Classification of microorganisms

Chapter 10
BIO 220

Taxonomy

- Is the study of classification
  - Organisms are classified based on relatedness to each other

<table>
<thead>
<tr>
<th>Characteristics of Archaea, Bacteria, and Eukarya</th>
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</thead>
<tbody>
<tr>
<td><strong>Archaea</strong></td>
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<tr>
<td>Sulfate sp.</td>
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<tr>
<td><strong>Cell Wall</strong></td>
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<tr>
<td><strong>Membrane Lipids</strong></td>
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<tr>
<td><strong>Amino Acid in Protein Synthesis</strong></td>
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<tr>
<td><strong>Antibiotic Sensitivity</strong></td>
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<tr>
<td><strong>DNA Loop</strong></td>
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<tr>
<td><strong>Common Arm of DNA</strong></td>
</tr>
</tbody>
</table>

Fig. 10.1

KEY CONCEPTS

- All organisms evolved from cells that formed over 3 billion years ago.
- The DNA passed on from ancestors is described as conserved.
- The domain Eukarya includes the kingdoms Fungi, Plantae, and Animalia, as well as protists. The domain Bacteria and Archaea are prokaryotes.
Species

- Binomial nomenclature for species identification
- A eukaryotic species is a group of closely related organisms that breed among themselves.
- A prokaryotic species is a population of cells with similar characteristics.

Classification of microorganisms

- Morphological characteristics
  - Cell morphology
  - Differences in endospores, flagella
  - Colony morphology
- Differential stains
Classification of microorganisms

- Biochemical tests
  - Based on differences in enzymatic make up
  - Fermentation of sugars, catalase test, oxidase test, IMViC
  - Can help distinguish between closely related bacteria

Use of metabolic characteristics

Fig. 10.8 Dichotomous key example

Classification of microorganisms

- Biochemical tests
  - Based on differences in enzymatic make up
  - Fermentation of sugars, catalase test, oxidase test, IMViC
  - Use of selective and differential media
  - Rapid identification methods aka numerical identification (several biochemical tests performed simultaneously, i.e. for enteric bacteria)
  - Also called numerical identification

Fig. 10.9
Classification of microorganisms

• Serological testing
  – Antibodies are formed against bacteria that make it into an animal body
  – Many of the antibodies are available commercially as a solution (antiserum)
  – Test unknown bacterium against known antiserum
  – Can be used to distinguish between strains (serovars or serotypes)
    • H, O, and K antigens

Slide agglutination test

Enzyme-linked immunosorbent assay (ELISA)

(a) A technician uses a microplate to add samples to a microplate for an ELISA.
(b) ELISA results are then read by the computer scanner.

Known antibodies are placed in and adhere to the wells of the microplate, add bacteria to each well.
Western blots

Classification of microorganisms

- Phage typing
  - A test that determines what phages a bacterium is susceptible to
  - Phages usually infect only members of a particular species, or even particular strains within a species
  - If two bacterial organisms can be parasitized by the same phage, the bacterial host cells must share surface antigens and therefore be similar

-- Phage typing of Salmonella

Phage typing of Salmonella

Classification of microorganisms

- Fatty acid profiles
  - Fatty acid synthesis constant for a particular species
  - FAME (fatty acid methyl ester) – fatty acid profiles
  - Can compare results to fatty acid profiles of known organisms
- Flow cytometry
Classification of microorganisms

- DNA base composition
  - Theoretically, the base composition of a single species is a fixed property
  - A comparison of the G+C content of different microbes can give us an idea about relatedness
    - If there is a difference of more than 10% in their percentage of G+C pairs, the microbes are probably not related
    - However, similarities in percentages are not a guarantee that the organisms are closely related

- DNA fingerprinting
  - Subjecting a molecule of DNA to a restriction enzyme digest results in production of restriction fragments (RFLPs)
  - Comparing the number and size of RFLPs from different organisms provides information about genetic similarities and differences
  - The more similar the patterns (fingerprints), the more closely related the organisms are likely to be

**Fig. 10.14**

Classification of microorganisms

- Nucleic acid amplification tests (NAATs)
  - Helpful if cannot culture the microbe by conventional means
  - A means by which small amounts of microbial DNA can be amplified to levels that can be assessed via gel electrophoresis
  - Makes use of various types of PCR
  - If a primer for a specific microbe is used, the presence of amplified DNA indicates that the microbe is present
Classification of microorganisms

• Nucleic acid hybridization
  – Background: If denature DNA and then cool it, the complementary nucleotide strands will reunite due to complementary base pairing
  – If two species are related, a major portion of their nucleic acid sequences will also be similar
  – The greater the degree of hybridization, the greater the degree of relatedness
  – Can perform with RNA and RNA/DNA combinations

DNA-DNA hybridization

Fig. 10.15

DNA probe for identifying bacteria

Fig. 10.16

DNA chips (microarrays)

Fig. 10.17