Forum Minireview

New Frontiers in Gut Nutrient Sensor Research
– From Taste Physiology to Gastroenterology: Preface

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The gastrointestinal tract, which begins at the mouth and ends at the colon, can be thought as the largest sensory organ in our body. Typically, gustatory signaling after taste sensation carries the information of nutrients necessary to maintain each nutrient homeostasis in the body. In the field of taste physiology, sweet, salty, and umami tastes have been thought as nutrient markers for energy (sugar and glucose), minerals (NaCl and KCl), and proteins (amino acids), respectively. Bitter and sour tastes are markers for toxic or pharmacologically active substances. Based on the taste information, we can determine what sort of foods to eat and which ones are beneficial to us. In contrast, the visceral information within the gut, which carries individual nutrient information, derives from foods digested in the gut by exocrine enzymes. This information is essential to maintain the homeostasis of each nutrient in the body.

Since Iggo et al. for the first time measured the nerve activity of the vagal afferent pathway with electrophysiological recordings (1), a variety of nutrients such as glucose, amino acids, and fatty acids have been found to activate the vagus from the gut, and a chemical perception system for each nutrient has been assumed in the gastrointestinal mucosa, the so called “gut nutrient-sensing” (2). For years, scientific knowledge about the mechanism and physiological significance of the gut nutrient-sensing has been unclear. However, identification of a series of taste receptors expressed in the gut as well as on the tongue elucidates the contribution of these receptors to the gut nutrient-sensing. For example, the bitter taste receptors (T2Rs) are expressed on enterochromaffin cells, and those for amino acid (T1Rs), glutamate (mGluRs), and fatty acid (GPR120 and GPR40) are also expressed on the gastrointestinal mucosa (3 – 6).

Many physiologists proposed a hypothesis that explains the recognition of nutrients on the lumen in the gastrointestinal tract. The Nobel Prize physiologist Ivan P. Pavlov presented the “nerve antenna theory” in the beginning of the 20th century. This theory gives an idea that sensory nerves are exposed to the lumen of the gastrointestinal mucosa and directly catch chemical messages of luminal nutrients at the nerve endings. Since then, many other hypotheses have been proposed and disappeared during the subsequent decades. Among those regarding gut nutrient-sensing, the most reliable theory is the “intestinal sensor cell theory”, originally proposed in the 1970s by Fujita at Niigata University School of Medicine (7). He proposed the existence of nutrient-sensing cells in the gastric antrum, and when these cells interact with luminal nutrients, they release hormones in an endocrine- or paracrine-fashion to transfer nutrient information to other organs, including the brain via endocrine- or vagal-pathways. His findings led to a new concept on the gut nutrient-sensing: luminal nutrients stimulate mucosal endocrine cells to release gut hormones via specific nutrient sensors.

Nutritional information from the gastrointestinal tract affects the regulation of food digestion and nutrient absorption and also eating behavior, eventually contributing to the formation of dietary habits. In particular, a more detailed knowledge on the physiological significance of gut nutrient perception would contribute...
to the development of new medicines to treat the medical problems recently attracting much attention, such as obesity, functional dyspepsia, and irritable bowel syndrome, because these problems can also be called “eating habit style–related disease”. We hope that this forum consisting of five mini-reviews provides the readers with knowledge about the current status of gut nutrient sensing research and gives us a new research strategy for understanding the pathophysiological aspects of gastrointestinal disorders.

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References