

Week	Date	Lecture	Topics	Assignments
1	9/6/2018	#1	Classroom: Basics of Nuclear Magnetic Resonance Magnetic resonance, gyromagnetic ratio, Larmor condition, energy levels, spin polarization, magnetization, Bloch equations, dipole-dipole interaction, relaxation, radio-frequency pulses, pulse-acquire, saturation, inversion, spin-echo	HW1 out, due 9/13/2018
2	9/13/2018	#2	Classroom: Basics of Magnetic Resonance Spectroscopy Concept of Fourier MRS, chemical shift, J-coupling, localization, water-suppression, outer volume suppression, STEAM, PRESS, LASER, J-difference editing, 1H, X nuclei, adjustments, data acquisition, frequency demodulation, analog-to-digital conversion	HW2 out, due 9/20/2018
3	9/20/2018	#3	Classroom: Basics of Biochemistry Biochemistry review, metabolites-of-interest (1H, 13C, 31P, 17O, 19F), non-invasive quantification with MRS, cellular integrity (NAA, choline, myo-inositol), neurotransmission (Glutamate, Glutamine, GABA), energy metabolism (13C, 31P, Cr/PCr, glucose, lactate), oxidative stress and antioxidant potential (GSH, ascorbic acid), psychotropic medication (19F, 7Li)	HW3 out, due 9/27/2017
4	9/27/2018	#4	Computer Lab: Data Processing Strategies Data handling, apodization, filtering, zero-filling, quality assessment, J-difference processing, phase/frequency/line shape/eddy current correction, combination of multi-dimensional data (Rx, NR), SVD water removal, concepts and strategies of Fourier processing	HW4 out, due 10/4/2018
5	10/4/2018	#5	Classroom: MRS in Mood / Anxiety Disorders MRS in unipolar major depression, bipolar disorder, anxiety disorders, obsessive compulsive disorder, post-traumatic stress disorder: roles of GABA and glutamate, evaluation of ECT, rTMS, and tDCS therapeutics, evaluation of ketamine treatment	HW5 out, due 10/11/2018
6	10/11/2018	#6	Classroom: MRS in Psychotic and Substance Abuse Disorders MRS in clinical high-risk for psychosis, first-degree relatives, first-episode schizophrenia, chronic schizophrenia, unmedicated state, effects of medication and other treatment modalities, addiction (ethanol, nicotine, cocaine), acute pharmacological challenge paradigms, pharmacological models of illness	no HW
7	10/18/2018	-	Midterm Exam (computer lab)	
8	10/25/2018	#7	Classroom: MRS in Neurodegenerative Disorders MRS in multiple sclerosis, Alzheimer's disease, Parkinson's disease, fronto-temporal dementia, Lewy body disease, amyotrophic lateral sclerosis: disturbances in myo-inositol, GABA, glutamate, and high-energy phosphates as indicators of glial integrity, excitation-inhibition disturbances, and tissue bioenergetic status	HW6 out, due 11/1/2018
9	11/1/2018	#8	Computer Lab: Data Analysis and Interpretation Model-based analysis, spectral fitting algorithms, Lorentzian/Gaussian/Voigt shapes, prior knowledge, identification of resonances, absolute quantification, Cramer-Rao lower bounds, Hessian error, Monte-Carlo error estimation, statistical testing, metabolic modeling, clinical diagnosis and pathophysiological interpretation, treatment monitoring, biomarkers as treatment targets, prediction of disease onset, prediction of illness exacerbation	HW7 out, due 11/8/2018
10	11/8/2018	#9	MR Scanner: Introduction to Environment and Hardware MR scanner, gradient system, gradient amplifiers, RF coils, RF filters, RF amplifier, controller / acquisition system, patient bed, patient monitoring, informed consent, metal detector, subject safety, pregnancy test, presentation software for functional tasks, stimulus paradigms, acquisition computer, acquisition software	HW8 out, due 11/15/2018
11	11/15/2018	#10	MR Scanner: Overall Experiment Setup and Execution (Phantom) Phantoms, phantom placement, MR system setup, RF coil setup, functionality testing, scout image, B0 shimming, FASTMAP, B1 shimming, RF power optimization, outer-volume suppression, water suppression, protocol design and execution,	HW9 out, due 11/22/2018
12	Thanksgiving 11/20/2018	#11	MR Scanner: MRS Experiment Setup and Execution (Phantom) MRS voxel placement, MRS problems and remedies: eddy currents, sequence timing, phase, baseline, residual water, STEAM, PRESS, semi-LASER, J-difference editing (JDE), spectroscopic imaging (MRSI), multi-planar chemical shift imaging (MPCSI)	HW9 out, due 11/29/2018
13	11/29/2018	#12	MR Scanner: In Vivo MRS Investigation (Volunteer) Representative in vivo MRS study procedure (comprising all aspect of classes 11-15) including informed consent, safety, subject preparation, anatomy and calibration, MRS setup, selective illustrative MRS protocols: STEAM, JDE	HW10 out, due 12/6/2018
14	12/6/2018	#13	Computer Lab: Processing, Quantification and Interpretation of In Vivo MRS Analysis of data acquired during class #12 with method and techniques discussed previously.	HW11 out, due 12/13/2018
15	12/13/2018	(#14)	Classroom: Potential, Limitations and Future Directions (OPTIONAL, Study Period) Promises and pitfalls, new neurochemicals, labeling, hyperpolarization, task-based MRS, multi-dimensional MRS, sparse MRS acquisition, information theoretical approaches / machine learning, 2-hydroxyglutarate (2HD) detection, Deuterium Magnetic Imaging (DMI)	no HW
16	12/20/2018		Final Exam (computer lab)	