Toxicology Team-Based Learning: Avoiding the Pitfalls from a Promising Pedagogy

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Objectives

- Review the Toxicology Learning Framework and its use in toxicology and non-toxicology courses
- Document the value and use of team-based learning in toxicology courses
- Stimulate discussion and brainstorming to improve toxicology teaching and learning
Review of Key Concepts from SOT Learning Framework

**Evolution:** Evolution drives the interplay between toxicants/toxins and xenobiotic defense mechanisms and justifies the use of model organisms.

**Biological Information:** Differences in genomes and environmental exposure drive differences in susceptibility and responses to toxicants.

**Risk Assessment and Risk Management:** Epidemiology and historical events together with science drive regulatory responses to risk to individuals and the environment.

**Systems Toxicology:** Toxicants affect cellular, organ, individual, and ecological systems.

**Pathways and Transformations of Energy and Matter:** Interaction of toxicants with organisms are described through paradigms in dose response, ADME, and toxico-/pharmacokinetics.
Courses I’ve Taught Using Tox Framework

- Environmental Toxicology (lecture)
- Evolutionary Neurobiology (lecture/lab)
- Neurosignaling (lecture/lab)
- Human Anatomy and Physiology
- Advanced Anatomy and Physiology (lecture/lab)

Biggest challenge: multi-section courses with rigid syllabi and curricula
Concepts and Levels Covered in Courses

Level 1: Evolution
  Level 2: Evolution of toxins
    Level 3: Explain the role of toxins in defense

Level 1: Biological information
  Level 2: Gene-environment interactions
    Level 3: Describe genetic polymorphisms that affect toxicokinetics and risk
      Level 4: Identify allelic differences that alter the response to heavy metals
Concepts and Levels Apply Across Courses

Level 1: Pathways and Transformations
  Level 2: Model organisms
    Level 3: Role of xenobiotic defense mechanisms
      Level 4: Explain Phase I and Phase II enzymes

Level 1: Risk and Risk Management
  Level 2: Environmental toxicology
    Level 3: Describe sources of heavy metal pollution
      Level 4: Describe physiological and ecological effects of cadmium, arsenic, mercury
Why Team-Based Learning

- Improves student engagement
- Improves student outcomes
  - 77% reported it helped them learn better
  - Teams consistently outscore individuals
- Excellent preparation for future careers
Service Learning: Environmental Toxicology

BACKGROUND: Village of Newtown, Ohio purchased a small lake from private owners for public use

PROBLEM: The lake was next to a landfill, surrounded by honeysuckle, toxic algae were present and Canada geese were multiplying

SOLUTION: Adopt-a-lake!
Undergraduate Educator Network Webinar

Evolution of Environmental Toxicology

- Team-based Service Learning Project remains core
- Focus is always applying toxicology principles to a risk management problem close to campus
- Problems have included PFAS in groundwater, landfill expansion, and fallout from a metal shredding facility
Tips for Successful Integration

- Strong community partner and university support
- Practice, Practice, Practice!
- Regular team meetings and reports (accountability)
- Confidential assessment of individual team members
- Fairness: Adjust grades based on participation and activity
Team-Based Learning Options

- Single lab experiments
- Multi-lab experimental design and implementation
- Group lecture activities (quizzes, problem-solving, share-pair, team projects)
- Service learning
Single Experiments with a Toxicology Twist

- Incorporated numerous toxins and toxicants to study organism’s response
- Nicotine and withdrawal in *Planaria*
- Alcohol in *Drosophila*
- Caffeine in mice

**BOTTOM LINE:** All can be directly tied back to at least 3 major themes and ultimately 4th level toxicology learning objectives
In-Class Team Activity: Toxicology Scavenger Hunt

- Find the most polluted or most harmful site near you
- Teaches students to use toxicology resources
- Can be competitive
- Can require team reports to the rest of the class
- Can be followed with individual report
Service Learning: Student Philanthropy Project

- Teams adopt a local non-profit
- Advocate for $1,000 or $2,000 grants
Improving Success in Team-Based Learning

- Provide choices to form more motivated groups
- Have clearly assigned roles and responsibilities
- Give them class time to work together
- Check in often
- Meet with each team individually
- Make sure all members present
References

- Toxicology Learning Framework: https://academic.oup.com/toxsci/article/170/1/20/5436486
- AAC&U Value Rubrics: https://www.aacu.org/initiatives/value-initiative/value-rubrics
- https://www.blog.intedashboard.com/blogs/tbl-learning/benefits-students
- Impact of team-based learning. https://journals.lww.com/academicmedicine/Fulltext/2010/11000/The_Impact_of_Team_Based_Learning_on_Medical.34.aspx

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