

Session Outline	
Session 1	August 28
<p>Topic: Introduction and course overview. Microbiome research</p> <p>Recommended readings: Xia et al. (2018). Chapter 1</p> <p>Assignments: Problem set 1 – Install R and R studio</p> <p>Learning Objectives: learn about the microbiome, discuss its role in biology and health, and review genomic, phylogenetic and bioinformatic methods to generate microbiome data</p>	
Session 2	September 4
<p>Topic: What Are Microbiome Data?</p> <p>Recommended readings: Xia et al. (2018). Chapters 2 and 4</p> <p>Assignments: Problem set 2 – dplyr, ggplot and ggpubr</p> <p>Learning Objectives: understand the unique structure, features and characteristics of microbiome data and introduce some R packages for handling and visualizing microbiome data</p>	
Session 3	September 11
<p>Topic: Overview of Statistical Analysis of Microbiome Data</p> <p>Recommended readings: Xia et al. (2018). Chapters 3 and 7.</p> <p>Assignments: Problem set 3 – phyloseq and microbiome</p> <p>Learning Objectives: introduce classic and newly developed statistical methods and R packages for the analysis of microbiome data and learn about their applications and limitations</p>	
Session 4	September 18
<p>Topic: Power and Sample Size Calculations for Microbiome Data</p> <p>Recommended readings: Xia et al. (2018). Chapter 5.</p> <p>Assignments: Problem set 4 – power analysis in R</p> <p>Learning Objectives: learn about statistical hypothesis testing, power analysis and sample size calculation for comparing diversity and composition in microbiome data</p>	
Session 5	September 25
<p>Topic: Community Diversity Measures and Calculations</p> <p>Recommended readings: Xia et al. (2018). Chapter 6.</p> <p>Assignments: Problem set 5 – Diversity estimation in R</p>	

Learning Objectives: learn methods and R packages to estimate and compare microbial alpha- and beta-diversity	
Session 6	October 2
Topic: Exploratory Analysis of Microbiome Data Recommended readings: Xia et al. (2018). Chapter 7. Assignments: Problem set 6 – Exploratory Analyses in R Learning Objectives: learn approaches and R packages to visualize composition and structure, clustering and ordination of microbiome data	
Fall Break – October 9-10	
Session 7	October 16
Topic: Univariate and Multivariate Community Analysis Recommended readings: Xia et al. (2018). Chapters 8 and 9. Assignments: Problem set 7– Univariate and multivariate analyses in R Learning Objectives: learn standard univariate statistical tests to compare diversity and composition in microbial community data and how to implement them in R	
Session 8	October 23
Topic: Machine learning approaches for microbiome analysis Recommended readings: Papoutsoglou et al. (2023) and Hernández Medina et al. (2022) Assignments: Problem set 8 – Random Forest analyses in R Learning Objectives: learn machine learning approaches to construct microbiome-based predictive models and identify biomarkers in R	
Session 9	October 30
Topic: Compositional Analysis of Microbiome Data Recommended readings: Xia et al. (2018). Chapter 10. Assignments: Problem set 9 - Compositional Analysis of Microbiome Data in R Learning Objectives: learn statistical methods and R packages to analyze microbial compositional data and their challenges	
Session 10	November 6
Topic: Modeling Over-Dispersed Microbiome Data Recommended readings: Xia et al. (2018). Chapter 11.	

Assignments: Problem set 10 – DESeq2

Learning Objectives: learn statistical methods to model overdispersion in microbial data and their challenges using the DESeq2 R package

Session 11

November 13

Topic: Modeling Zero-Inflated Microbiome Data

Recommended readings: Xia et al. (2018). Chapter 12.

Assignments: Problem set 11 – Zero-Inflated analyses in R

Learning Objectives: learn statistical methods and R packages to model overdispersion in microbial data and their challenges

Session 12

November 20

Topic: Analysis of longitudinal microbiome data

Recommended readings: Xia and Sun (2023). Chapter 15

Assignments: Problem set 12 – lmer

Learning Objectives: learn statistical methods and R packages to analyze longitudinal microbial data

Thanksgiving – November 24-29

Session 13

December 4

Topic: Analysis of microbiome data using comprehensive R packages

Recommended readings: – Xu et al. (2023). Barnett et al. (2021)

Assignments: Problem set 13 – MicrobiotaProcess, MicroEco

Learning Objectives: introduce and apply comprehensive R packages for the analysis and visualization of microbial data

Last Day of Classes – December 8