

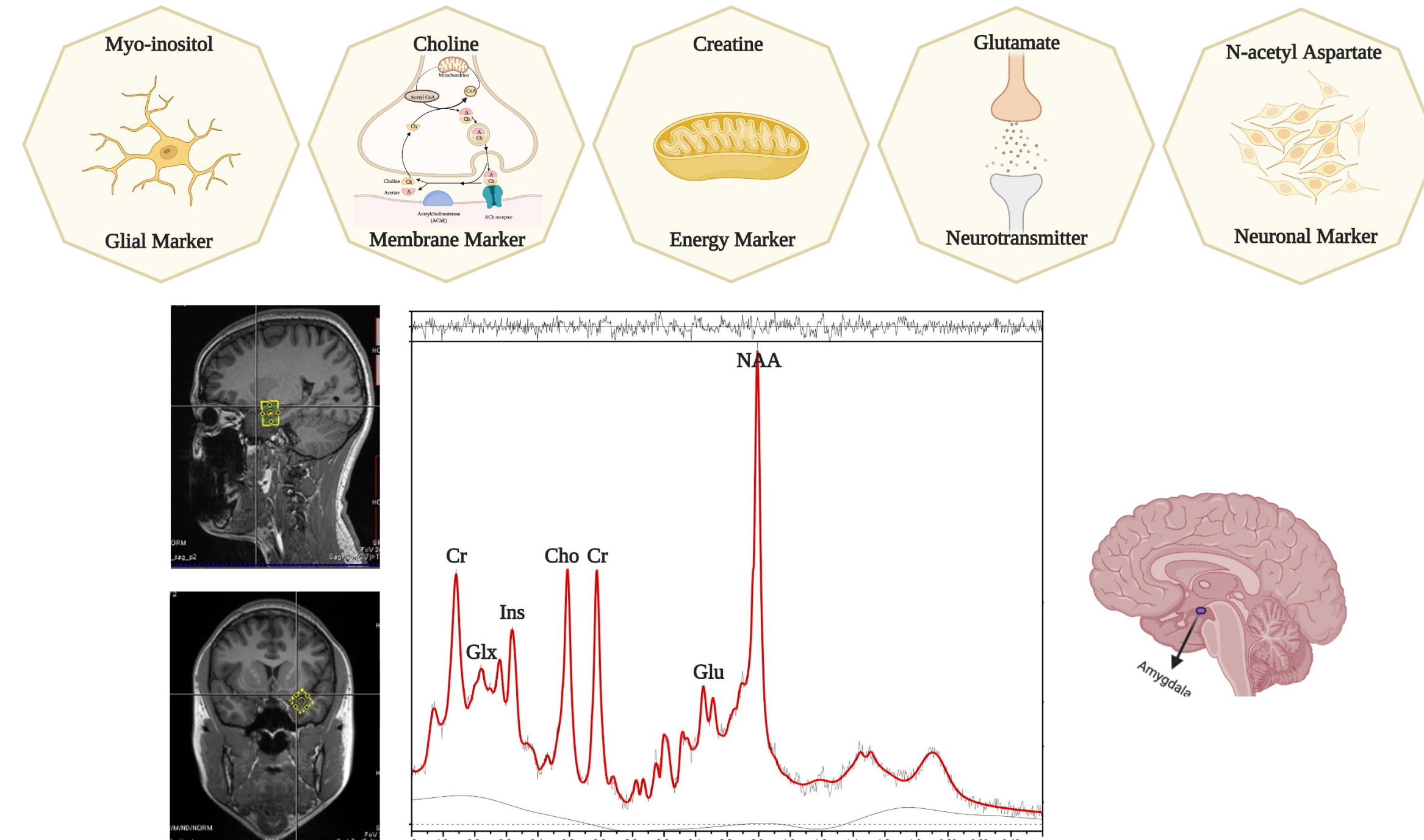
### Abstract

Magnetic resonance spectroscopy (MRS) is a noninvasive technique used for measuring biochemical changes in the tissue, and it can be conducted as a part of routine magnetic resonance imaging (MRI) on any commercially available scanners. While MRI identifies the anatomical changes, MRS creates a spectrum displaying the types and quantity of biomarkers. In clinical *in vivo* studies MRS can be utilized to investigate composition and function of human organs in various maladies such as psychiatric and neurological disorders, cerebrovascular diseases, monitoring carcinomas, liver cirrhosis, and breast cancer staging and treatment monitoring.

### Objectives

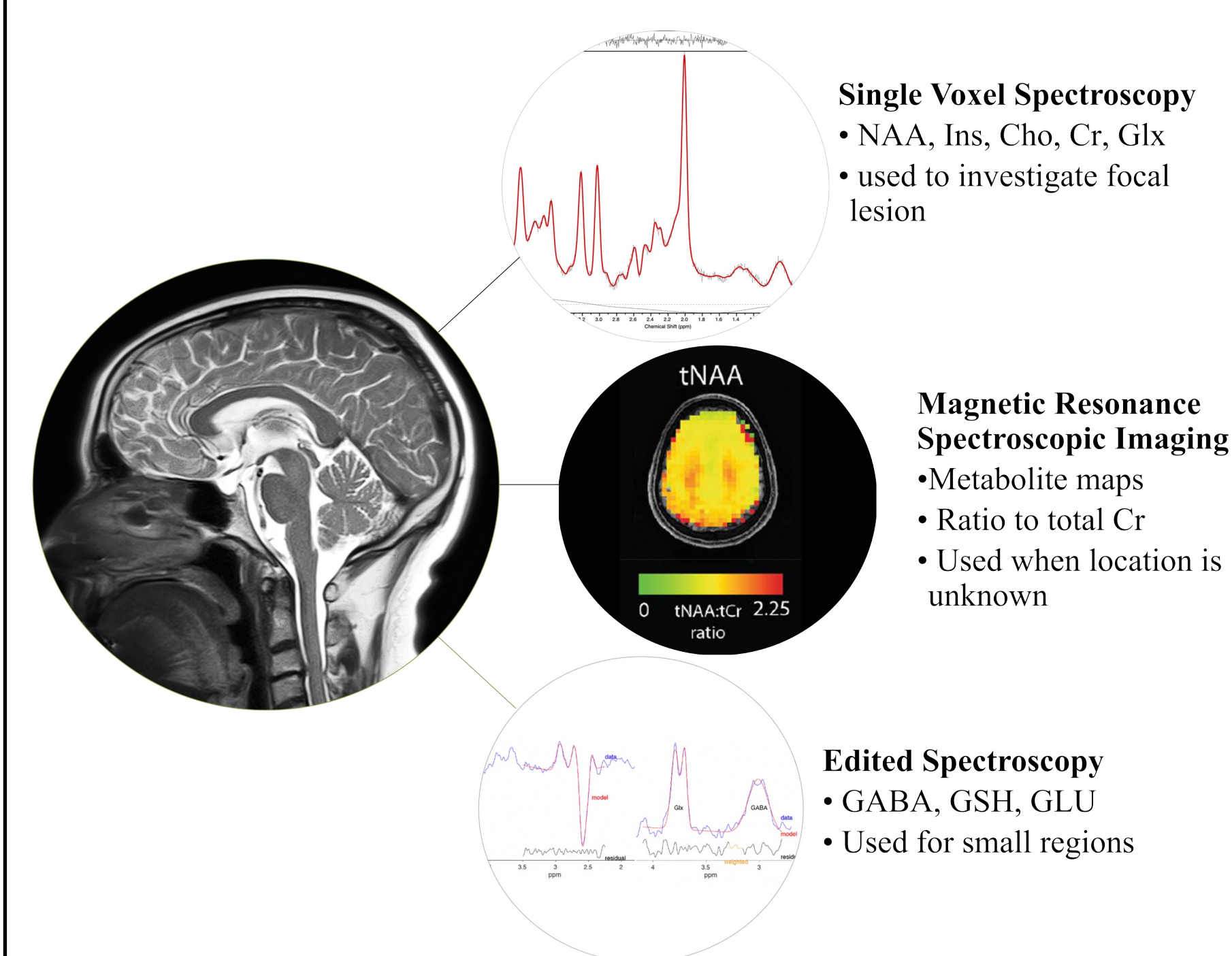
- Theory and principles of MRS implementation in clinical studies.
- Diverse clinical applications of MRS and ongoing projects at Purdue MRI Facility.
- MRS applications in Women's Health: Breast cancer diagnosis.
- MRS applications in Women's Health: Overcoming mental health stigma.

### Concept Drawing of Magnetic Resonance Spectroscopy



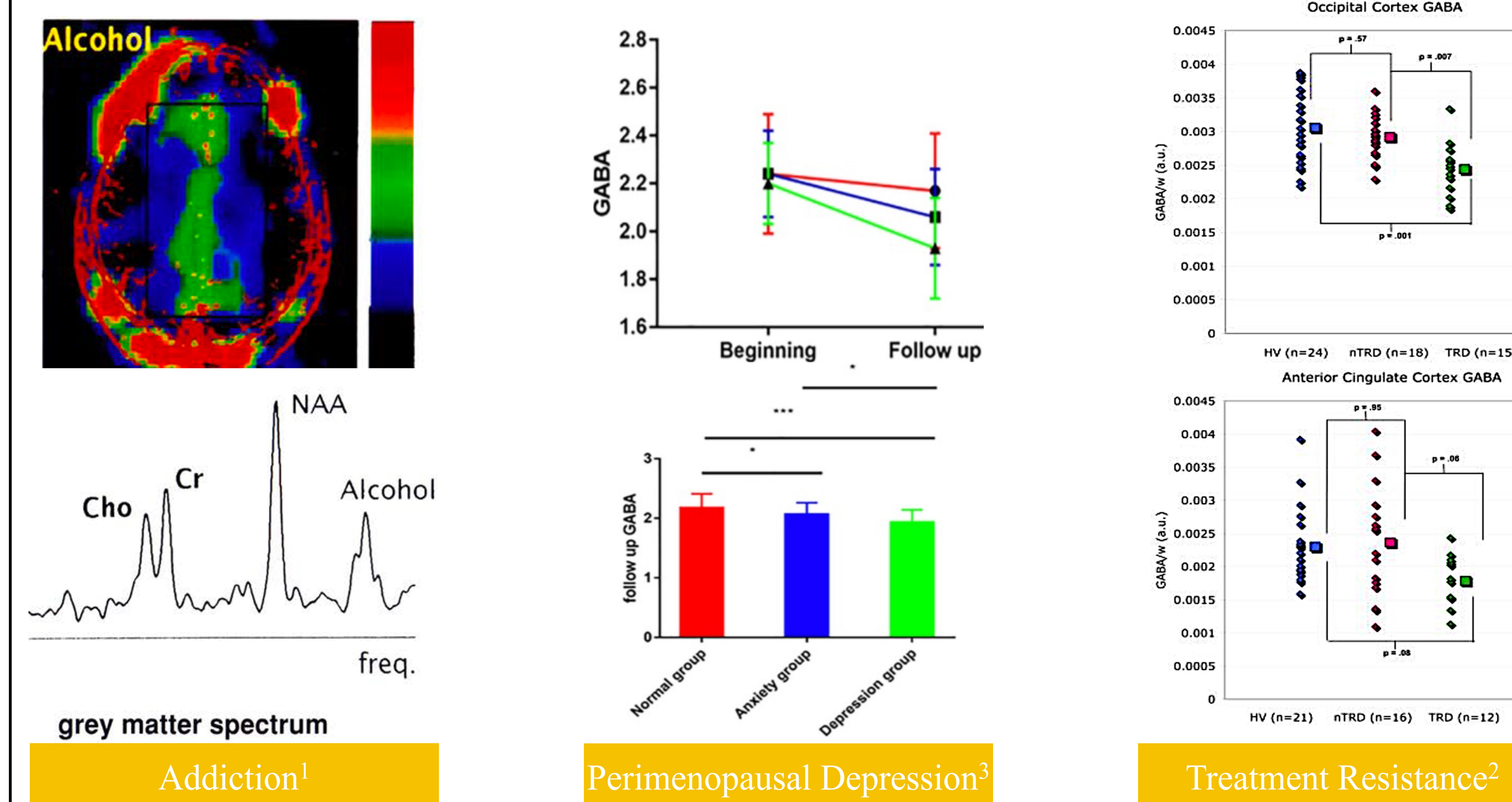
Clinically relevant biomarkers such as N-acetyl aspartate (NAA), choline (Cho), creatine (Cr), glutamate (Glu) and myoinositol (Ins) can be differentiated because they resonate at slightly different frequencies based on their local chemical environments.

### Principle of Implementation



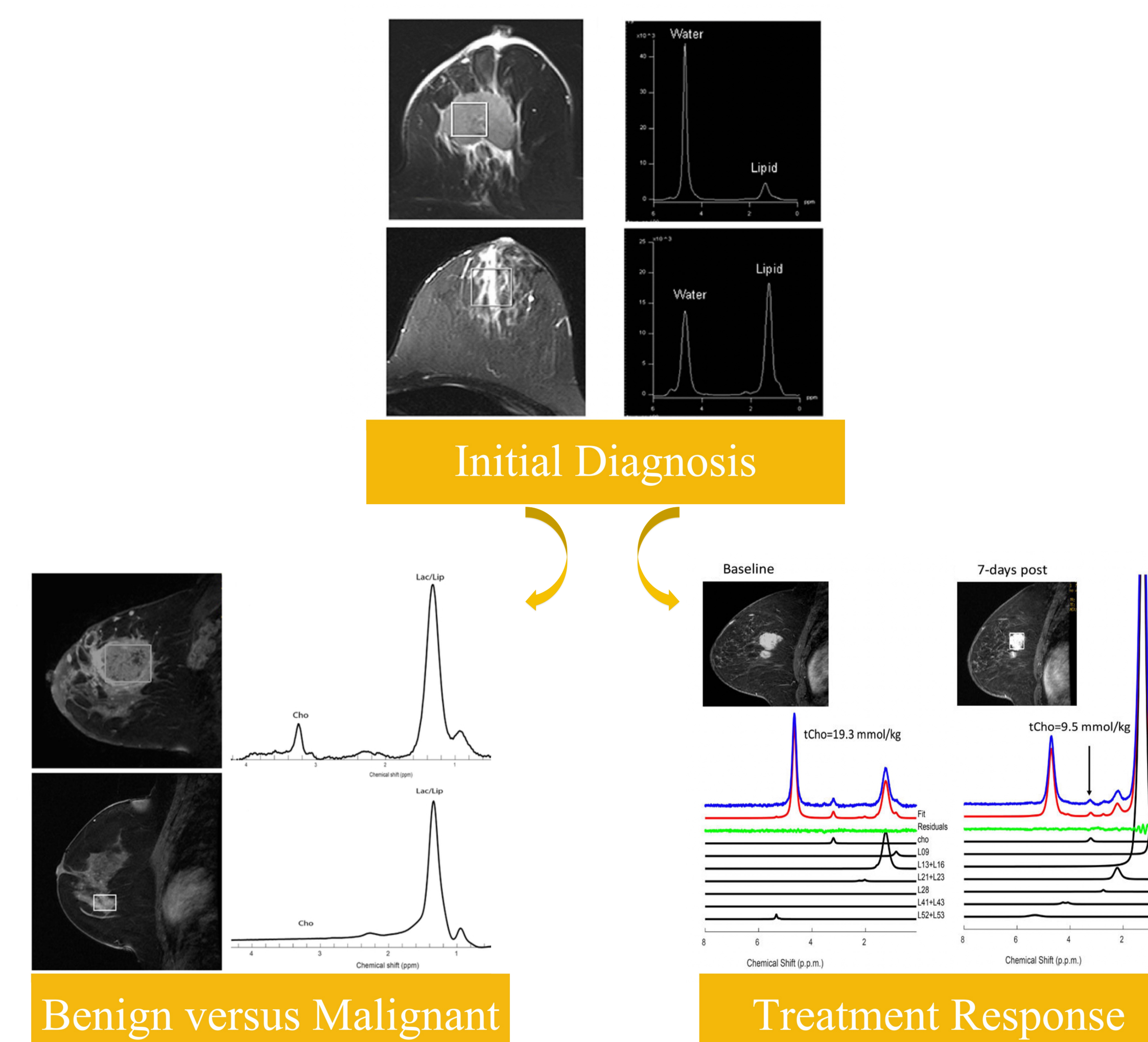
Single voxel spectroscopy is relatively fast and clinically valuable method used to acquire data from a small region, while magnetic resonance spectroscopic imaging is suggested when the location of interest is unknown<sup>4</sup>. Edited MRS is an advanced technique used to quantify the neurotransmitter GABA and the antioxidant glutathione.

### Biochemical Imbalances in Mental Health



MRSI allows researchers to determine effects of alcohol in the brain as well as its distribution<sup>2</sup>. Edited MRS can detect changes in GABA concentrations in the anterior cingulate cortex (ACC) which are related to the pathophysiological mechanism and symptoms of perimenopausal depression<sup>5</sup>. Moreover, edited MRS can be used to evaluate treatment resistance in patients with depression disorder. Decrease of GABA/W ratios in the occipital cortex (OCC) and ACC of treatment-resistant depression patients (TRD) provide evidence for a distinct neurochemical profile in patients who have failed to respond to standard antidepressants<sup>3</sup>.

### Breast Cancer Diagnosis and Treatment Response



MRS has been heavily investigated as an adjunct to morphologic and dynamic MRI to improve diagnostic accuracy in breast cancer, obviating unnecessary benign biopsies. Total choline signal (Cho) measured *in vivo* MRS has been used as a diagnostic test in the workup of malignant breast lesions. In addition to Cho metabolites, multiple lipids can be detected and monitored to differentiate between cancerous and healthy tissue<sup>1</sup>.

### Ongoing Studies at Purdue MRI Facility



Ongoing studies at Purdue MRI Facility include assessment of hyperbaric oxygen therapy in military veterans with PTSD, manganese toxicity in welders, repetitive sub-concussive hits in collegiate and high school football players, oxidative stress and neuronal activity affected by smoking in PTSD, neurochemical imbalances in post partum depression, neuronal biomarkers in addiction, clinically feasible MRSI, and optimization and sequence development for myelin imaging.

### Conclusions

- MRS was the first tool that demonstrated brain metabolism imbalances in mental health patients, changing the stigma of mental health.
- MRS has been implemented as an adjunct to morphologic and dynamic MRI to improve diagnostic accuracy in breast cancer, obviating unnecessary biopsies and altering the therapeutic approaches.

### Future Directions

- Actively recruit subjects for all our ongoing studies to advance MRS applications in Women's Health into larger clinical settings.
- Create new collaborations within the University to utilize MRS applications in novel translational studies.

### References

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2. Fein, George et al. (1995) PMID: PMC6875742
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4. Steel, Adam et al. (2018), doi:10.1038/s41598-018-26096-y
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