写在最前：本材料为个人整理仅供参考，一切以老师说的为准。

可能不是最全也可能不是最正确，仅供参考!

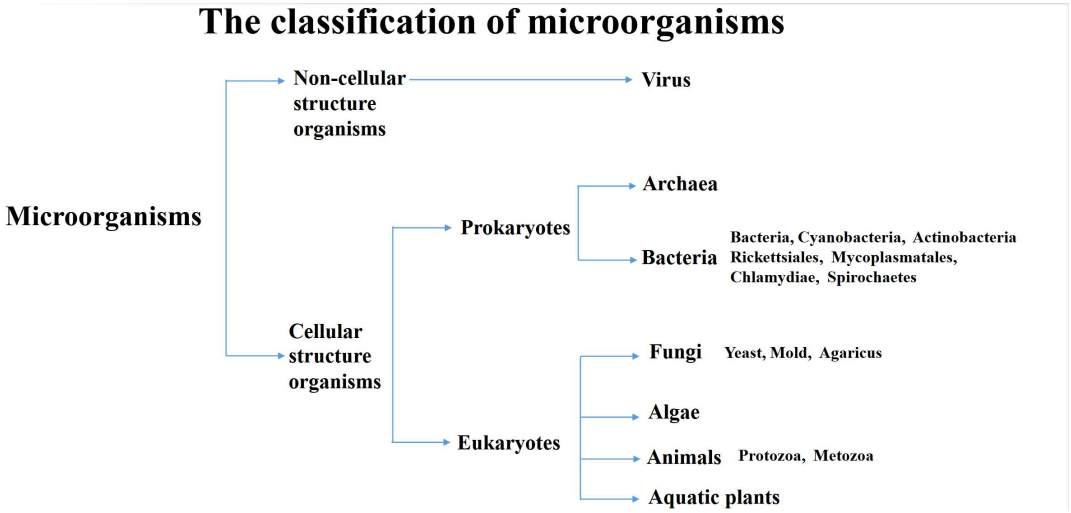
2025-2026 学年第一学期

Chapter 00 绪论

#1.微生物的四大特征（第 7 也是，以 7 为准）
Characteristics of microorganisms
a) Individually small (~μm)
b) Widely distributed and various kinds
c) Reproduce fast
d) Variability

2.关键名词解释
Sterile: free from living organisms
Inoculate: to add a biological entity into a system

3.微生物分类



4.微生物的分类法
The classification of microorganisms:
域（Domain）界（Kingdom）门（Phylum）纲（Class）
目（Order）科（Family）属（Genus）种（Species）

5.原核生物有哪些?

Prokaryotes:

- Bacteria(细菌)
- Archaea(远古细菌)
- Actinobacteria(放线菌)
- Mycoplasmatales(支原体)
- Rickettsiales(立克氏体)
- Chlamydiae(衣原体)
- Cyanobacteria(蓝细菌)

6.原核生物真核生物的比较

Features	Prokaryotic Cells	Eukaryotic Cells
True Nucleus	Absent	Present
Cell Wall Composition	Non-cellulosic and complex	Cellulosic (in plants), chitinous (in fungi), absent (in animals)
Size	3-5μm	10-20μm (except RBCs: 7μm)
Cell Cycle	Not divided into phases	Divided into proper phases
Membrane-bound Organelles	Absent	Present
Cilia	Absent	Present
Flagella Structure	The random arrangement of flagellin proteins, basal body, hook, filament	Tubulin protein, 9+2 arrangement, basal body, filament
Specialized Structures	Pilli, Fimbrae, Mesosomes, Plasmid, Inclusion Bodies	Absent
Examples	Monera kingdom (Eubacteria and Archaebacteria)	Protista (Unicellular eukaryotes), Fungi, Plantae, Animalia

*7.微生物的五大常见特点

Five Common Characteristics of Microorganisms

1. Small volume, large surface area
2. Fast absorption and conversion
3. Rapid duplication and growth
4. Strong adaptability
5. Widespread distribution and diversified species

8.活着的生物的特点

Characteristics of living system:

(1) Compartmentalization and metabolism

Cells take up nutrients from the environment, transform them and release wastes into the environment.

(2) Reproduction (growth)

Chemicals from the environment are turned into new cellsunder the genetic direction of preexisting cells.

(3) Differentiation

Some cells can form new cell structure such as a spore, usually as part of a cellular life cycle.

(4) Communication (quorum sensing)

Cells communicate or interact by means of chemicals that are released or taken up.

(5) Movements

Some cells are capable of self-propulsion.

(6) Evolution

Cells contain genes and evolve todisplay new biological properties.

Chapter 01 Virus

1. 病毒的分类

According to hosts viruses infect:根据宿主类型分类

- Bacterial viruses (Bacteriophage，噬菌体)
- Plant viruses (less studied)
- Others
- Animal viruses (well studied)

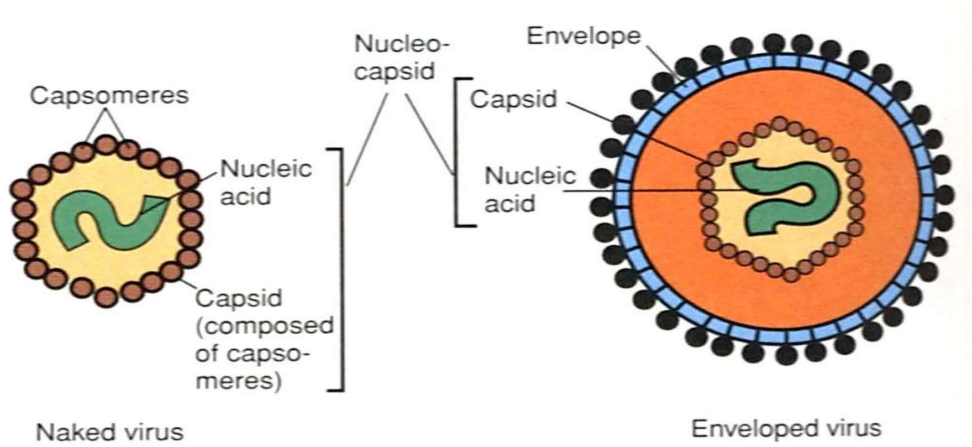
According to nucleic acid structures:根据核酸类型分类

- DNA viruses
- RNA viruses
- RNA DNA viruses

2. 病毒的大小

Virus Size: 20 nm to 300 nm

3. 病毒的结构



Viruses consist of nucleic acids, capsid (衣壳), and/or envelope (被膜).

4. 病毒的生命周期

Virus Life Cycle

1. Attachment (adsorption) of the virion to the host cell
2. Penetration (entry, injection) of the virion nucleic acid into the host cell
3. Synthesis of virus nucleic acid and protein by host cell machinery as redirected by the virus
4. Assembly of capsids and packaging of viral genomes into new virions
5. Release of new virions from the cell

5. 重要名词解释

Replication 复制 – making a copy of the DNA

Transcription 转录 – making a (usually) single strand copy of one strand of the DNA but into RNA and U for T

Translation 翻译 – changing the 'language' from nucleic acids to protein based on the sequence in the RNA

Chapter 02 Prokaryote

1.主要的 Bacteria(细菌)

Archaea(古细菌) Actinobacteria(放线菌) Mycoplasmatales(支原体)
Rickettsiales(立克氏体) Chlamydiae(衣原体) Cyanobacteria(蓝细菌) Spirochaetes(螺旋体)

2.名词解释:

Bacteria: members of a large group of unicellular microorganisms which have cell walls but lack organelles and an organized nucleus

3.细胞壁的作用

Function of cell wall

1.Protection of protoplasts from rupture caused by osmotic pressure
2.Maintain bacterial cell morphology
3.The role of porous molecular sieve
4.Provides a fulcrum for the flagella

4.革兰氏阳性阴性细胞性质对比

Gram Negative	Gram Positive
Wall thinner, about 100-150 A	Wall thick, about 200 A
Usually can see a double member structure	Usually no structures visible under EM
Smaller % as peptidoglycan	Greater % as peptidoglycan
Amino sugar % lower, 1-10%	Amino sugar % higher 10-30%
Lipid content higher, 10-20%	Lipid content lower 0-2% (with exceptions)
14-18 Major amino acids	5-7 Major amino acids
Usually diamopimelic acid	Often lysine as diamoacid
No teichoic acids	Teichoic acids

6. 细胞质膜的作用

Functions of the Cytoplasmic Membrane

1.Maintain osmotic pressure gradient and solute transfer
2.Synthetic cell wall
3.Intermediate formation
4.Matter and energy metabolism
5.Provide attachment points for the flagella

7. 名词解释

Flagellum: Organelle used for bacterial movement.

Chapter 03 Eukaryote

1. 真核微生物的种类:

Algae（藻类）Fungi（真菌）Protozoa（原生动物）Metozoa（真核动物）

■ Algae:

Phototrophic eukaryotic microorganisms;

■ Fungus:

Nonphotosynthetic eukaryotic microorganisms that contain rigid cell walls;

■ Protozoa:

Unicellular eukaryotic microorganisms that lack cell walls;

■ Metozoa:

Multicellular eukaryotic microorganisms.

*Fungi: Yeast（酵母）Mold（霉菌） Agaricus/ Mushrooms（香菇）

2. Classification of Algae

■ Chlorophyll（叶绿素）

■ Carbon Reserve Polymers

■ Cell Wall Structure

■ Type of Motility

3. The role of protozoa in the biological treatment of wastewater

原生动物在污水处理中的作用

1.Indicator organism

2.Pollutants removal

3.Promotion of the flocculation and precipitation

4. 真核生物名词解释

Eukaryota: organisms whose cells have a nucleus enclosed within a nuclear envelope.

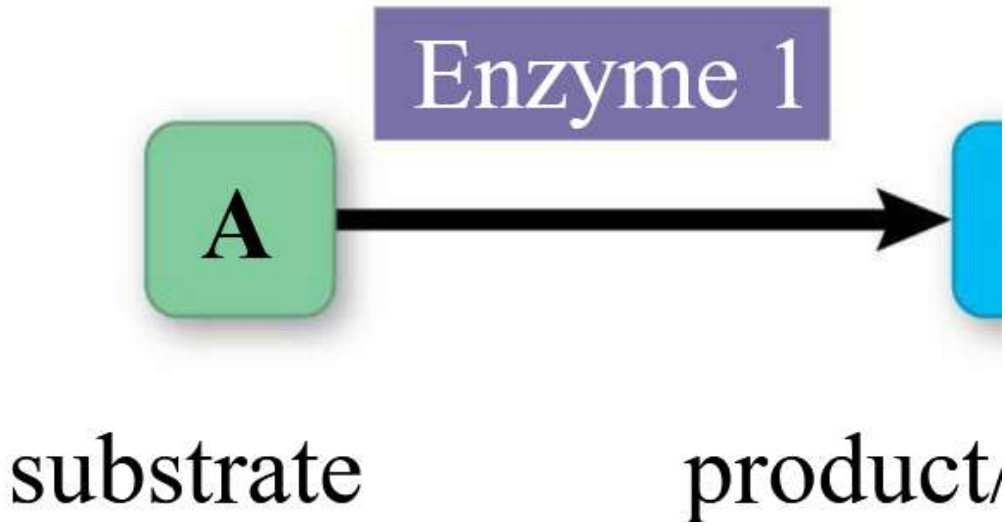
Chapter 04 Microbial physiology

1. 重要名词解释:

新陈代谢: **Metabolism** is the totality of an organism's chemical reactions

酶 **Enzymes** are a class of biological macromolecules with active sites and special conformations that are produced by cells and can play a catalytic role in vivo or in vitro including protein enzymes and nucleic acid enzyme.

2. 酶促反应的示意图：



3. 酶催化反应的原理

Enzymes speed up metabolic reactions by lowering activation energy (E_A)

4. Classification of enzymes
   1. Oxidation-reduction enzyme：氧化还原酶类
   2. Transferases：转移酶类
   3. Hydrolases：水解酶类
   4. Lyases：裂解酶类
   5. Isomerase：异构酶类
   6. Ligases (join molecules together)：合成（连接）酶类
   7. Translocases：移位酶

5. Oxidation-reduction enzyme: 氧化还原酶类反应机理

Typical reaction AH + B → A (oxidized) + BH (reduced)

6. Hydrolases：水解酶类反应机理

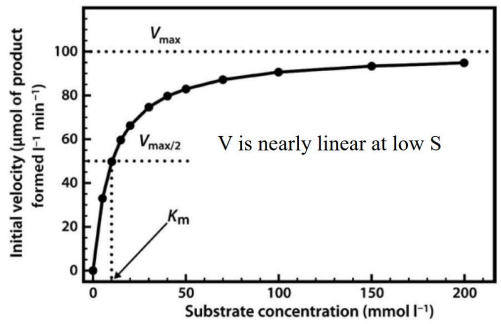
Formation of two products from a substrate by hydrolysis

$AB + H_2O \rightarrow AOH + BH$

7. 米门方程

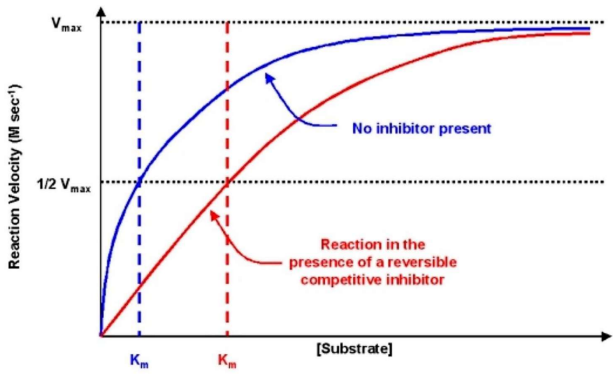
Plot of reaction velocity versus substrate concentration

反应速率与底物浓度的曲线

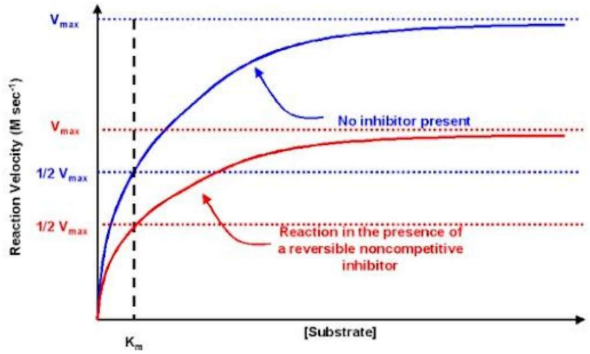


省流：K_m是 $V_{max}/2$ 时对应的底物浓度

加入竞争性抑制剂对 K_m 的影响



加入非竞争性抑制剂对 K_m 的影响



机理别管了反正也记不住。叽里咕噜一长串。

8. 细胞的化学组成

$CH_2O_{0.5}N_{0.15}$ is the chemical formula for a cell

9. Nutrients and Culture Media

(1) Water

(2) Carbon source and energy source

(3) Nitrogen sources
(4) Mineral salt
(5) Growth factors
10. 水作为营养物质的重要性
the necessary solvent and involved in some important **biochemical reaction.**重要的反应介质
Water has a good physical feature, such as **the high heat capacity**。高比热容稳定体温

11. 重要名词解释
碳源：**Carbon sources** Anything that can supply carbon nutrients for microorganism is called a carbon source
氮源：**Nitrogen sources** Anything that can supply nitrogen nutrients for microorganism is called a nitrogen source

12. 无机盐作为营养物质的重要性 Mineral salt
It constitutes cell components（细胞组成）, components of enzymes（酶的组成）, and maintains enzyme activity（维持酶活性）, regulates osmotic pressure (渗透压), hydrogen ion concentration（氢离子浓度）, redox potential (氧化还原电位), etc.

13. 超重要超难记的前后缀
Type of Energy:
Photo- energy comes from light 光能
Chemo- energy comes from chemical reactions 化能
Electron Donor:
Organo- organic (e- donor is organic, has C-H bonds) 有机
Litho- inorganic (i.e.: H2S, NH4+, Fe2+ etc) 无机
Carbon Source:
Heterotroph - organic (carbon source not CO2) 异养
Autotroph - CO2 自养

14. 氮源分类
Nitrogen (N2) ： Nitrogen-fixing microorganism
Inorganic nitrogen compound： Nitrate (硝酸盐), amine salt (氨盐)
Organic nitrogen： compound Protein, amino acid, carbamide (尿素)

15. 培养基制备步骤
Weight the constitutions of medium at a certain proportion
Dissolve the constitutions and adjust the pH value
Subpackage the solution (分装液体)
Distilled in the autoclave (高压灭菌锅)

16. 培养基分类
Different types of medium
According to the **different physical features** of the medium：根据培养基形态

Liquid medium
Solid medium
Semi-solid medium

According to the **different function and purpose** of the medium：根据培养基功能

Selective medium
Differential medium
Enriched medium

17. 物质进出细胞的方法:

The pathways of the compounds in and out the cell involve fourmain types:

simple diffusion (单纯扩散)
facilitated diffusion(促进扩散),
active Transportation(主动运输)
group translocation (基团转位)

18. 四个转移物质的方式的特点

Items	Simple diffusion	Facilitated diffusion	Active transportation	Group translocation
Carrier protein (载体蛋白)	no	yes	yes	yes
Speed (运送速度)	slow	fast	fast	fast
Direction (溶质运送方向)	High to low	High to low	Low to high	Low to high
The concentration in and out at equilibrium (平衡时内外浓度)	Equal inside and outside	Equal inside and outside	Higher inside	Higher inside
Molecules delivery (运送分子)	Non-specific	specific	specific	specific
Energy consumption (能量消耗)	no	no	yes	yes
Molecules before and after delivery (运送前后溶质分子)	Not change	Not change	Not change	Change
Carrier saturation effect (载体饱和效应)	no	yes	yes	yes
Substance similar to the solute (与溶质类似物)	no competitive	competitive	competitive	competitive
Inhibitor (运送抑制剂)	no	yes	yes	yes
Target (运送对象)	H_2O, CO_2,O_2, glycerinum (甘油), ethanol (乙醇)	SO_4^{2-}, PO_4^{2}, saccharides (eukaryotic)	Amine acid, K^+, Na^+, sulfate, phosphate	Glucose (葡萄糖), fructose (果糖), purine (嘌呤)

19. 呼吸类型 Respiration types:

Fermentation 发酵
Aerobic respiration 有氧呼吸
Anaerobic respiration 无氧呼吸

20. 能量来源 The center of energy transfer：ATP(adenosine triphosphate，腺苷三磷酸)

Substrate level phosphorylation (基质水平磷酸化，anaerobic or facultative microorganisms)
Oxidative phosphorylation (氧化磷酸化)
Photophosphorylation (光合磷酸化)
The hydrolysis of 1 mole of ATP releases 31.8KJ/mol of energy

21. 发酵特点#感觉不考默写 选择会出现

No external electron acceptor
Organic matter is partially oxidized and the intermediate product is the final electron acceptor

Glycolysis（糖酵解）EMP process
Low energy utilization rate (26%)
Substrate for fermentation
22. 有氧呼吸特点#感觉不考默写 选择/计算会出现
O_2 is the final electron acceptor
TCA cycle
Energy balance
  1mol of glucose can be converted to 38mol ATP
  High conversion efficiency (42%)
Electron transport system
  Transfer electrons
  Synthesize ATP
Endogenous and exogenous respiration

23. 无氧呼吸特点#感觉不考默写 选择会出现
Anaerobic respiration
NO^{3-} is the final electron acceptor
SO_4^{2-} is used as the final electron acceptor
CO_2 is used as the final electron acceptor

Chapter 05 Microbial growth

1. 平板计数法相关#感觉不考默写 选择会出现
Plate (or viable (living)) counts
Problems:
1) Assume each colony comes from one cell
2) Not all bacteria can be grown on solid media or in isolation
3) Colony number can change during long incubations

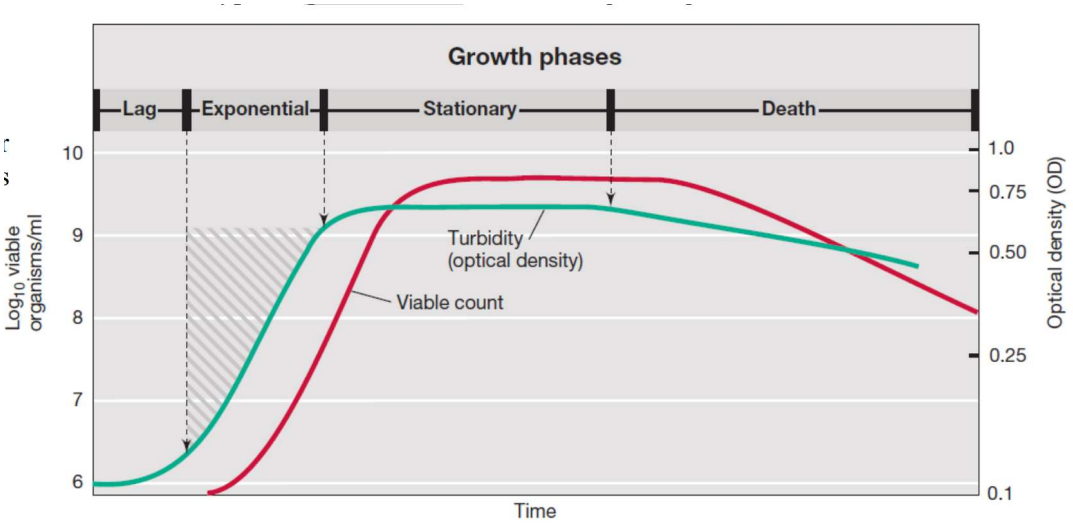
2. 血细胞计数板#感觉不考默写 选择会出现
Problems:
1) Can't tell live and dead cells apart
2) Need fairly high density of cells
3) Swimming cells need to be stopped

3. 电子计数#感觉不考默写 选择会出现
Problems:
1) Can't tell live from dead
2) Clumping（聚集）can be a problem
3) Some inert (non-living) particles will be counted

4. 可见光计数#感觉不考默写 选择会出现
Abs = $\log(I/I_o)$

This measures absorbance* which means that the values decrease as cell numbers increase which is not consistent what we want to measure, which is an increase in cell number.
So instead an optical density (OD) measurement is determined which is log10(Io/I). This number increases as cell number increases, since the I value gets smaller, and is the value reported by a spectrophotometer.

5. 细菌生长曲线



6. 水活度概念

Water activity: The ratio of the vapor pressure of the air in equilibrium with a substance or solution to the vapor pressure of pure water.

Chapter 06 Bioengetics

1. 能量转移

Energy is harnessed through a directed flow of electrons (e-) from an Electron Donor to an Electron Acceptor

Free energy (G): energy that is available to do work (not released as heat)

$\Delta G^{0'}$ = change in free energy at standard condition and pH 7

exergonic if $\Delta G^{0'} < 0$ 能自发反应

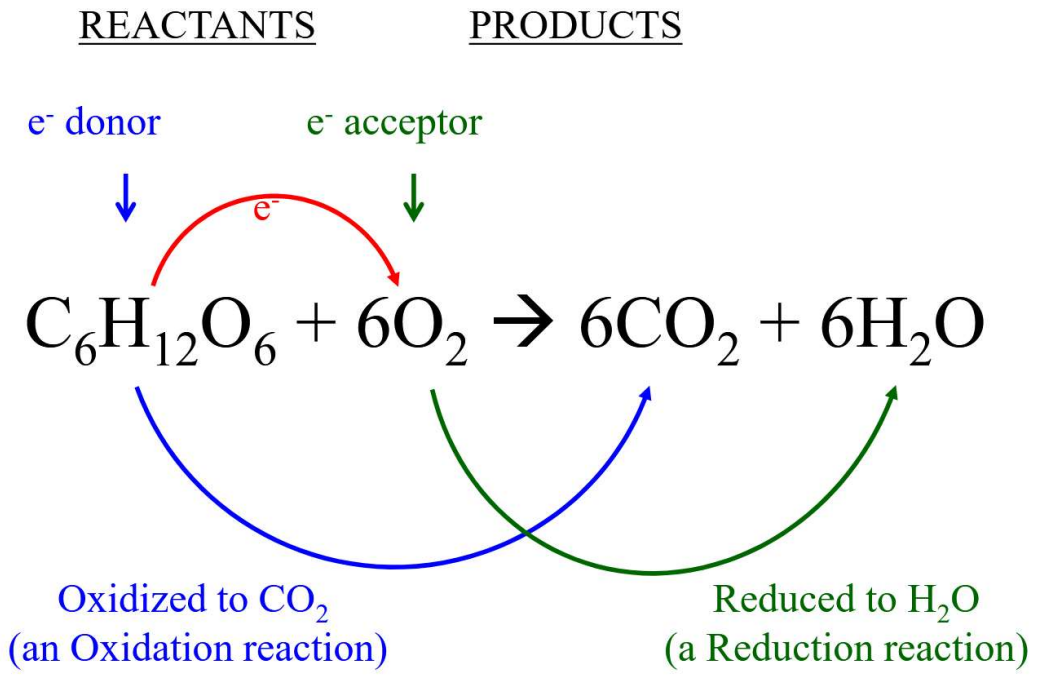
endergonic if $\Delta G^{0'} > 0$ 不自发反应

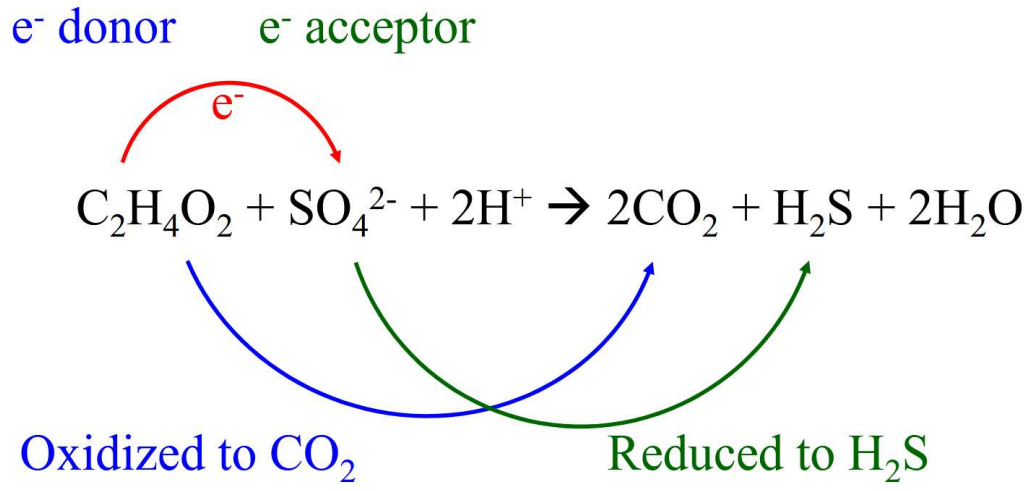
2. 氧化还原相关概念

Redox reactions: reactions in which atoms have their oxidation state changed, generally through transfer of electrons from an Electron Donor to an Electron Acceptor

Reduction is when an electron is added to an atom (the charge is reduced, i.e. it becomes more negative)

Oxidation is when an electron is removed





3. Reduction potential ($E^{0'}$):还原电位

– Tendency to donate electrons (e^-)
– Measured in units of volts (V)
– Substances can be either

e- donors or acceptors

– Substance with more negative E0' will donate electrons

还原电位较低的失去电子

4. 计算反应中的 ΔG

aA + bB → cC + dD

$\Delta G^{0'} = [(c \times C) + (d \times D)] - [(a \times A) + (b \times B)]$

5. 计算反应ΔG'

$\Delta G' = \Delta G^{0'} + RT \ln K$

aA + bB ⇌ cC + dD

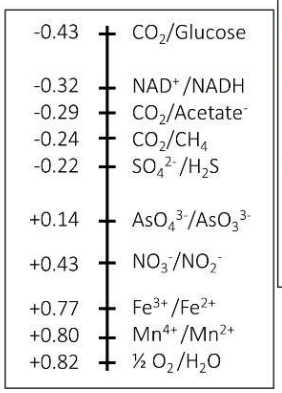
$K = [C]^c[D]^d / [A]^a[B]^b$

6. ΔG'和$\Delta G^{0'}$的关系 #仅为例题分析

Is life on mars possible?

$CH_4 + SO_4^{2-} + 2H^+ \rightarrow H_2S + CO_2 + 2H_2O$

a) Yes
b) No
c) Probably depends on the concentration of CH_4



	kJ/moles
H_2	0
CO_2	-394
SO_4^{2-}	-745
H^+	-40
CH_4	-51
H_2S	-28
H_2O	-237

由计算可得

$\Delta G^{0'}$小于 0，应为可以自发反应，但是 mars 的温度比标准值（地球）低

即$\Delta G' = \Delta G^{0'} + RT \ln K > \Delta G^{0'}$，就不一定小于 0 了，具体大于还是小于 0 要看 K（即浓度商），所以反应能否自发进行要看 CH_4 的浓度。选 c

7. Metabolism has two components: 新陈代谢的两种类型

Catabolism 异化作用（分解代谢）

- Generate reducing power (ie: NADH, NADPH, $FADH_2$)
- Generate energy in the form of high energy bonds (ie: ATP)
- Generate building blocks needed for anabolism

Anabolism 同化作用

- biosynthetic reactions (make cellular material)

8. ATP 的定义

What is ATP?

- The universal energy carrier
- Provides the energy that drives many enzymes

9. 常见的电子供体分子 #感觉不考默写 选择会出现

Molecules commonly used to transfer electrons in cells

$NADH \rightleftharpoons NAD^+ + H^+ + 2e^-$

$NADPH \rightleftharpoons NADP^+ + H^+ + 2e^-$

$FADH_2 \rightleftharpoons FAD + 2H^+ + 2e^-$

10. ATP 的来源 #小标题可能默写 小小标题应该只考选择

How is ATP generated?

- Substrate Level Phosphorylation 底物磷酸化
  - Fermentation 发酵
  - No external e- acceptor 没有电子受体
  - ATP synthesized from a high energy intermediate 由高能中间体合成 ATP
- Oxidative Phosphorylation (i.e. Electron Transport) 氧化磷酸化（即电子传递）
  - Respiration (anaerobic or aerobic) 呼吸
  - Requires an external e- acceptor 需要外部电子受体
  - ATP is produced from the proton motive force (PMF) 由质子动力（PMF）产生 ATP
- Photophosphorylation 光合磷酸化
  - Phototrophy (oxygenic or anoxygenic) 光合作用（有氧或无氧）
  - May or may not require an external e- acceptor 可能需要也可能不需要外部电子受体
  - ATP is produced from the proton motive force (PMF) 由质子动力（PMF）产生 ATP

11. 三个反应能量的重要公式 #感觉不考默写 计算会出现

$\Delta G^{0'} = -nF\Delta E_o'$

The energy available increases with the difference in reduction potential (Eo') between the electron donor and electron acceptor.

可用能量随着电子供体和电子受体之间还原电位（Eo'）的差异而增加。

$\Delta G^{0'} = \Sigma G_f^\circ$ Products - ΣG_f° Reactants

The energy available can also be described as the total energy left over in your products minus the amount you started with in your reactants.

可用能量也可以描述为产品中剩余的总能量减去反应物中初始的能量。

$\Delta G' = \Delta G_{0'} + RT \ln K$

The energy available changes depending on the concentrations of reactants and products, becoming more favorable when reactants are abundant and products are scarce.

可用能量会随着反应物和产物的浓度变化而变化，当反应物充足而产物稀缺时，能量条件会变得更为有利。

Chapter 07 Fermentation & Respiration

1. 糖酵解 #感觉不考默写 选择会出现

Glycolysis

- a common pathway for catabolism of glucose
- glucose is the electron donor
- anaerobic (no O2 required)
- ATP is generated by Substrate Level Phosphorylation
- Generates 2 ATP, 2 NADH, and 2 pyruvate ($C_3H_3O_3$)

核心反应式：Glucose → 2 ATP, 2 NADH, 2 Pyruvate

2. 常见发酵产物及制品 #感觉不考默写 选择会出现

Common fermentation products include:

- CO_2: bread
- Acetic acid: vinegar, soy sauce, cheeses
- Ethanol : beer, wine, spirits
- Lactic acid : yogurt, sourdough bread, sauerkraut, pickles, sausages, cheeses, sour cream, etc
- Propionic acid : cheeses, sausages
- Butyric acid : rancid butter

3. 三羧酸循环 #感觉不考默写 选择会出现

Citric acid Cycle

- Pyruvate (C_3) enters
- Generates: 3 CO_2, 1 ATP, 1 $FADH_2$, 4NADH

4. 发酵和呼吸的能量变化

Process	Substrate Level Phosphorylation	Oxidative Phosphorylation
Fermentation (glucose → 2 lactate)	2 ATP mol^{-1} glucose	NA
Aerobic Respiration (glucose → 6 CO_2)	4 ATP* mol^{-1} glucose	34 ATP mol^{-1} glucose

* (2 from glycolysis + 2 from Citric Acid Cycle)

个人解读：发酵不需要氧气，所以无氧条件（底物磷酸化）有 2molATP/mol 葡萄糖产生，没有氧化磷酸化。

有氧呼吸在无氧条件下先 2molATP 来自糖酵解 2molATP 来自三羧酸循环，（也可以说这两步不需要氧气参与）（底物磷酸化）；有氧气参与的情况下，底物彻底氧化产生 CO_2，额外产生了 34molATP（氧化磷酸化）

Chapter 09 Microbial carbon and nitrogen cycles

1. 水处理 #感觉不考默写 选择会出现

Wastewater Treatment

Goals:

eliminate pathogens from water

reduce biological oxygen demand (BOD),

remove nutrients and contaminants (e.g. N, P, metals)

Stages:

Primary Treatment (Physical): -screens, sedimentation,

Secondary Treatment (Biological) : -activated sludge

-anaerobic digestion

Tertiary Treatment (Chemical) : -e.g. chlorination, UV, chemical flocculation

2. 生物圈循环的特点#感觉不考默写 选择会出现

Features of Biogeochemical Cycles

- Each step is mediated by a set of organisms
- Cycling replenishes reactants over time
- Cycling couples the oxidation and reduction of reactants, and this typically requires coupling of aerobic and anaerobic processes
- Steps can be driven by Assimilatory or Dissimilatory processes

Assimilatory: molecule is assimilated into biomass (anabolic reactions)（同化作用）

Dissimilatory: molecule is transformed but nor assimilated (carabolic reactions)（异化作用）

3. 生物氮循环 #感觉不考默写 选择会出现

The Nitrogen Cycle

Animals

Organic N (protein) → Organic N (e.g. protein, urea)

Organic N (protein) → NH_4^+

Plants

NO_3^- → Organic N (protein)

NH_4^+ → Organic N (protein)

4. 硝化作用

Nitrification

Metabolism: Chemo-litho-autotrophs, obligate aerobes

Electron Donors: NH_4^+ or NO_2^-

Electron Acceptors: O_2

Carbon Sources: CO_2 (typically)

Habitat: widespread in oxic soil and aquatic habitats

5. 生物氮循环的主要部分

Nitrogen fixation (固氮) — Nitrogen fixation bacteria

$N_2 + 8\ H^+ + 8\ e^- \rightarrow 2\ NH_3 + H_2$ — Soil, natural water systems and so on.

Ammonia oxidization (氨氧化) — Ammonia oxidization bacteria/archaea (AOB/AOA)

$2\ NH_4^+ + 3\ O_2 \rightarrow 2\ NO_2^- + 2\ H_2O + 4\ H^+$ — Seawater (including deep sea), soil, wastewater

Nitrification (硝化) — Nitrifying bacteria (NOB)

$2\ NO_2^- + O_2 \rightarrow 2\ NO_3^-$ — Seawater (including deep sea), soil, wastewater

Denitrification (脱氮/反硝化) — Denitrifier (bacteria)

$NO_3^- \rightarrow NO_2^- \rightarrow NO \rightarrow \boxed{N_2O} \rightarrow N_2$ — Seawater (including deep sea), soil, wastewater

Anammox (full name? 厌氧氨氧化) — *Planctomycetes* (浮霉菌门bacteria)

$NH_4^+ + NO_2^- \rightarrow N_2 + 2H_2O$ — Sediment, wastewater