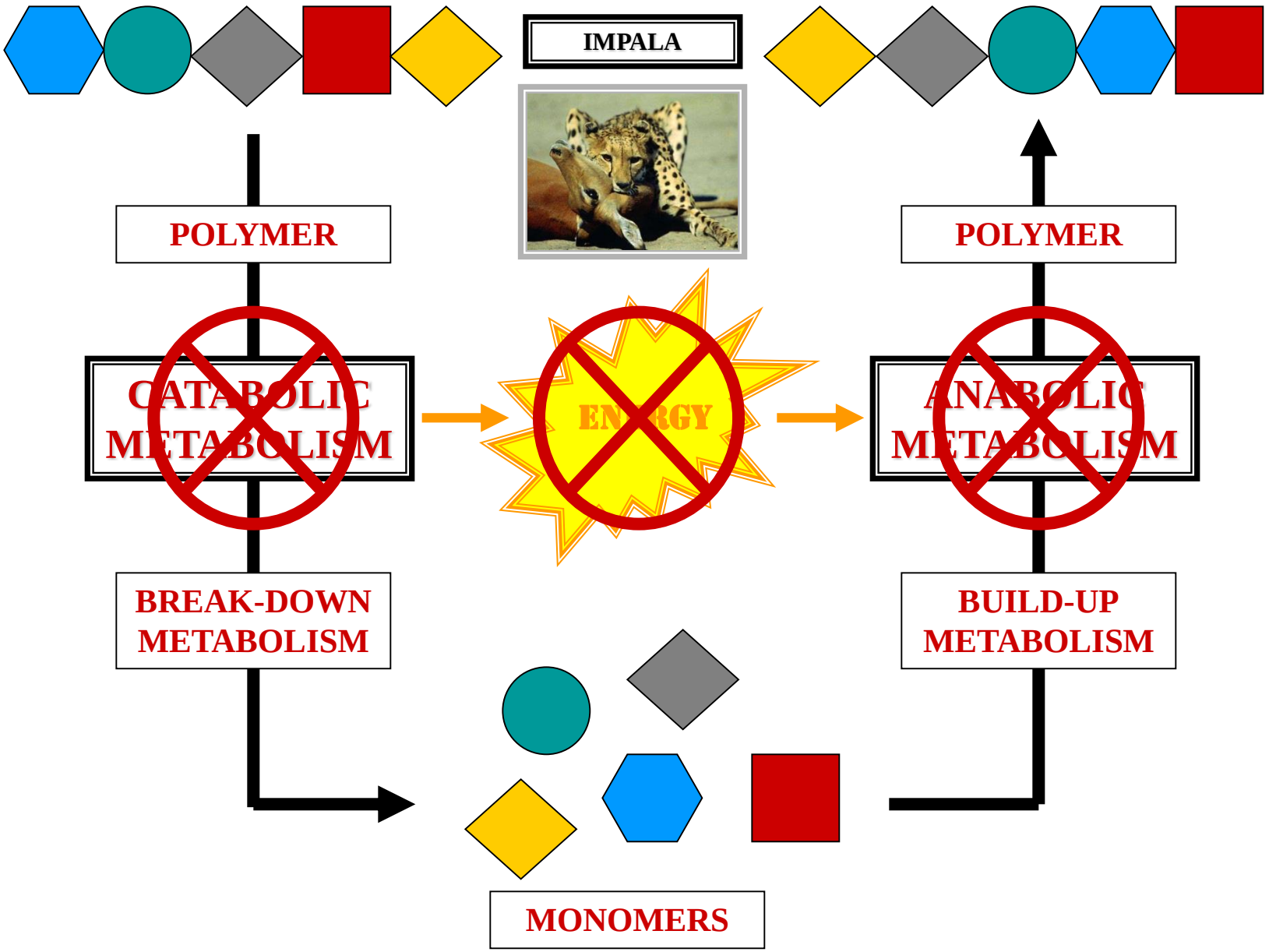


LOW ORGANIZATION

E



ENTROPY


IMPALA
POLYMER
POLYMER
CATABOLIC METABOLISM
ENERGY
ANABOLIC METABOLISM
BREAK-DOWN METABOLISM
BUILD-UP METABOLISM
MONOMERS

HIGH ENTROPY

IMPALA

POLYMER

CATABOLIC METABOLISM

BREAK-DOWN METABOLISM

ENERGY

POLYMER

ANABOLIC METABOLISM

BUILD-UP METABOLISM

MONOMERS

DEAD ORGANISM

IMPALA

POLYMER

CATABOLIC METABOLISM

ENERGY

ANABOLIC METABOLISM

POLYMER

BREAK-DOWN METABOLISM

BUILD-UP METABOLISM

MONOMERS


CHEETAH
DISPATCHES
IMPALA

C

LIVING ORGANISM

CHEETAH

CHEETAH

CHEETAH

POLYMER

POLYMER

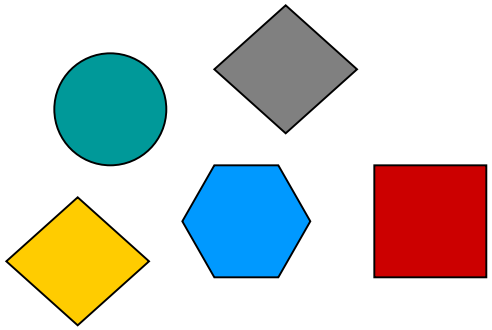
CATABOLIC METABOLISM

ENERGY IN PUT

ANABOLIC METABOLISM

BREAK-DOWN METABOLISM

BUILD-UP METABOLISM



MONOMERS

METABOLISM

CHEETAH

POLYMER

POLYMER

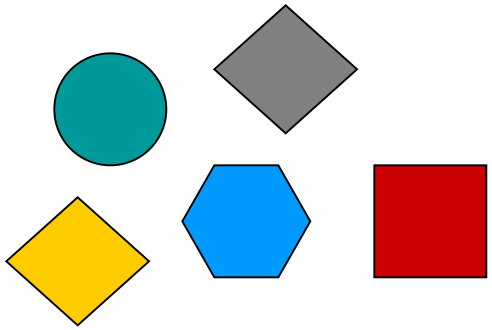
CATABOLIC METABOLISM

ENERGY IN PUT

ANABOLIC METABOLISM

BREAK-DOWN METABOLISM

BUILD-UP METABOLISM



MONOMERS

YES METABOLISM

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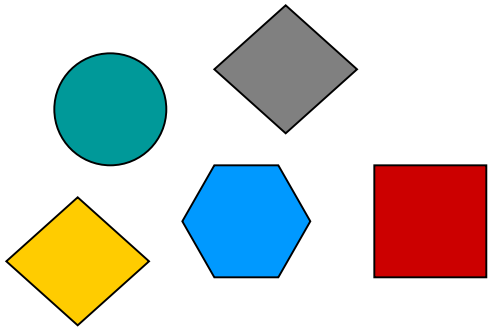

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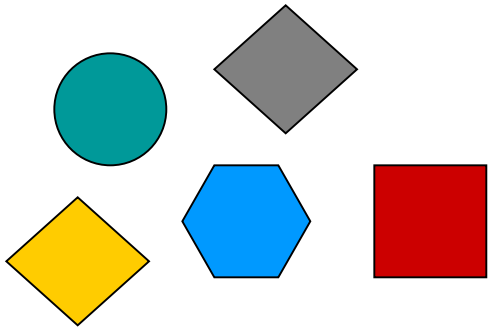

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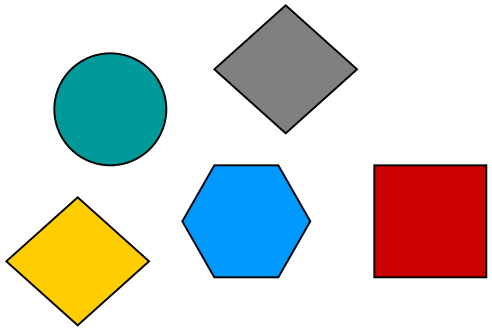

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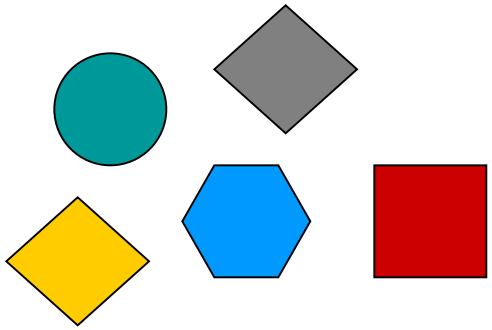

MONOMERS

HIGH ORGANIZATION

CHEETAH

POLYMER

POLYMER

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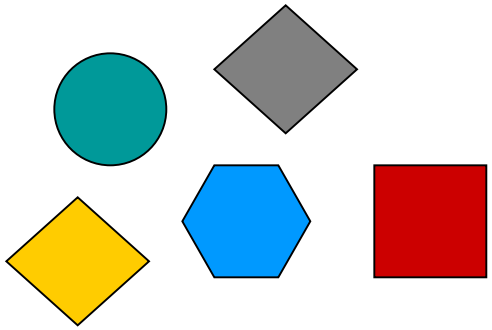

MONOMERS

ENTROPY

CHEETAH

POLYMER

POLYMER

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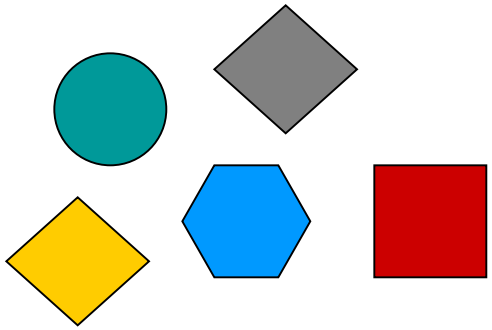

MONOMERS

LOW ENTROPY

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CHEETAH

POLYMER

POLYMER

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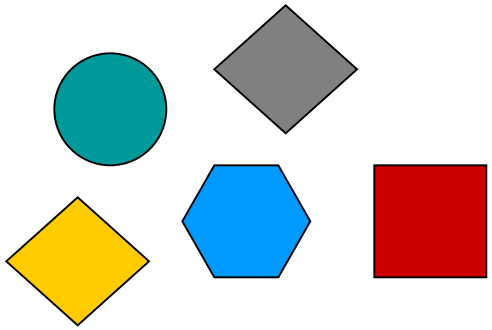

MONOMERS

LIVING ORGANISM

CHEETAH

POLYMER

POLYMER

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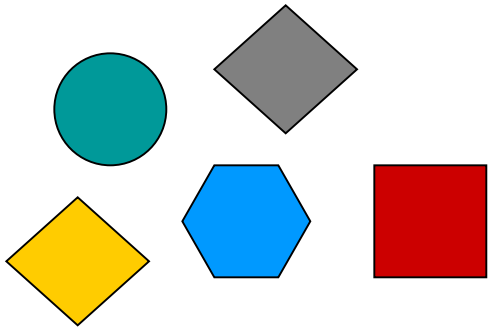

MONOMERS


LIVING ORGANISMS
MAINTAIN
LOW ENTROPY
VIA
METABOLISM
METABOLIC PATHWAYS

METABOLIC PATHWAYS

METABOLIC PATHWAY

EG

METABOLIC PATHWAY

SPECIFIC SEQUENCE BIOCHEMICAL REACTIONS

METABOLIC PATHWAY

METABOLIC PATHWAY EXAMPLE