

FOOD FERMENTATIONS – MICROBIOLOGY AND TECHNOLOGY

FS 515

SUMMER 2015

Session:	12 Week
Dates:	5/12/2015 - 8/1/2015
Time:	225-minute instruction/week (25 min/lecture block; 9 (25-min) lecture blocks/week)
Location:	Online space (Blackboard)
Instructor:	Gulhan Unlu, Ph.D. Associate Professor School of Food Science University of Idaho Office: Agricultural Biotechnology (AgBioTech) 205 Office Phone: 208-885-7771 Office Fax: 208-885-2567 Cell Phone: 208-596-9777 Email: gulhan@uidaho.edu
Credits:	3
Pre-requisites:	General Microbiology, Food Microbiology, and Biochemistry OR instructor permission
Required Text:	Microbiology and Technology of Fermented Foods, 2006, Robert Hutkins, IFT Press, Blackwell Publishing Available at The Bookie website, the e-library, and on reserve
Recommended Books:	Fugelsang, K.C. and Edwards, C.G. 2007. Wine Microbiology: Practical Applications and Procedures. Springer. Donnelly, C.W. 2014. Cheese and Microbes. ASM Press. Fox, P.F., McSweeney, P., Cogan, T.M., and Guinee, T.P. 2004. Cheese: chemistry, physics, and microbiology. Elsevier Academic Press.

Doran, P.M. Bioprocess Engineering Principles. 2013. Elsevier Academic Press.

All books will be made available at the e-library.

Other readings will be made available electronically.

Student Office Hours: By appointment
 Set up appointments via phone or email (preferred)
 Location: Agricultural Biotechnology 205

Student Learning Outcomes and Assessment

Student Learning Outcomes for this course: At the end of this course, students should be able to:	Course Topic/Dates The following topic(s)/date(s) will address the outcome	Evaluation of Outcome: This outcome will be evaluated primarily by:
Demonstrate a fundamental understanding of food fermentation science and technology knowledge and principles	<ul style="list-style-type: none"> ▪ Microorganisms and Metabolism ▪ Starter cultures ▪ Bioprocess Engineering Principles ▪ Cultured dairy products Cheese ▪ Meat fermentation ▪ Fermented vegetables ▪ Bread fermentation ▪ Vinegar Fermentation ▪ Beer Fermentation ▪ Wine Fermentation ▪ Fermented Foods of Asia ▪ Microbial production of metabolites/food ingredients ▪ Bioconversion of agricultural by products and food processing byproducts to value added products <p>May 12-August 1, 2015</p>	Tests Term paper
Apply scientific knowledge to assess and solve food fermentation science and	Same as above	Tests Term paper

technology problems		
Exhibit communication skills to convey technical information and defending scientific findings in the area of food fermentations.	Same as above	Tests Term paper
Have the professional skills for entry-mid level positions in food fermentation and allied industries, government or academia.	Same as above	Tests Term paper

Course Outline:

Week [Dates]	Unit	Day	Topic	Assignments & Assessments
Week 1 [May 12-18]	1		<p>Introduction</p> <ul style="list-style-type: none"> ➤ Fermented foods and human history ➤ Fermented foods: from art to science ➤ The modern fermented foods industry ➤ Properties of fermented foods ➤ Fermented foods in the twenty-first century <p>Microorganisms and Metabolism</p> <ul style="list-style-type: none"> ➤ A primer on microbial classification ➤ Bacteria used in the manufacture of fermented foods <ul style="list-style-type: none"> ○ The lactic acid bacteria ○ Other bacteria important in food fermentations ➤ Yeasts and molds used in the manufacture of fermented foods ➤ Fermentation and metabolism basics <ul style="list-style-type: none"> ○ Sugar metabolism ○ Protein metabolism ○ Other metabolic systems ○ Metabolic engineering 	<p>Textbook chapters 1 & 2</p> <p>Lesson 1 [Blackboard]</p> <p>Weekly chat [May 18]</p> <p>Paper topic confirmed [May 18]</p>
	2		Starter cultures	

Week 2 [May 19-25]			<ul style="list-style-type: none"> ➤ Role of starter cultures ➤ History ➤ Starter culture microorganisms <ul style="list-style-type: none"> ○ Bacterial starter cultures ○ Yeast starter cultures ○ Mold starter cultures ○ Strain identification ➤ Starter culture math ➤ Culture composition ➤ Manufacture of starter cultures ➤ Evaluating culture performance ➤ How starter cultures are used ➤ Bacteriophages and their control ➤ Engineered phage resistance ➤ Starter culture technology in the twenty-first century ➤ Encapsulated and immobilized cells ➤ Probiotics and culture adjuncts ➤ The starter culture industry 	Textbook chapter 3 Lesson 2 [Blackboard] Weekly chat [May 25]
Week 3 [May 26-June 1]	3		Bioprocess Engineering Principles <ul style="list-style-type: none"> ➤ Introduction to bioprocess development <ul style="list-style-type: none"> ○ Material and energy balances ○ Physical processes <ul style="list-style-type: none"> ▪ Fluid flow ▪ Mixing ▪ Heat transfer ▪ Mass transfer ▪ Unit operations ○ Reactions and reactors <ul style="list-style-type: none"> ▪ Homogeneous reactions ▪ Heterogeneous reactions ▪ Reactor engineering ▪ 	Lesson 3 [Blackboard] Weekly chat [June 1] Paper outline due [June 1] Paper reference list due [June 1]
Week 4 [June 2-8]	4		Cultured dairy products <ul style="list-style-type: none"> ➤ Introduction ➤ Consumption of cultured dairy products ➤ Fermentation principles ➤ Cultured dairy products <ul style="list-style-type: none"> ○ Yogurt ○ Cultured buttermilk ○ Sour cream ○ Kefir ○ Other cultured dairy products ➤ Current issues in cultured dairy products technology ➤ Recent technological advances in cultured dairy products technology 	Textbook chapter 4 Lesson 4 [Blackboard] No weekly chat Test 1 [June 8]

<p>Week 5 [June 9-15]</p>	<p>5</p>	<p>Cheese</p> <ul style="list-style-type: none"> ➤ Introduction ➤ Manufacturing principles ➤ General steps in cheese making ➤ Types of cheese <ul style="list-style-type: none"> ○ Cheddar family ○ Cheese with eyes ○ Mozzarella and pasta filata (stretched curd) cheeses ○ Hard Italian cheese ○ Dutch-type cheeses ○ Surface-ripened by bacteria ○ Mold-ripened cheese ○ Blue-mold ripened cheese ○ White-mold ripened cheese ○ Pickled cheese ○ Processed and cold pack cheese ➤ Cheese ripening ➤ Microbial defects, preservation, and food safety ➤ Current issues in cheese technology ➤ Recent technological advances in cheese technology ➤ Whey utilization 	<p>Textbook chapter 5</p> <p>Lesson 5 [Blackboard]</p> <p>Weekly chat [June 15]</p> <p>Paper (first draft) due [June 15]</p>
<p>Week 6 [June 16-22]</p>	<p>6</p>	<p>Meat fermentation</p> <ul style="list-style-type: none"> ➤ Introduction ➤ History and evolution of the fermented meats industry ➤ Meat composition ➤ Fermentation principles ➤ Meat starter cultures ➤ Protective properties of cultures ➤ <i>Micrococcaceae</i> cultures ➤ Principles of fermented sausage manufacture ➤ Manufacture of fermented sausage <ul style="list-style-type: none"> ○ Cutting and mixing ○ Stuffing <ul style="list-style-type: none"> ▪ Casing materials ○ Fermentation ○ Cooking, drying, and smoking ○ Mold-ripening ➤ Flavor of fermented meats ➤ Defects and spoilage of fermented meats ➤ Current issues in meat fermentation ➤ Recent technological advances in meat fermentation 	<p>Textbook chapter 6</p> <p>Lesson 6 [Blackboard]</p> <p>Weekly chat [June 22]</p>

Week 7 [June 23-29]	7	Fermented vegetables <ul style="list-style-type: none"> ➤ Introduction ➤ Products and consumption ➤ Production principles ➤ Manufacture of Sauerkraut ➤ Principles of pickle production ➤ Olives: products and markets ➤ Fermented vegetables and biogenic amines ➤ Current issues in fermented vegetable technologies ➤ Recent technological advances in fermented vegetable technologies 	Textbook chapter 7 Lesson 7 [Blackboard] Weekly chat [June 29]
Week 8 [June 30- July 6]	8	Bread fermentation <ul style="list-style-type: none"> ➤ Introduction ➤ History ➤ Wheat chemistry and milling ➤ Flour composition ➤ Yeast cultures ➤ Bread manufacturing principles ➤ Modern bread technology ➤ Sourdough fermentation ➤ Bread spoilage and preservation ➤ Bread quality ➤ Current issues in bread fermentation ➤ Recent technological advances in bread fermentation Vinegar Fermentation <ul style="list-style-type: none"> ➤ History ➤ Definitions ➤ Vinegar manufacturing principles ➤ Microorganisms ➤ Metabolism and fermentation ➤ Vinegar technology ➤ Vinegar quality ➤ Current issues in vinegar fermentation ➤ Recent developments in vinegar fermentation 	Textbook chapters 8 and 11 Lesson 8 [Blackboard] Test 2 [July 6] Paper (second draft) due [July 6]
Week 9 [July 7-July 13]	9	Beer Fermentation <ul style="list-style-type: none"> ➤ Introduction ➤ Beer spoilage and the origins of modern science ➤ The modern beer industry ➤ Beer manufacturing principles ➤ Enzymatic reactions: malting and mashing ➤ Hops ➤ Kettle boil 	Textbook chapter 9 Lesson 9 [Blackboard] Weekly chat [July 13]

			<ul style="list-style-type: none"> ➤ The beer fermentation ➤ Fermenters ➤ Inoculation ➤ Yeast metabolism ➤ Flocculation ➤ Post-fermentation steps ➤ Beer defects ➤ Waste management in the brewing industry ➤ Current issues in the beer industry ➤ Recent developments in the beer industry ➤ Biotechnology and the brewing industry 	
Week 10 [July 14- July 20]	10		<p>Wine Fermentation</p> <ul style="list-style-type: none"> ➤ Introduction ➤ History ➤ Production and consumption ➤ Wine basics ➤ Viticulture and grape science ➤ Grape composition ➤ Wine manufacture principles <ul style="list-style-type: none"> ○ Harvesting and preparing grapes for wine making ○ Crushing and maceration ○ Sulfur dioxide treatment ○ Other pre-treatments ○ Microbial ecology and spontaneous wine fermentations ○ Separation and pressing ○ Fermentation ○ Yeast metabolism ○ Factors affecting yeast metabolism ○ Sulfur and nitrogen metabolism ○ Stuck fermentations ○ Adjustments, blending, and clarification ○ Aging ○ Malolactic fermentation ➤ Types of wine ➤ Wine spoilage and defects ➤ Current issues in the wine industry ➤ Recent technological advances in the wine industry ➤ 	<p>Textbook chapter 10</p> <p>Lesson 10 [Blackboard]</p> <p>Weekly chat [July 20]</p> <p>Paper (final) due [July 20]</p>
Week 11 [July 21-27]	11		<p>Fermented Foods of Asia</p> <ul style="list-style-type: none"> ➤ History ➤ Types of Asian fermented foods ➤ Plant-based fermentations <ul style="list-style-type: none"> ○ Koji and tane koji manufacture ○ Manufacture of soy sauce and related products 	<p>Textbook chapter 12</p> <p>Lesson 11 [Blackboard]</p> <p>Weekly chat</p>

			<ul style="list-style-type: none"> ○ Natto ○ Tempeh ○ Manufacture of sake and rice wines ➤ Fermented fish-type foods ➤ Safety of fungal fermented foods ➤ Current issues regarding fermented foods in the orient ➤ Recent developments regarding fermented foods in the orient 	[July 27]
Week 12 [July 28-August 1]	12		<p>Microbial production of metabolites/food ingredients</p> <ul style="list-style-type: none"> ➤ Monosodium glutamate ➤ Xanthan gum ➤ Xylitol ➤ Organic acids ➤ Nisin <p>Bioconversion of agricultural by products and food processing byproducts to value added products</p> <ul style="list-style-type: none"> ➤ Protein-based byproduct conversion ➤ Carbohydrate-based byproducts conversion 	<p>Lesson 12 [Blackboard]</p> <p>No weekly chat</p> <p>Final exam [July 31]</p>

Attendance Policy

You are expected to adhere to all deadlines for tests and assignments.

Description of Required Assignments

Reading: You are expected to read (and thus responsible for) all chapters in your required textbook and select chapters recommended in recommended textbooks.

Paper: A term paper (minimum 20 pages, double space) will be required. The paper will deal with current issues and/or recent developments in the fermentation industry with an emphasis on science and technology affecting one or more of the following products: dairy, meat, vegetable, bread, beer, wine, ingredient/supplement, processing aid (culture, enzymes) etc.).

	Student submission due date	Late submission	Instructor comments due date	Possible points	Expectations
Topic	Monday, May 18, 2015	2 points deduction	Friday, May 22, 2015	10	Selection of a topic on current issues

		(20%) per day			and/or recent developments in the fermentation industry
Outline	Monday, June 1, 2015	4 points deduction (20%) per day	Friday, June 5, 2015	20	One-page outline that illustrates the major components of the paper (see example below)
List of references	Monday, June 1, 2015	4 points deduction (20%) per day	Friday, June 5, 2015	20	Complete list of new references to be used
Draft 1	Monday, June 15, 2015	10 points deduction (20%) per day	Friday, June 19, 2015	50	First draft of term paper written following the paper outline
Draft 2	Monday, July 6, 2015	10 points deduction (20%) per day	Friday, July 10, 2015	50	Draft 1 is fully revised based on instructor's suggestions for improvement
Final	Monday, July 20, 2015	10 points deduction (20%) per day	Grading	50	Draft 2 is fully revised based on instructor's suggestions for improvement

Example outline:

Title: Kefir: A Multifaceted Fermented Dairy Product

Section:	Details:
Abstract	
Kefir: An Introduction	Definition, description of kefir, history, geography, kefir grains
Kefir Structure	The exterior, the interior, SEM findings
Kefir's Microbial Profile	Lactic acid bacteria, yeast, molecular identification
Kefir Production	Pure culture starts, lyophilized starts Traditional kefir vs. industrial kefir
Kefir as a Probiotic	Protection from toxins, antimicrobial properties, ACE inhibition, cholesterol

	reduction, immunomodulation, antimutagenic properties, antitumor properties, lactose digestion
Other Uses of Kefir and Kefir Products	Medical, industrial, food applications
References	

Tests: There will be two tests and a final exam (open book, online, timed). They will be worth 100 points each.

	Week	Date	Possible points
Test 1	4	Monday, June 8, 2015	100
Test 2	8	Monday, July 6, 2015	100
Final Exam	12	Friday, July 31, 2015	100

Question Types: There are many types of questions that can be included in an assessment. Your instructor decides what type of questions to include, what order the questions appear, and whether you are allowed to go back and change your answers.

Question Type:	Explanation:
Either/Or	A statement with a predefined choice of two answers (Yes/No, On/Off).
Essay	A question where the answer must be typed in a text box.
File Response	Uploaded files are used to respond to the question.
Fill in Multiple Blanks	Multiple responses are inserted into a sentence or paragraph.
Fill in the Blank	A statement that requires an answer to complete it. Answers are evaluated based on an exact text match.
Hot Spot	A specific point on an image is used to indicate the answer.
Jumbled Sentence	A sentence with a number of variables within it.
Matching	Two columns of items where each item in the first column must be matched to an item in the second column.
Multiple Answer	A number of choices with one or more correct answers.
Multiple Choice	Allows a number of choices with one correct answer. Indicate the correct answer by selecting the correct answer.
Opinion Scale/Likert	A rating scale used to measure attitudes or reactions.
Ordering	A question that requires users to provide an answer by selecting the

	correct order of a series of items.
Quiz Bowl	An answer appears; the users responds with a who, what, or where question to respond.
Short Answer	Similar to Essay questions; answer length is limited.
True/False	A statement with the option to choose either true or false. True/False answer options are limited to the words True and False.

Grading Policy

2 tests and 1 final exam: 100 points each; 300 points total
 1 Term Paper 200 points
 Maximum points: 500 points

>90% A
 80-89% B
 70-79% C
 60-69% D
 <60% F

See the Education Policies and Procedures on syllabi and University Academic Regulation #90:
<http://www.registrar.wsu.edu/Registrar/Apps/Acadregs.ASPX/#90>)

WSU Reasonable Accommodation Statement

“Students with Disabilities: Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please either visit or call the Access Center (Washington Building 217; 509-335-3417) to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center. For more information contact a Disability Specialist on your home campus:

Pullman or WSU Online: 509-335 3417

<http://accesscenter.wsu.edu>, Access.Center@wsu.edu

Spokane: <http://spokane.wsu.edu/students/current/studentaffairs/disability/>

Tri-Cities: <http://www.tricity.wsu.edu/disability/>

Vancouver: 360-546-9138 <http://studentaffairs.vancouver.wsu.edu/student-resource-center/disability-services>

WSU Academic Integrity Statement

“As an institution of higher education, Washington State University is committed to principles of truth and academic honesty. All members of the University community share the responsibility for maintaining and supporting these principles. When a student enrolls in Washington State University, the student assumes an obligation to pursue academic endeavors in a manner consistent with the standards of academic integrity adopted by the University. To maintain the academic integrity of the community, the University cannot tolerate acts of academic dishonesty

including any forms of cheating, plagiarism, or fabrication. Washington State University reserves the right and the power to discipline or to exclude students who engage in academic dishonesty.”

Students found responsible for academic integrity violations may receive an F on the particular assignment or exam, as well as an F for the course. Repeated and/or serious offenses may result in referral to the conduct board and expulsion from WSU. For graduate students, academic integrity violations may also result in the loss of teaching and/or research assistantships. Academic Integrity Statement and link to WSU's policy:

<http://www.wsulibs.wsu.edu/plagiarism/main.html>

<http://conduct.wsu.edu/academic-integrity-policies-and-resources/>

Safety and Emergency Notification

The Campus Safety Plan, which can be found at <http://safetyplan.wsu.edu>, contains a comprehensive listing of University policies, procedures, statistics, and information relating to campus safety, emergency management, and the health and welfare of the campus community. All faculty, staff, and students are encouraged to visit this web site as well as the University emergency management web site at <http://oem.wsu.edu/Emergencies.html> to become familiar with the campus safety and emergency information provided.