UNIT-I
Bioenergetics

Chemical Bioregulation in Physiological functions
Course No. – VPY- 609
Credit Hrs. – 3+0=3

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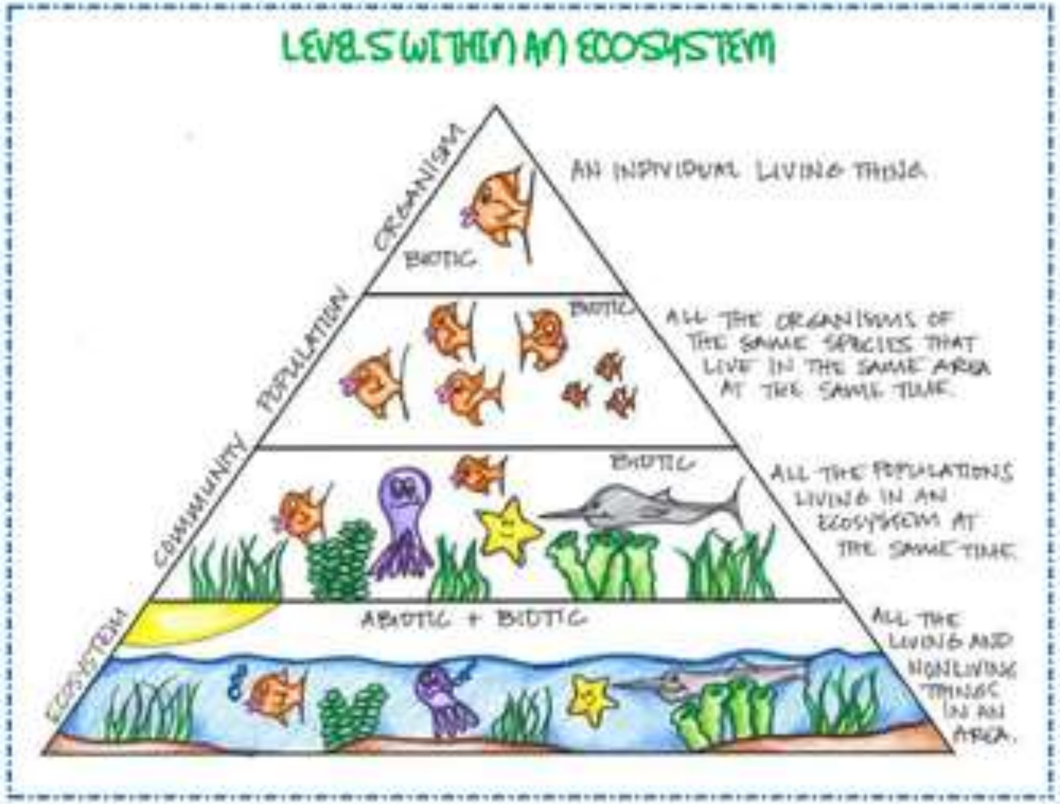
Overview

Bioenergetics is the part of biochemistry concerned with the energy involved in making and breaking of chemical bonds in the molecules found in biological organisms. It can also be defined as the study of energy relationships and energy transformations and transductions in living organisms. The ability to harness energy from a variety of metabolic pathways is a property of all living organisms that contains earth science. Growth, development, anabolism and catabolism are some of the central processes in the study of biological organisms, because the role of energy is fundamental to such biological processes. Life is dependent on energy transformations; living organisms survive because of exchange of energy between living tissues/cells and the outside environment. Some organisms, such as autotrophs, can acquire energy from sunlight (through photosynthesis) without needing to consume nutrients and break them down. Other organisms, like heterotrophs, must intake nutrients from food to be able to sustain energy by breaking down chemical bonds in nutrients during metabolic processes such as glycolysis and the citric acid cycle. Thermodynamics first law states that the autotrophs and heterotrophs participate in a universal metabolic network—by eating autotrophs (plants), heterotrophs harness energy that was initially transformed by the plants during photosynthesis.



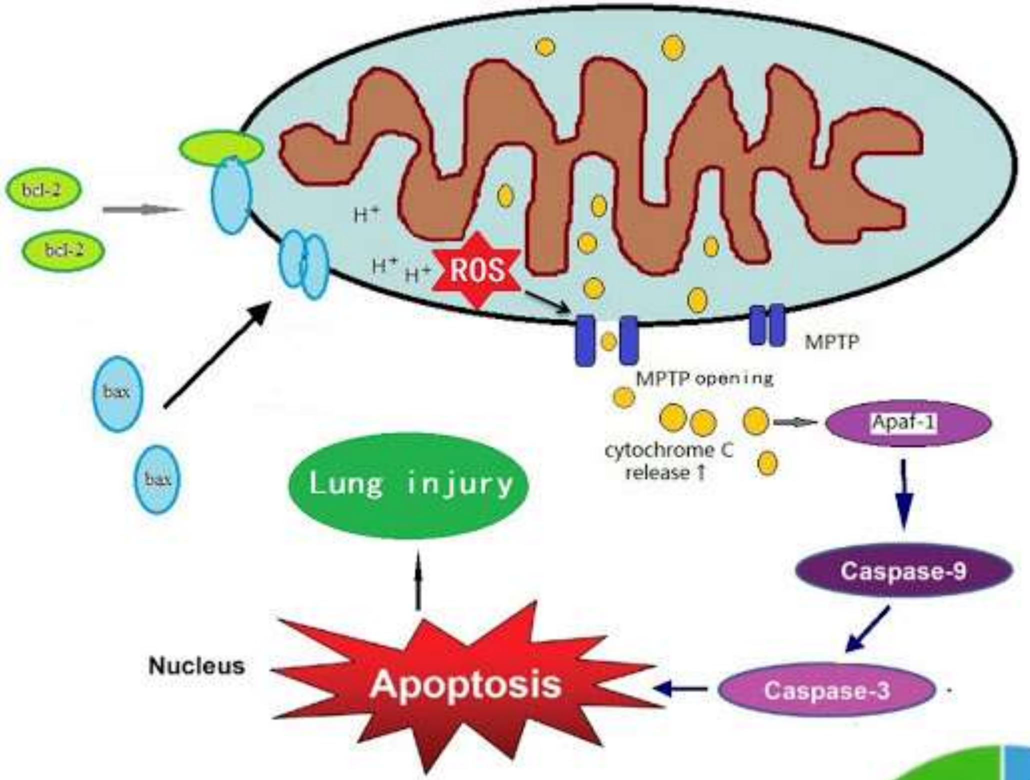
LEVELS WITHIN AN ECOSYSTEM
ORGANISM
BIOTIC
AN INDIVIDUAL LIVING THING
POPULATION
BIOTIC
ALL THE ORGANISMS OF THE SAME SPECIES THAT LIVE IN THE SAME AREA AT THE SAME TIME.
COMMUNITY
BIOTIC
ALL THE POPULATIONS LIVING IN AN ECOSYSTEM AT THE SAME TIME.
ECOSYSTEM
ABIOTIC + BIOTIC
ALL THE LIVING AND NONLIVING THINGS IN AN AREA.

- In a living organism, chemical bonds are broken and made as part of the exchange and transformation of energy. Energy is available for work when weak bonds are broken and stronger bonds are made. The production of stronger bonds allows release of usable energy.

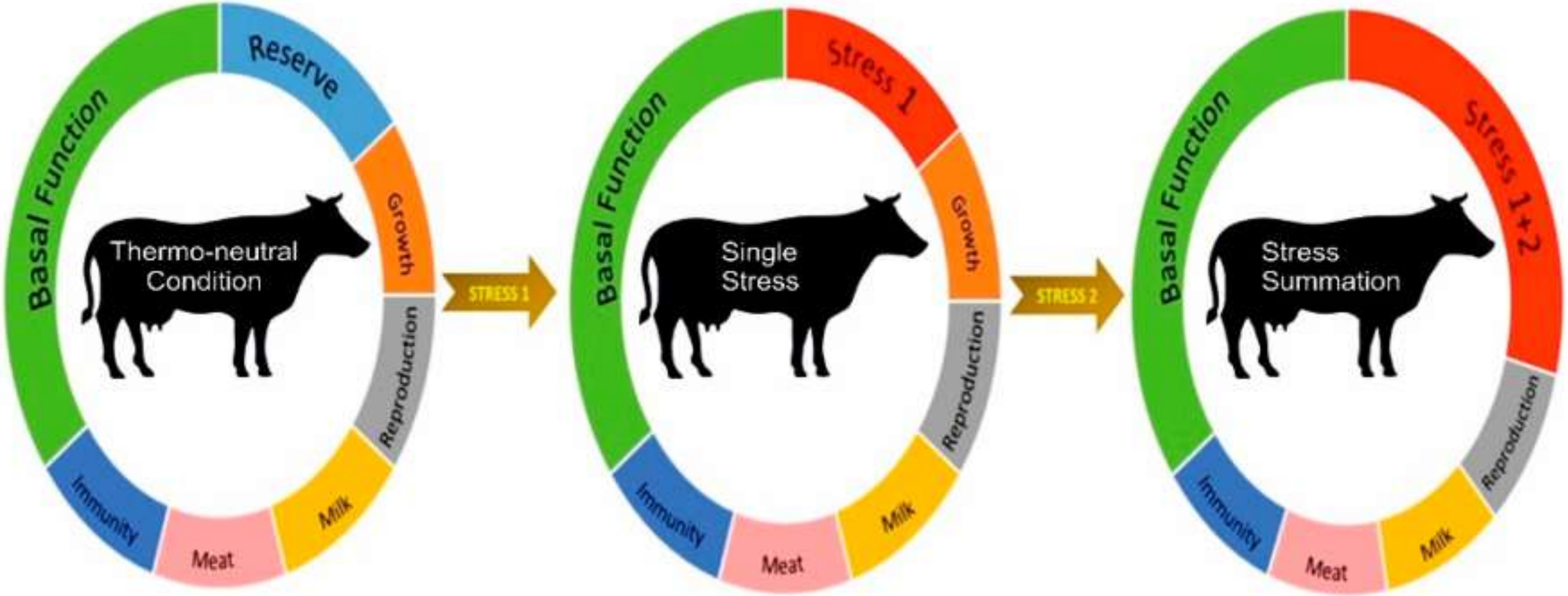
- Adenosine triphosphate is the main "energy currency" for organisms; the goal of metabolic and catabolic processes are to synthesize ATP from available starting materials (from the environment), and to break- down ATP (into adenosine diphosphate and inorganic phosphate) by utilizing it in biological processes. In a cell, the ratio of ATP to ADP concentrations is known as the “energy charge” of the cell. A cell can use this energy charge to relay information about cellular needs; if there is more ATP than ADP available, the cell can use ATP to do work, but if there is more ADP than ATP available, the cell must synthesize ATP via oxidative phosphorylation.

- Living organisms produce ATP from energy sources, mostly sunlight or O_2, mainly via oxidative phosphorylation. The terminal phosphate bonds of ATP are relatively weak compared with the stronger bonds formed when ATP is hydrolyzed to adenosine diphosphate and inorganic phosphate. An organism's stockpile of ATP is used as a battery to store energy in cells. Utilization of chemical energy from such molecular bond rearrangement powers biological processes in every biological organism.

- Living organisms obtain energy from organic and inorganic materials; i.e. ATP can be synthesized from a variety of biochemical precursors. The amount of energy actually obtained by the organism is lower than the amount released in combustion of food; there are losses in digestion, metabolism, and thermogenesis.



bcl-2
bcl-2
H+
H+ H+
ROS
MPTP
MPTP opening
bax
bax
Apaf-1
cytochrome C release ↑
Lung injury
Caspase-9
Nucleus
Apoptosis
Caspase-3



Basal Function
Reserve
Growth
Reproduction
Milk
Meat
Immunity
Thermo-neutral Condition
STRESS 1
Basal Function
Stress 1
Growth
Reproduction
Milk
Meat
Immunity
Single Stress
STRESS 2
Basal Function
Stress 1+2
Reproduction
Milk
Meat
Immunity
Stress Summation

- Environmental materials that an organism intakes are generally combined with oxygen to release energy, although some can also be oxidized anaerobically by various organisms. The bonds holding the molecules of nutrients together and in particular the bonds holding molecules of free oxygen together are relatively weak compared with the chemical bonds holding carbon dioxide and water together. The utilization of these materials is a form of slow combustion because the nutrients are reacted with oxygen. The oxidation releases energy because stronger bonds (bonds within water and carbon dioxide) have been formed. This net energy may evolve as heat, which may be used by the organism for other purposes, such as breaking other bonds to do chemistry required for survival.

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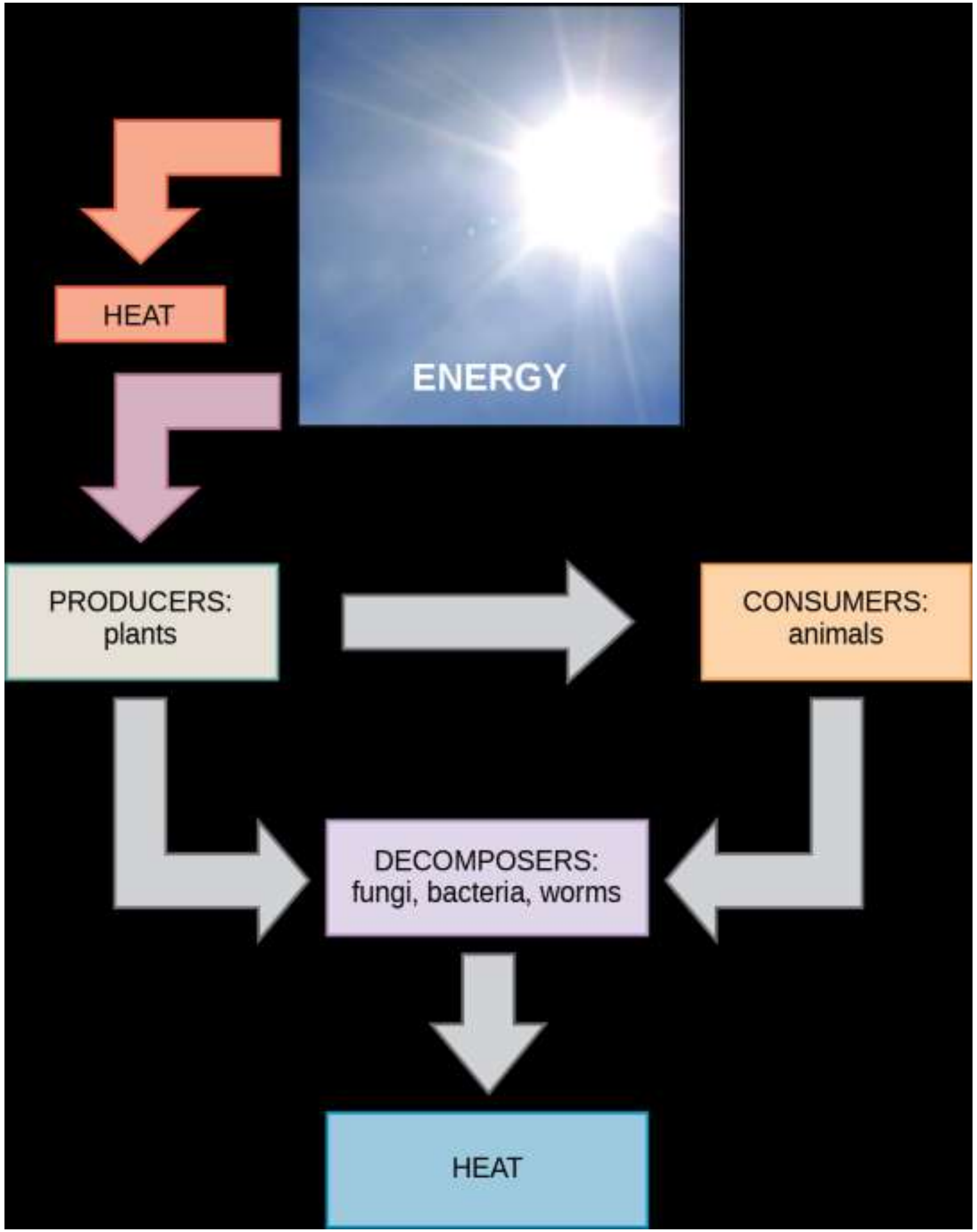
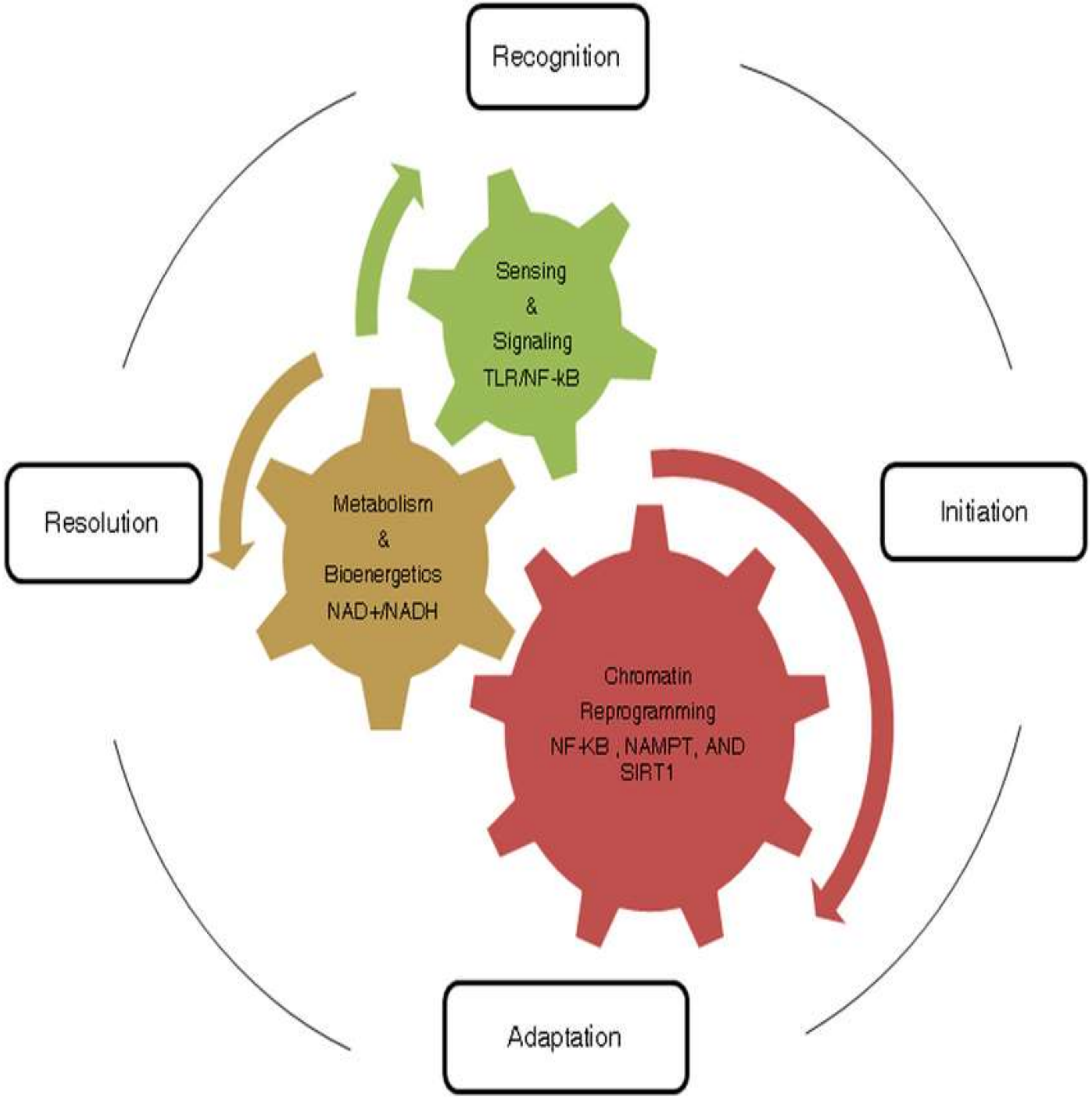

ENERGY
HEAT
PRODUCERS: plants
CONSUMERS: animals
DECOMPOSERS: fungi, bacteria, worms
HEAT


Recognition
Initiation
Adaptation
Resolution
Sensing & Signaling TLR/NF-kB
Metabolism & Bioenergetics NAD+/NADH
Chromatin Reprogramming NF-KB , NAMPT, AND SIRT1