Title of course: **Introduction in Life science Education**

Credits: **2 (about 1 contact session per week of 2 hours)**

Course Instructors: **Deepti Gupta & Rohini Karandikar**

Semester 1: **January 2nd week to April 2nd week**

The emergence of Biology Education Research (BER) in the early 20th century was largely led by science educators and focused primarily on efforts to improve teaching in high school and introductory college biology courses. It was only towards the end of the century when scientists involved in biology research began to foray into education research. In the last decade, research has been directed towards specific needs and challenges of biology learning in general but also focussing on sub-disciplines such as zoology, botany, biochemistry, cell biology and molecular biology. The field has also been cross-fertilized by research in other disciplines like physics, chemistry and mathematics and increasingly adopting interdisciplinary approaches for teaching and learning of modern biology: now aptly referred to as life science education which amalgamates learning from all science disciplines.

The primary objective of this course is to acquaint participants with major areas of life science education research and how teaching and learning of biology as a discipline has co-evolved with science education research. The course includes articles related to several emerging themes in biology education and science education in general.

Introductory paper: DeHaan, Robert L. "Education research in the biological sciences: A nine-decade review." Second Committee Meeting on the Status, Contributions, and Future Directions of Discipline-Based Education Research.

Theme 1: History and Philosophy

1. Douglas Allchin (2003) Scientific Myth-Conceptions *Science Education 87 (3),* 329-351
2. Ernst Mayr: What Makes Biology Unique? Considerations on the autonomy of a scientific discipline (Book).

Theme 2: Misconceptions/Alternate Conceptions Learning Life Sciences

1. John D. Coley and Kimberly D. Tanner (2012) Common Origins of Diverse Misconceptions: Cognitive Principles and the Development of Biology Thinking. *CBE—Life Sciences Education* Vol. 11, 209–215.
2. Development and Evaluation of the Conceptual Inventory of Natural Selection. (2002). Dianne L. Anderson, Kathleen M. Fisher, Gregory J. Norman. *Journal of Research in Science Teaching* Vol 39(10) 952–978.

3. Mahajan, B. S. & Chunawala, S. (1999). Indian secondary students' understanding of different aspects of health. *International Journal of Science Education,* 21(11), 1155-1168.
4. Jyotsna Vijapurkar & Pooja Konde (2014) "*Omne Vivo Ex Vivum*"? A Study of Middle School Students' Explanations of the Seemingly Sudden Appearance of Some Life Forms. *Research in Science Education*. Vol 44(6), 885-902.

Theme 3: Role of Diagrams/Models

1. Trevor R. Anderson, Konrad J. Scho¨nborn, Lynn du Plessis, Abindra S. Gupthar, and Tracy L. Hull (2013). Identifying and Developing Students' Ability to Reason with Concepts and Representations in Biology. Book chapter in "Multiple Representations in Biology Education, pp 19-38.
2. Anveshna Shrivastava and Jayshree Ramadas (2013) Analogy and Gesture for Mental Visualization of DNA structure Book chapter in "Multiple Representations in Biology Education Springer, Netherlands pp 311-329.
3. Marco Kragten, Wilfried Admiraal & Gert Rijlaarsdam (2015) Students' Learning Activities While Studying Biological Process Diagrams. *International Journal of Science Education* Vol 37(12), 1915-1937.
4. Eli Meir, Judith Perry, Derek Stal, Susan Maruca, and Eric Klopfer (2005) How Effective Are Simulated Molecular-level Experiments for Teaching Diffusion and Osmosis? *Cell Biology Education* Vol.4, 235-248.
5. Jakob Christensen-Dalsgaard & Morten Kanneworff (2009) Evolution in Lego®: A Physical Simulation of Adaptation by Natural Selection. *Evolution: Education and Outreach*. Vol 2, 518-526.
6. Kim Quillin and Stephen Thomas (2015) Drawing-to-Learn: A Framework for Using Drawings to Promote Model-Based Reasoning in Biology. *CBE-Life Sciences Education*, Vol 14, 1-16.

Theme 4: Teaching and Learning

1. Caleb M. Trujillo, Trevor R. Anderson, and Nancy J. Pelaez (2016) An instructional design process based on expert knowledge for teaching students how mechanisms are explained. *Advances in Physiology Education* Vol 40, 265-273
2. Patricia J. Friedrichsen, Sandra K. Abell, Enrique M. Pareja, Patrick L. Brown, Deanna M. Lankford, Mark J. Volkmann (2009). Does Teaching Experience Matter? Examining Biology Teachers' Prior Knowledge for Teaching in an Alternative Certification Program. *Journal of Research in Science Teaching*, Vol 46(4), 357-383
3. Gustav Bohlin, Andreas Göransson, Gunnar E. Höst & Lena A. E. Tibell (2017). Insights from introducing natural selection to novices using animations of antibiotic resistance. *Journal of Biology Education* http://dx.doi.org/10.1080/00219266.2017.1368687

4. Hedda Falk , Gilat Brill & Anat Yarden (2008) Teaching a Biotechnology Curriculum Based on Adapted Primary Literature. *International Journal of Science Education*. Vol 30(14) 1841-1866.
5. Atilla Cimer (2012) What Makes Biology Learning Difficult and Effective: Students' Views. *Educational Research and Reviews*. Vol 7(3): 61-71.

Theme 5: Interdisciplinary Approaches to Understand Concepts

1. Stephanie E. Pierce (2002) Non-Equilibrium Thermodynamics: An Alternate Evolutionary Hypothesis Crossing Boundaries – an interdisciplinary journal VOL 1,2.
2. Ruiz-Mirazo K, Briones C, dela Escosura A. (2017) Chemical roots of biological evolution: the origins of life as a process of development of autonomous functional systems. Open Biol. 7: 170050.
3. Laura Ann Schoenle, Matt Thomas. The American Biology Teacher (2017) Solving Hardy-Weinberg with Geometry: An Integration of Biology and Math.
4. Reinhard Bürger. Some Mathematical Models in Evolutionary Genetics.

Theme 6: Miscellaneous

1. Ayelet Baram-Tsabari & Anat Yarden Girls' biology, boys' physics: evidence from free-choice science learning settings (2008) *Research in Science and Technological Education*, Vol 26(1): 75-92.
2. Joanna Hubbard, Macy Potts and Brian Couch(2017). How Question Types Reveal Student Thinking: An Experimental Comparison of Multiple-True-False and Free-Response Formats *CBE-Life Sciences Education*, 16:ar26.
3. Moon-Heum Cho & Deanna M. Lankford & Daniel J. Wescott (2011). Exploring the Relationships among Epistemological Beliefs, Nature of Science, and Conceptual Change in the Learning of Evolutionary Theory. *Evolution: Education and Outreach*. Vol 4, 313-322.
4. Sugra Chunawala , Pooja Birwatkar, Adithi Muralidhar & Chitra Natarajan (2013) Looking at Science through the Lens of Diversity: Views of Indian Students and Teachers. *Proceedings of epiSTEME* 5, 185-191.
5. A Textbook Case of the Nature of Science: Laws and Theories in the Science of Biology William F.McComas (2003) *International Journal of Science and Mathematics Education*. 1(2): 141-155.

Assessment:

Assessment would be done on the following basis:

1. Atheme-wise summary of all the papers under a particular theme (60 %)
2. Students' participation in the class discussions (40 %)