

# Traceability of Testing Laboratory Measurements

(Moving Forward without Losing  
Sight of Where We Have Been)



# ISO/IEC 17025 and NELAC



- Calibrate equipment and make measurements traceable to SI
  - SI = International System of Units
- If traceability to SI not possible or relevant, then establish traceability to certified reference materials, specified methods, or consensus standards
  - ISO = International Organization for Standardization
  - IEC = International Electrotechnical Commission
  - NELAC = National Environmental Laboratory Accreditation Conference



# Derived Units



- Volume
  - Liter (length-cubed)
- Concentration
  - mg/L
  - part per million (by weight or volume)
- Conductivity
  - $\text{ampere}^2 \text{ sec}^3 / \text{kg m}^3$

# Radiochemistry Measurements



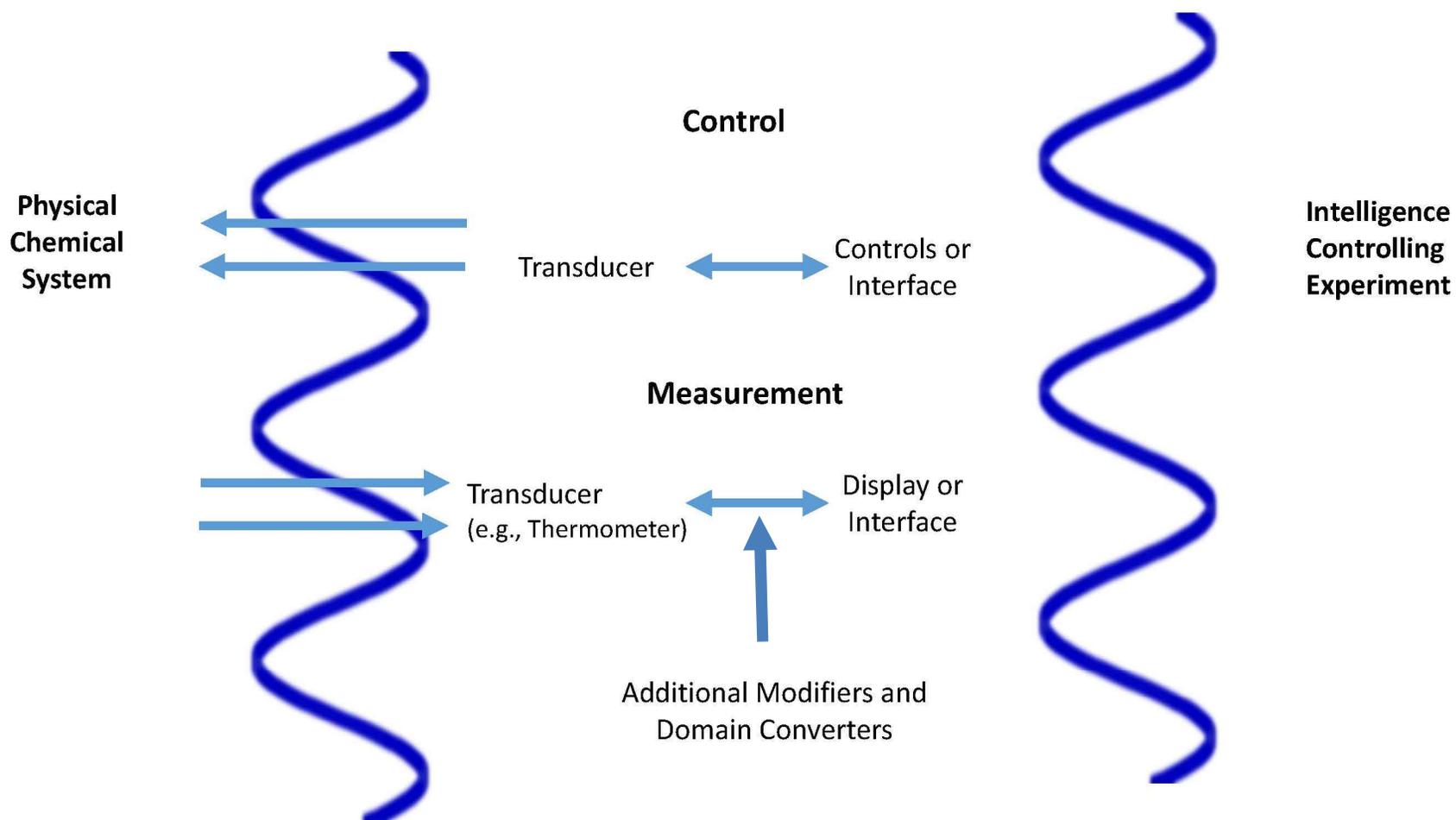
- Might be the most easily traceable to SI units
- Becquerel = disintegrations / sec
- Radionuclide determines half-life but not activity
  - Secular equilibrium
  - Energy (quantized)

# ANSI N42.22

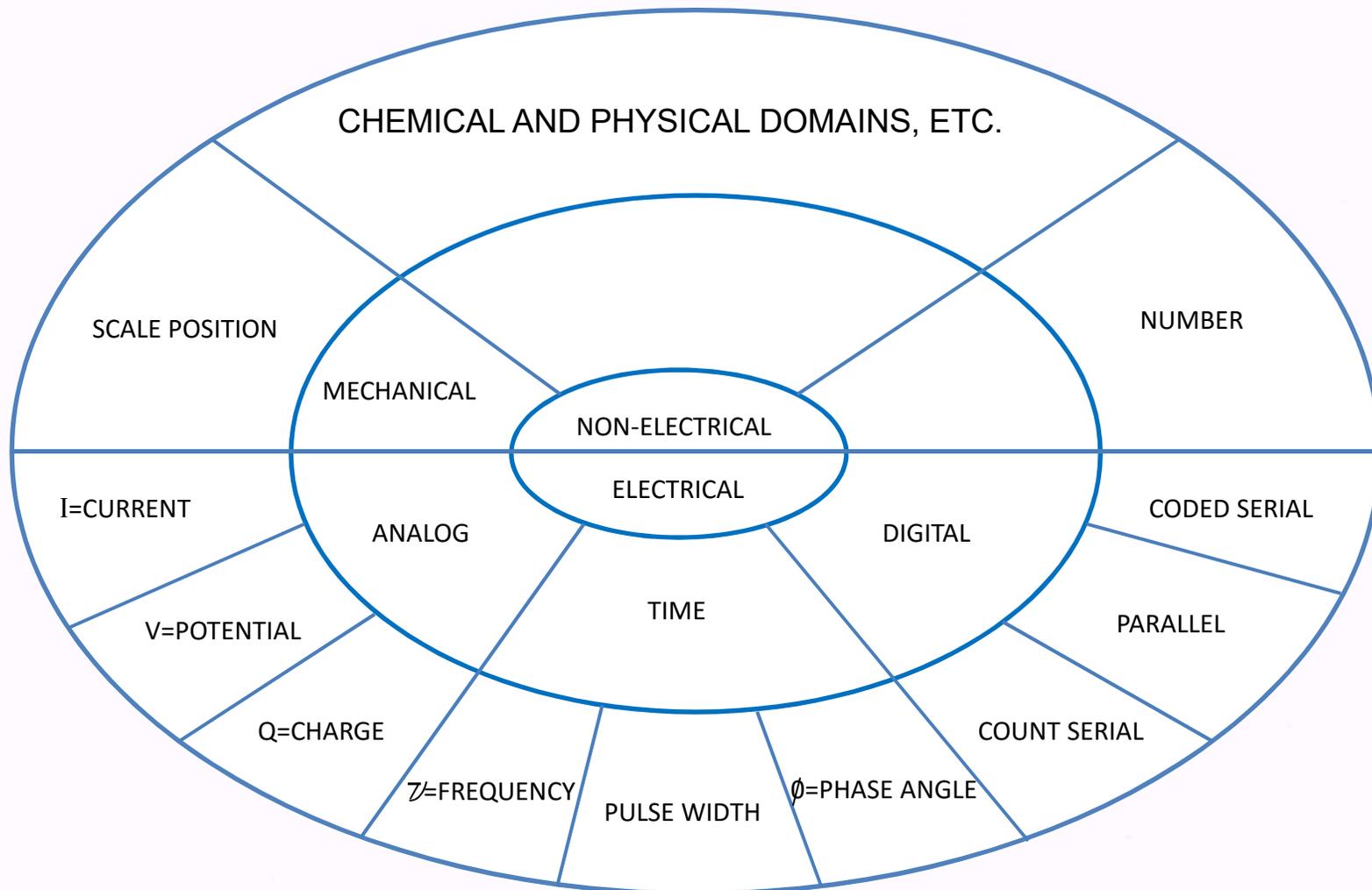


- ANSI = American National Standards Institute
- Mechanism to establish traceability of radionuclide sources that are certified for radionuclide activity
- Sponsored by the National Committee on Radiation Instrumentation
- Participation on a National Institute of Standards and Technology (NIST) Measurements Assurance Program (MAP)
  - Annually for each calibration technique and instrument type
  - Every 3 years or prior to use if used less often than 3 years (absolute calibration techniques only)
  - Each radionuclide eventually included in the testing program

# Chemistry Measurements



# Data Domains Map



# Inorganic Chemistry Measurements



- Primary Standards
  - Do not require standardization
  - Highly pure, stable, homogeneous (e.g., no water of crystallization), uniform size and shape of crystals, not hygroscopic, non-toxic, readily available, cheap
- Examples
  - Copper wire
  - KHP
  - NaCl

# Inorganic Chemistry Measurements



- Secondary Standards
  - Usually standardized against Primary Standards
  - Standards prepared for a specific analysis
- Examples:
  - NIST Standard Reference Materials
  - Certified Reference Materials
  - Reference Materials

# Organic Chemistry Measurements



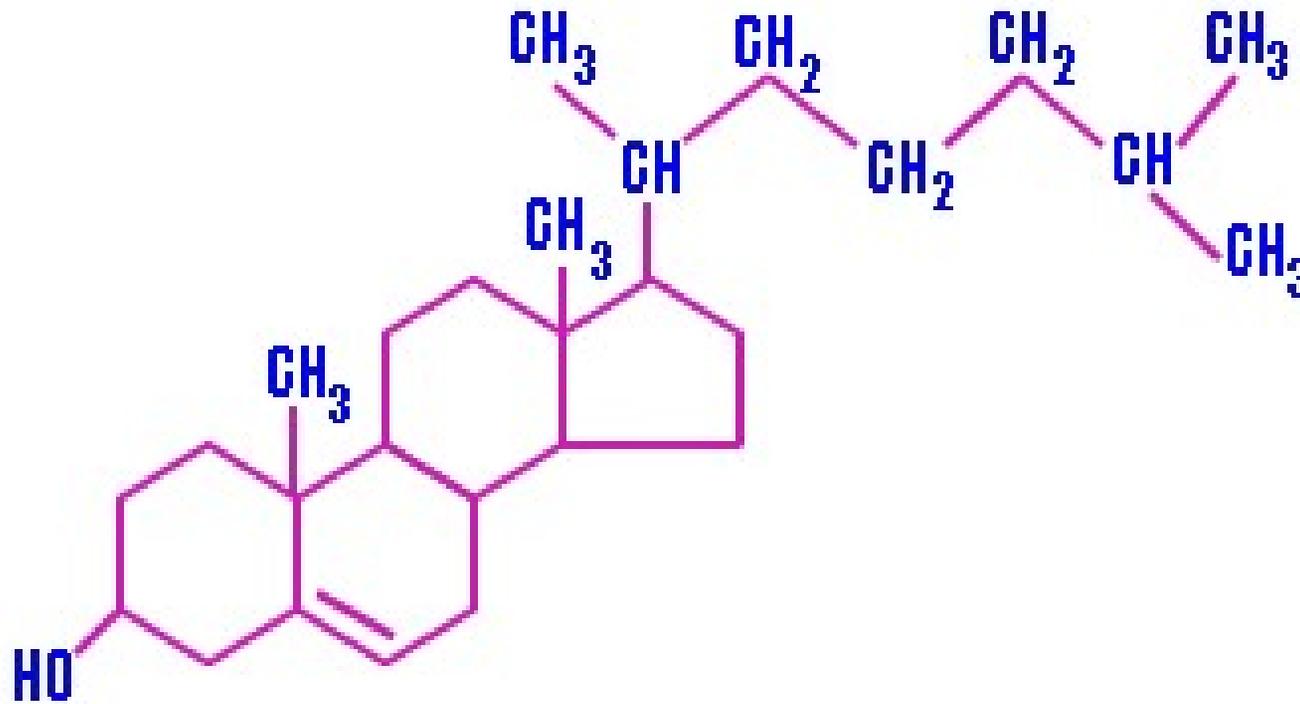
- Various “grades” available
  - Reagent grade
  - Pesticide grade
  - HPLC grade
  - Analytical grade
  - Technical grade
  - Distilled-in-glass grade
  - USP (United States Pharmacopeia)

# Organic Chemistry Measurements

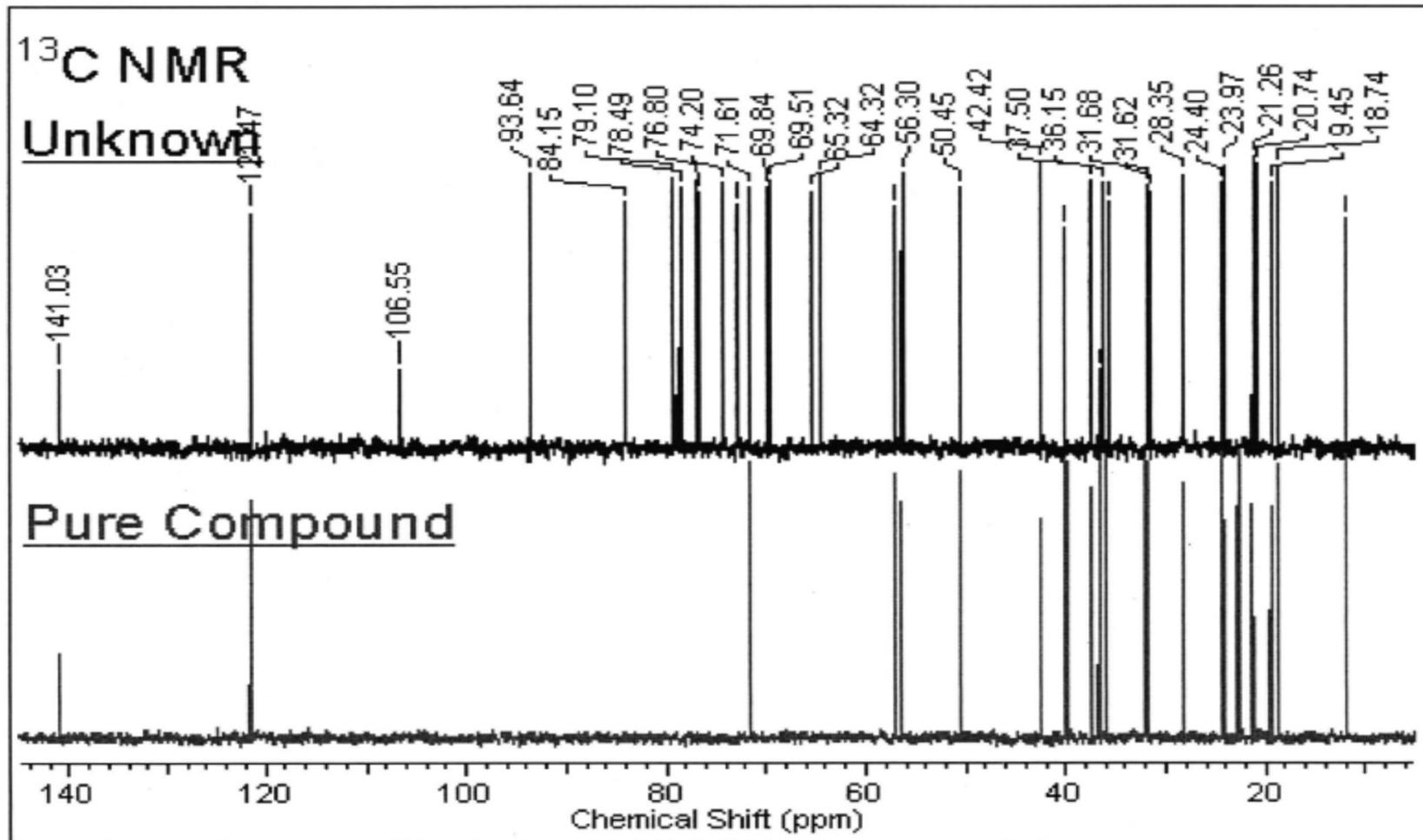


- Ways to determine purity
  - Physical properties (e.g., melting point, boiling point)
  - X-ray diffraction (also works for inorganic chemicals such as Asbestos)
  - IR spectrum
  - NMR spectrum
  - Mass spectrum

# Cholesterol



# Cholesterol



# Chemistry Measurements



- Reported concentration

Usually traced to:

- Instrument calibration versus Standards
- Ratio results – derived from (at least) 2 measurements

# Can Some Measurements Be Untraceable?



- Cardinal measurements (yes/no)
- Physical properties (odor, taste)
- Observations (air opacity)
- Others?

# Microbiology Measurements



- Based on living organisms rather than chemical substances
- Taxonomy (Genus, species)
  - *Escherichia coli*, for example
- Use of Reference Cultures or Certified Reference Cultures (Examples:)
  - American Type Culture Collection (ATCC)
  - National Collection of Type Cultures (NCTC)

# Microbiology Measurements



- Support equipment measurements also need to be traceable
  - To SI: thermometers, balances
  - To reference standards: pH meter
- Chemical tests for water quality
  - Chlorine, toxic metals, total organic carbon

# Micro-organism Identification

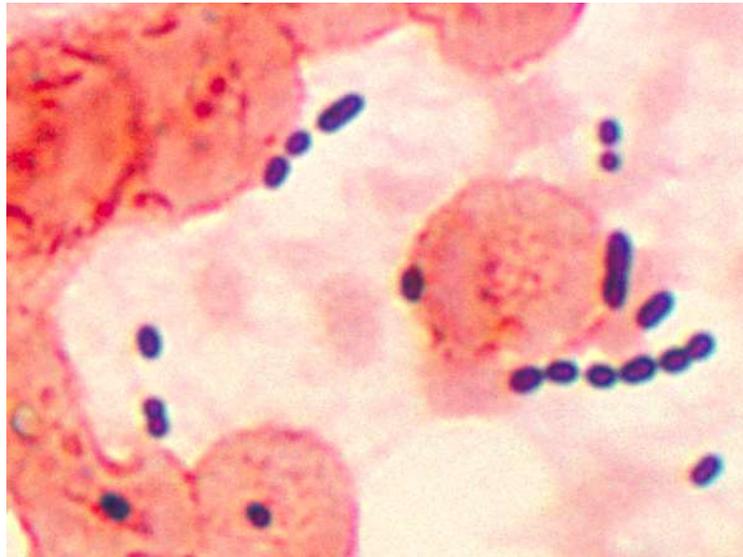


- Microscopic examination
- Biochemical tests
- Combination of the above

# ***Enterococcus faecalis***



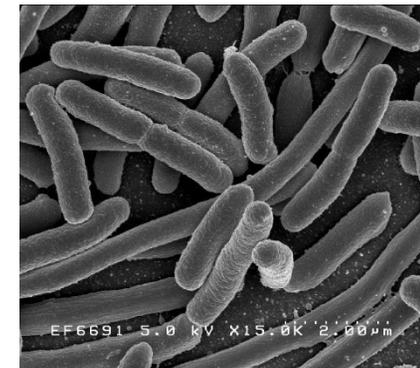
- Tests used:
  - Gram staining (gram positive)
  - Mannitol salt agar
  - Urea



# *Escherichia coli*



- Gram-negative enterotube (or IMViC tests)
  - Glucose +
  - Gas production + or -
  - Lysine +
  - Ornithine +
  - H<sub>2</sub>S -
  - Indole + (IMViC: +)
  - Adonitol -
  - Lactose +
  - Arabinose +
  - Sorbitol + or -
  - Voges-Proskauer - (IMViC: -)
  - Dulcitol + or -
  - Phenylalanine deaminase -
  - Urea -
  - Citrate - (IMViC: -)
  - Methyl Red (IMViC: +)



By Credit: Rocky Mountain Laboratories, NIAID, NIH - NIAID

# Whole Effluent Toxicity



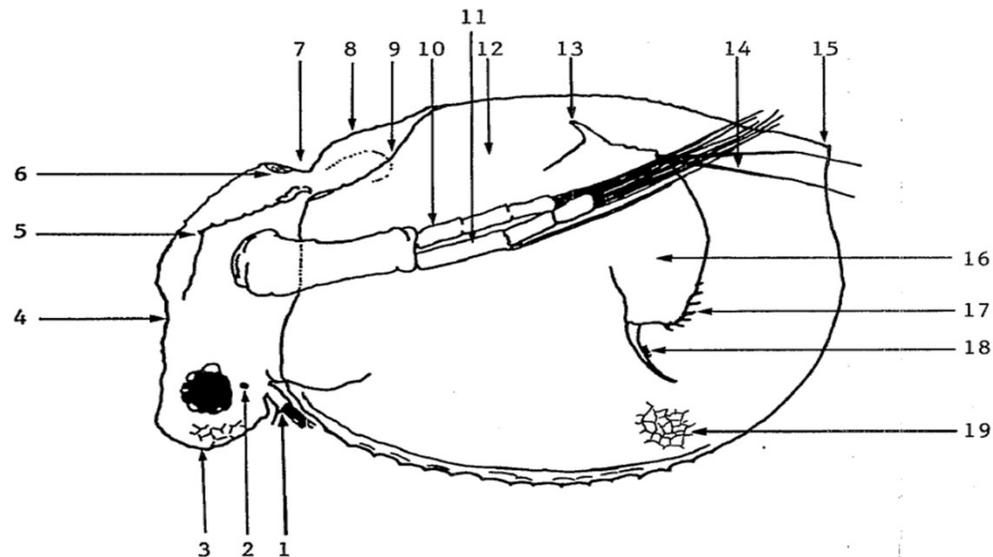
- Test species (aquatic plants, vertebrates, and invertebrates)
- Endpoint (point estimate or hypothesis)
- Survival, reproduction (visual observation)
- Growth (weight gain)
- Support equipment (test temperature)
- Chemical tests (water and food quality)
- Reference Toxicant

# Organism Identification to Species



- Required annually, per NELAC Standards
- Taxonomic reference (citation and page(s))
- Taxonomic expert who made the identification

# Ceriodaphnia dubia



1. Antennule with anterior sense hair and terminal aesthetascs (fine sensory hairs)
2. Ocellus
3. Frons
4. Supraocular depression
5. Fornix
6. Fenestra (headpore)
7. Cervical notch
8. Cardiac bulge (heart shown as dotted line beneath)
9. Ecdysial line
10. Exopod of antenna
11. Endopod of antenna
12. Brood chamber
13. Abdominal appendage
14. Abdominal seta
15. Posterodorsal angle
16. Postabdomen
17. Anal denticles
18. Postabdominal claw with a pecten
19. Reticulations

# Conclusions



- NELAP-accredited environmental testing laboratories should be able to comply with ISO/IEC 17025 requirements
- Measurement traceability should be possible either to SI or to certified reference materials, specified methods, or consensus standards
- Current ISO/IEC 17011 requires accreditation bodies to provide information about suitable ways to obtain traceability

# Questions?



Thank you for your attention!

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