Course Title: The Gut-Brain Axis and Behavior				
Identification number	**Workload** 90h	**Credit points** 3ECTS	**Frequency of occurrence** Weekly, Tuesdays 17-19hr CEST (10-13hr EST)	**Duration** One Semester (August 30th-December 7th)

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size**
	a) Lecture b) Seminar	a) 27 h b) 12 h	51 Hrs, L and S preparation and preparation of for the oral presentation/exam	a) unlimited b) unlimited

2 **Aims of the module and acquired skills**

Course Description: All organisms must procure energy to survive. As such, many strategies have evolved to optimize the acquisition, use and storage of energy sources. Energetic value must be sensed, and costs determined and balanced against the physiological state of the organism and competing demands on behavior, such as seeking safety or showing aggression to secure a mate. To accomplish this, peripheral signals about acute and stored energy must be integrated with brain mechanisms regulating both metabolism and behavior. Until recently, metabolic and behavioral regulation were treated as operating relatively independently and often described as competing homeostatic and hedonic forces over behavior. However, this artificial boundary has begun to dissolve and with it the realization has emerged that mind and metabolism are highly integrated. More specifically, the biological imperative of optimal energy management results in metabolic signals having the potential to influence every facet of cognition, from basic perception to executive functioning, mood, affect and social interactions. Likewise, cognitive operations can directly impact metabolism, enabling organisms to bring all sources of information together in ensure optimal metabolic and behavioral "decision making."

This course will introduce the student to the gut-brain axis and its role in behavior. We begin with a series of lectures on the basics to provide an understanding of the types of signals that are used to communicate between the brain and the body. Then we review functions that are shaped or impacted by the gut-brain pathways. The didactic aspect of the course concludes with lectures that overview disorders in which gut-brain signaling plays a pathophysiological role. Students will be asked to make journal club style presentations, work together in small groups to design a conference symposium proposal and write a final paper on a topic of their choice. The course will conclude with symposium proposal presentations by the students.

The course will take place on Tuesdays from 10am-1pm EST (16hr-19hr Germany) and will be hosted on Zoom. NOTE: The first session with the local students will be held on August 31st 2021, using Microsoft Teams.

3	**Contents of the module**
	• Introduction to the gut-brain axis: Ivan de Araujo
	• Brain Sensory Circuits
	• Direct sensing of nutrients by the brain
	• Direct sensing of hormones by the brain
	• Microbiome and brain
	• Vagus signaling in the obese state
	• Gut-brain neural circuits of reward rodents
	• Gut-brain neural circuits of reward humans
	• Gut-brain axis and:
	  ○ nonfood reinforcement
	  ○ cognition humans
	  ○ neuroeconomics
	  ○ maternal nutrition
	  ○ alcohol
	  ○ depression
	  ○ addiction
	  ○ autism

4	**Teaching/Learning Methods** • Lecture • Seminars
5	**Requirements for Participation** Enrollment in a Master's degree course or PhD program in Berlin/Brandenburg, Audits from Postdocs/Undergraduates will be allowed with prior email confirmation
6	**Type of module examination** The final examination will be an oral exam where the students work in teams to develop a project idea related to the 'next idea/experimental question' based on the content of one (or more) of the lectures. The students will prepare a poster/presentation of the proposed project and then answer questions regarding the proposed project from their peers. The resulting presentation and discussion will be evaluated.
7	**Requirement for the allocation of credits** Regular and active participation in the exercises, after each lecture students must submit 1 Question/Answer about the specific lecture via email to both Prof. Park and Dr. Lippert by 17hr the following Wednesday. Final exam (= module exam) after the module Exam content: material of the lecture and exercises
8	**Compatibility with other Curricula** None
9	**Significance of the module mark for the overall grade** The grade will be based on a Pass/Fail system. 80% attendance at lectures (based on Question/Answer email submission) and completion of the final exam is required to receive a 'Pass'
10	**Local Module coordinator:** Professor Soyoung Park (Charité/DIfE; soyoung.park@dife.de) and Dr. Rachel Lippert (DIfE, Rachel.lippert@dife.de) **Course Directors**: Prof. Dana Small and Prof. Ivan de Araujo

11	**Additional Information:** **Literature:**

1