

The main types of nutrition in microorganisms

Learning Objective

- Identify the main types of nutrition in microorganisms

Success criteria

1. Analyse information about microbes and name them.

2. Name and identify correctly at least four types of nutrition.

Terminology

- bacteria, yeast, fungus, dose, continuous growth curve, a lag phase, an exponential / lag phase, stationary phase, a dead phase, monitors, viable cell microorganism, optical density, seeding
- Growth factor, Trace elements, Macronutritions, Nitrogen, carbohydrates, Hydrogen, Phosphorus, oxygen, Sulfur, Potassium, Calcium, glucose, carbon dioxide, water, pH, temperature, mineral ions
- Nutrient supply, agar medium/growth medium, aeration
- Aseptic techniques, sterile, streak pattern

Classification of Nutrition in Microorganisms

Carbon sources – Autotrophs – CO₂ sole or principal source

Heterotrophs – reduced, preformed organic molecules

Energy sources

Phototrophs – light

Chemotrophs – oxidation of chemical compounds
(organic/inorganic)

Electrons/Hydrogen sources

Lithotrophs – use reduced inorganic compounds as electron donors

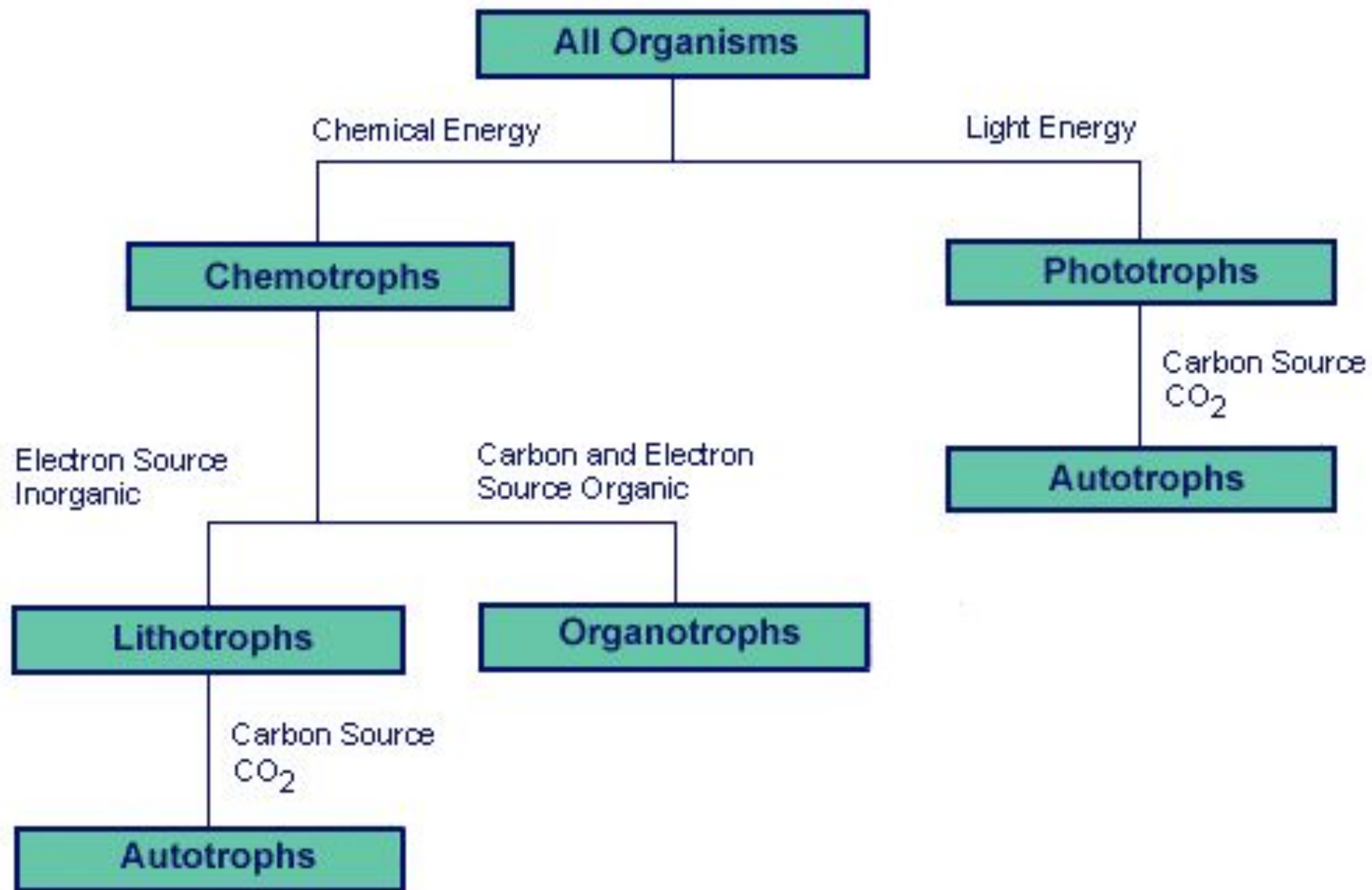
Organotrophs – organic compounds/molecules

“mixotrophs: they can alter their metabolic patterns in response to the particular environment.

All bacteria require two things for growth:

1) A source of energy

**2) A source of matter for building
additional cells: C, O, H, N, S, P, trace
minerals.**



Nutrient Required for Growth

Carbon – heterotrophs: glucose, fatty acids, alcohols, hydrocarbons...

Nitrogen – organic: amino acids, peptides, proteins

inorganic: ammonium salts and nitrates

Water – chemical reactions

Growth factors, Vitamins, Mineral salts – positive ions: calcium, potassium, sodium, B vitamins, some in TRACE (small) amounts

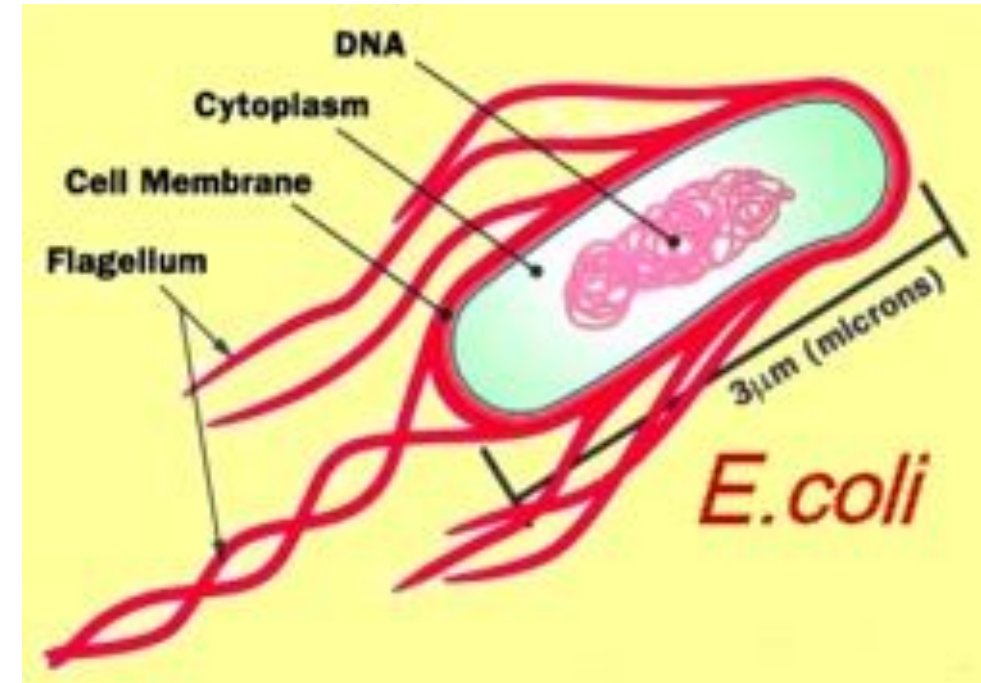
Energy – chemical or light

chemotrophs-chemical energy – glucose

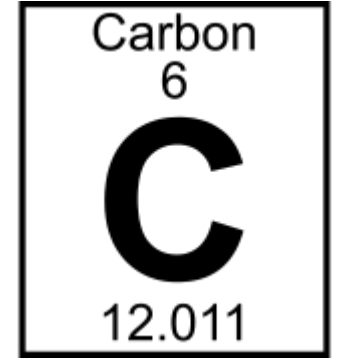
phototrophic – light energy: blue green algae bacteria

Elemental Assay of E. coli (dry weight)

- 50% carbon
- 20% oxygen
- 14% nitrogen
- 8% hydrogen
- 3% phosphorus
- 2% sulfur
- 2% potassium
- 0.05% calcium, magnesium, chlorine
- 0.2% iron
- 0.3% trace elements

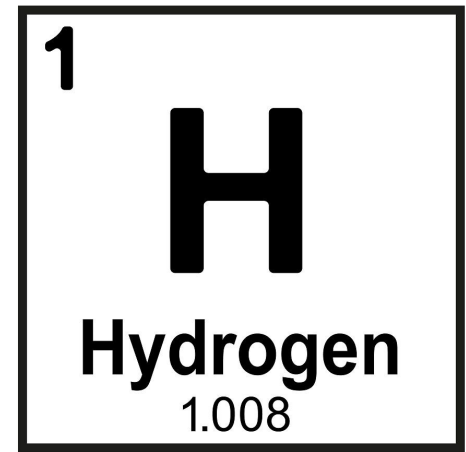


Carbon



- **the backbone of functional biological molecules:** cells vary in their ability to synthesize all of their carbon compounds. Range of carbon compounds utilized: CO, CH₄, to complex organic compounds.

Hydrogen



- **structural molecule, participant in process of energy generation.**

Protons (H⁺) involved in ATP production, CO₂ reduction, anaerobic and aerobic respiration.

Nitrogen

- **in amino acids, nucleic acids, membranes, cell walls, and most macromolecules.** Most free-living microbes assimilate ammonia from their environment or reduce nitrate. An array of microbial types can "fix" atmospheric nitrogen.

7
N
Nitrogen
14.007
<small>www.TeachersParadise.net</small>

Sulfur

sulfur
16
S
32.065

- **in certain amino acids, some B-vitamins (biotin and thiamine).**
Reduced inorganic sulfur (e.g. H₂S) used as energy source for *thiobacilli*. Sulfur serves as terminal electron acceptor in some Archaea.

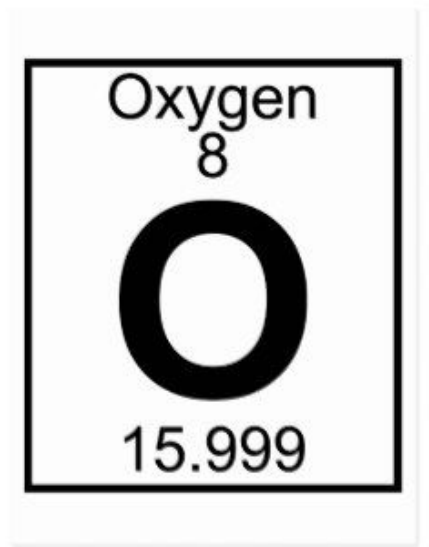
Phosphorus

- a constituent of high energy compounds (ATP), phospholipids in membranes, nucleic acids.

phosphorus
15
P
30.974

Oxygen

- **equal amounts in aerobes and anaerobes**, but free oxygen toxic to anaerobes, so they obtain it in **a combined form from the substrate.**



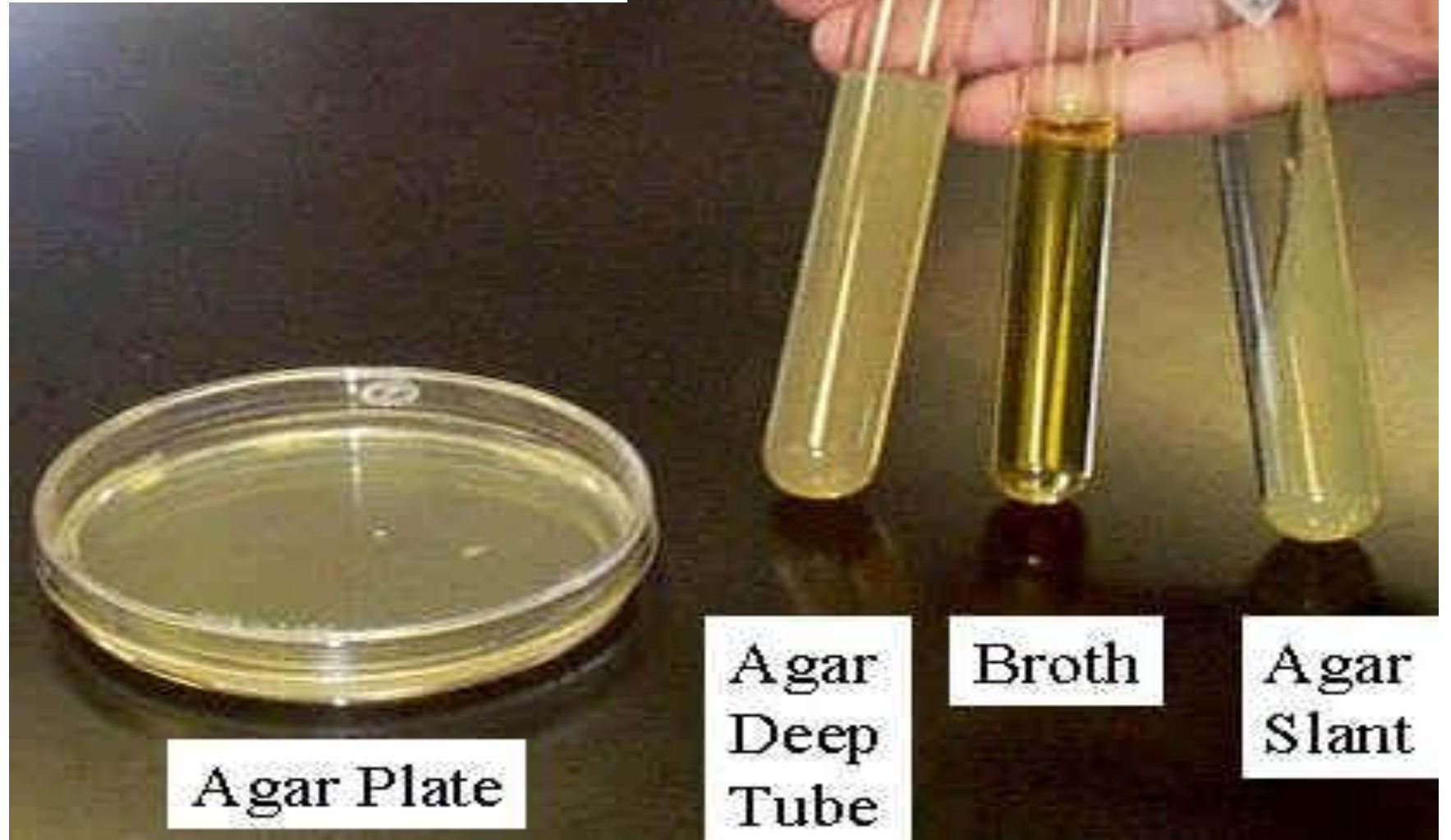
Trace elements, though not required in large amounts, are essential for cellular growth:

- K^+ Principle cellular counterion
- Mg^{++} DNA polymerase
- Ca^{++} Intracellular signalling, wall structure
- Fe^{++} Cytochromes
- Mn^{++} PsII, photosynthesis
- Co^{++} Vitamin B12 constituent (methylations)
- Cu^{++} Superoxide dimutase
- Zn^{++} Some DNA binding proteins

Organic Growth Factors

- Organic Growth Factors are essential organic compounds that an organism is unable to synthesize. They must be obtained directly from the environment.
- Examples: **Vitamins, Amino acids, Purines, pyrimidines**

Types of AGAR Media



Agar Plate

Agar
Deep
Tube

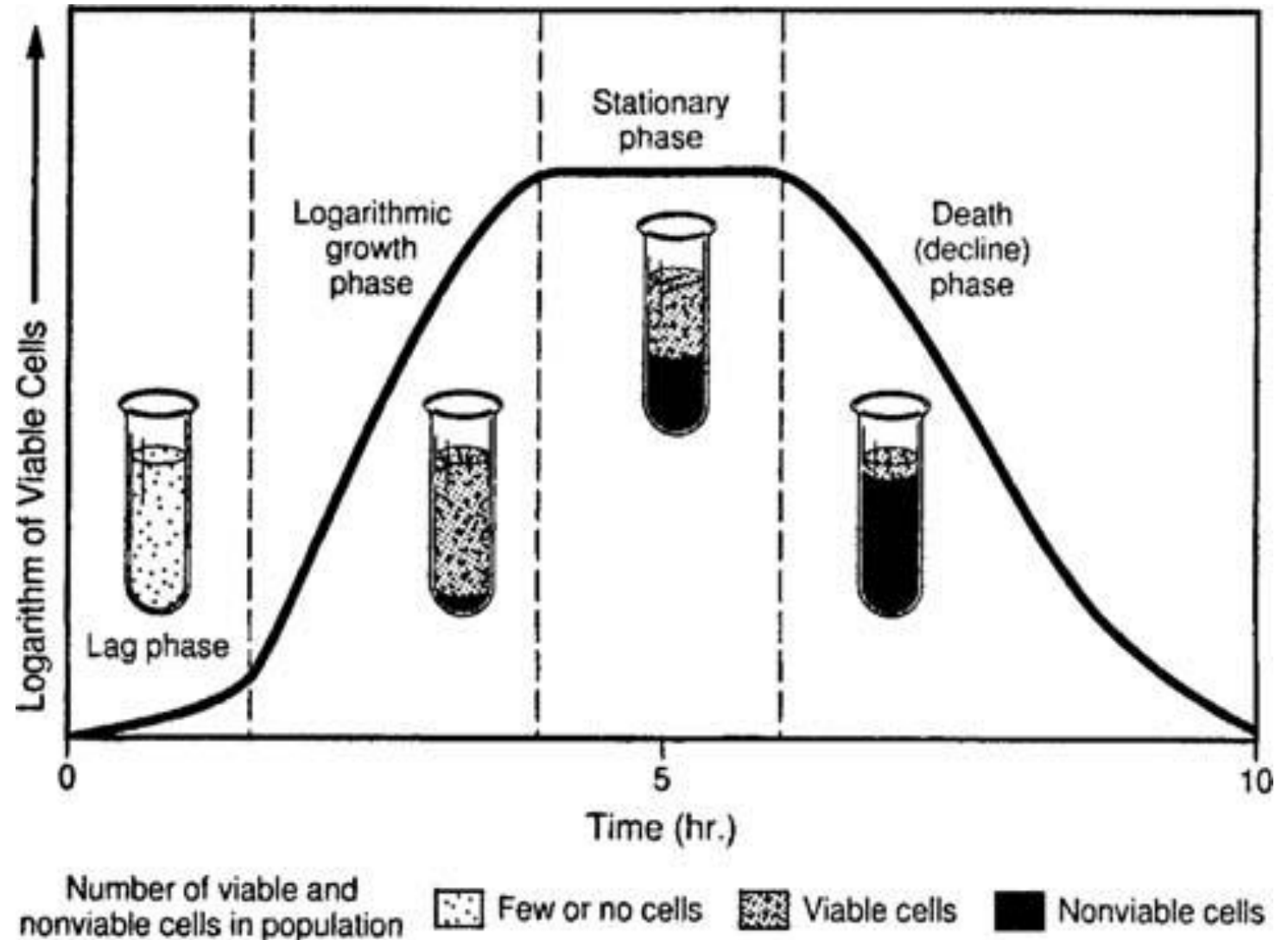
Broth

Agar
Slant

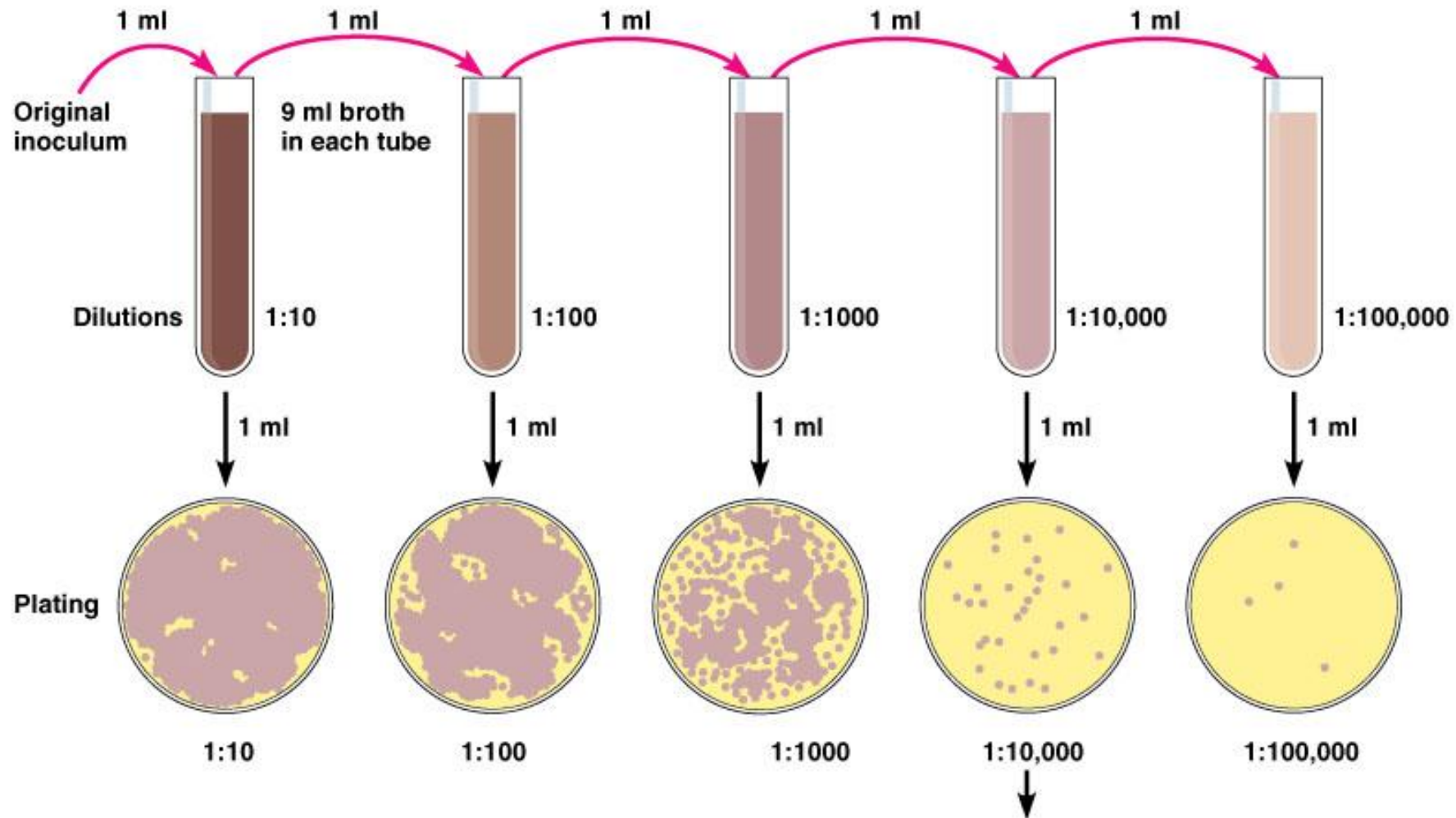
Liquid agar cultures of bacteria at the different stages of growth.

What the limiting factors a time = 4.5 – 5.5 hours?

What is happening to the culture at time = 5.5-10 hours?



Serial Dilutions are used to reduce the number of bacterial colonies from liquid agar culture so they may be easily counted.

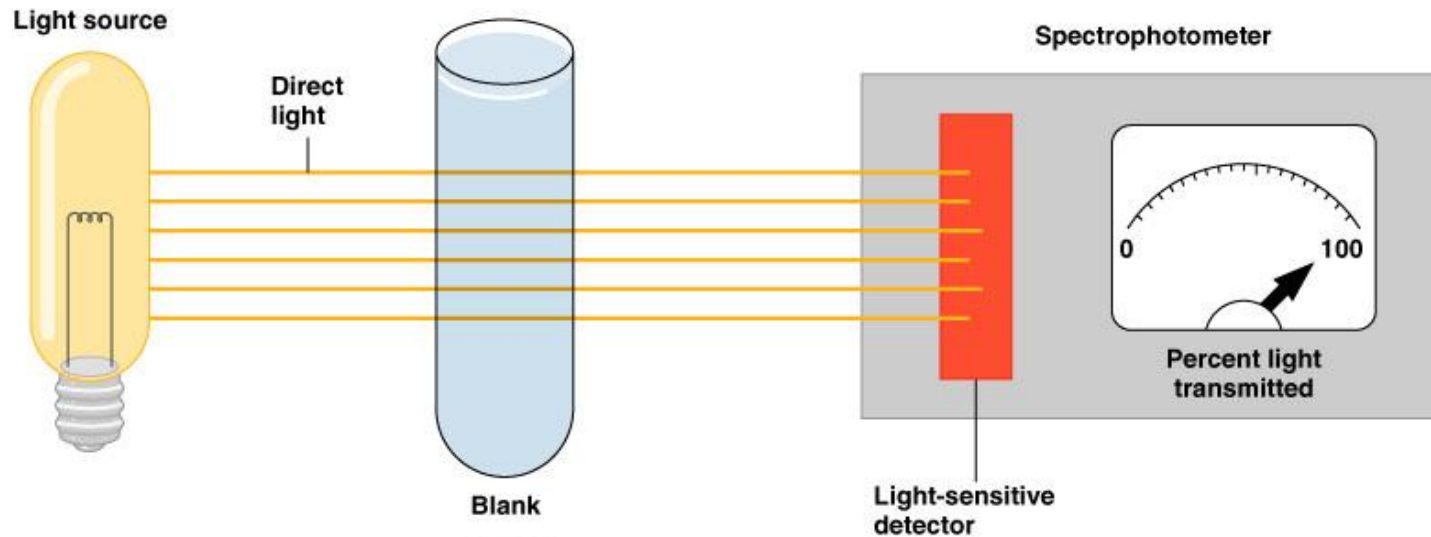


Calculation: Number of colonies on plate \times reciprocal of dilution of sample = number of bacteria/ml
(For example, if 32 colonies are on a plate of $1/10,000$ dilution, then the count is $32 \times 10,000 = 320,000/\text{ml}$ in sample.)

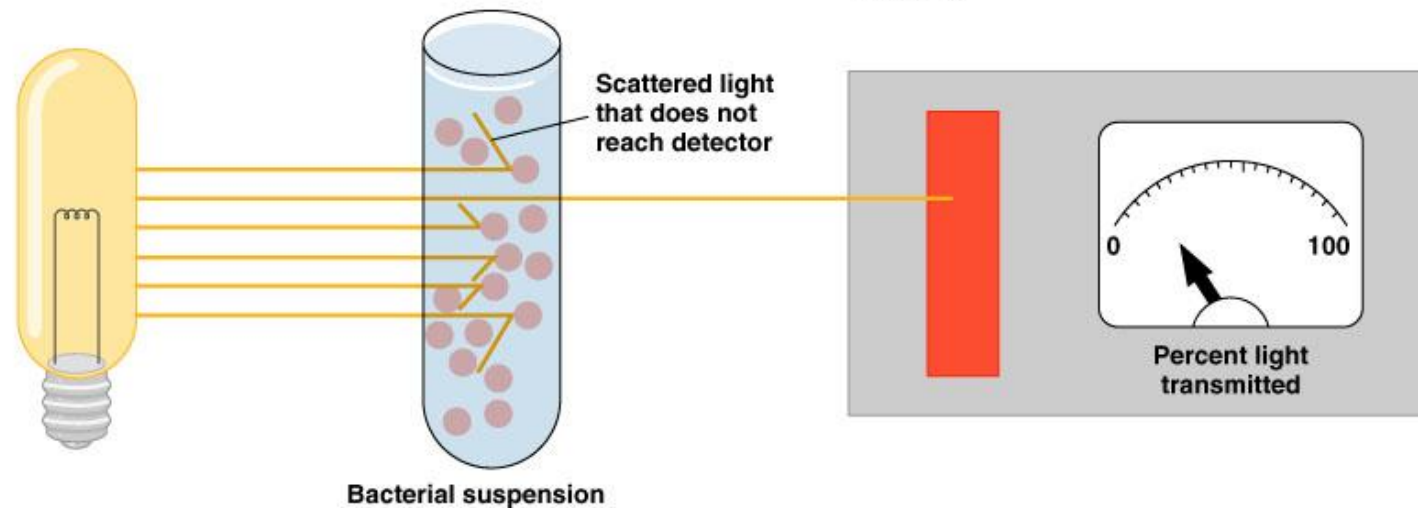
Spectrophotometer or a colorimeter measures transmission of light

Used to measure 'turbidity'
concentration of bacterial in solution

100 % Transmittance
0 % Absorbance



20 % Transmittance
80 % Absorbance



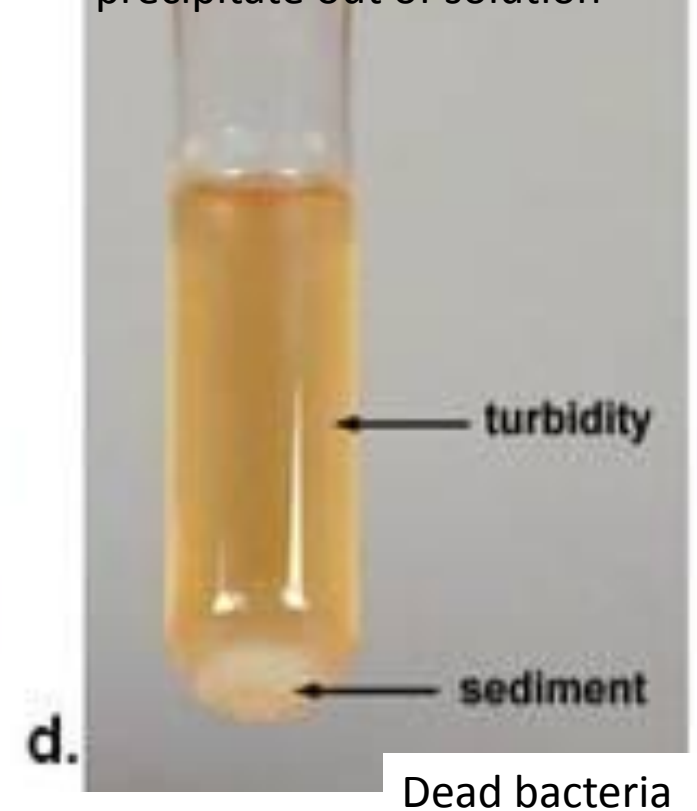
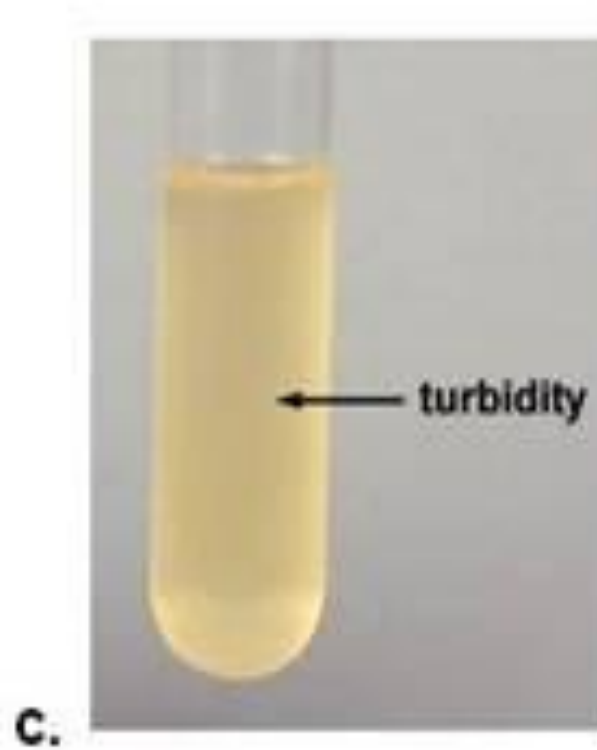
Turbidity – the cloudiness shows bacterial growth

Sterile Broth

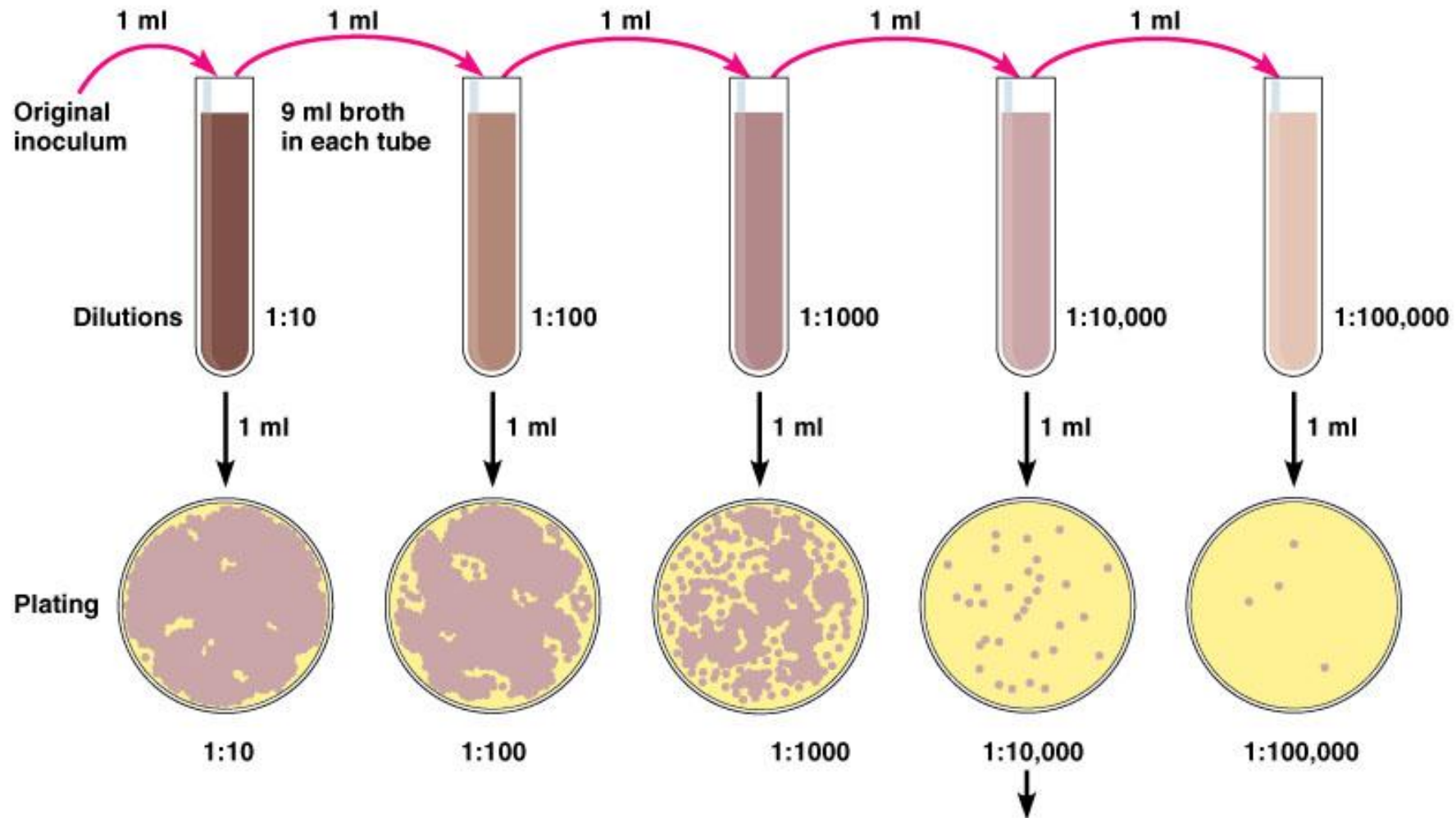
Slight turbidity
-some bacteria

Significant turbidity
-lots of bacteria

Turbidity and Sediment
-death phase – dead bacteria
precipitate out of solution



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Practical: **Plate it on different nutrient agar dishes**

1- Nutrient closed petri dish

2- No nutrient closed petri dish

3- Glucose closed petri dish

4 – No glucose closed petri dish

5 – Nutrient open petri dish

6 - No nutrient open petri dish

72 hours in incubator or 72 hours covered in warm part of room.

Success criteria

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<http://oregonstate.edu/instruct/mb302/field/Lecture12.htm>