ARE CURRENT TEXTBOOKS GOOD ENOUGH FOR PHYSIOLOGY EDUCATION? FOR EXAMPLE, THE ECL CELLS ARE MISSING

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Current textbooks are believed to provide an updated knowledge. Medical students usually read the textbooks but not the literature that contain the original research articles and reviews. Here, we examined the gap between the current textbooks and literature with the enterochromaffin-like (ECL) cells as an example. A total of 70 textbooks that were published for medical education during the last 10 yr was examined. The literature has been searched mainly from the Internet. We found that most textbooks (59 of 70) fail to mention the ECL cells. Due to the lack of information on the ECL cells, the mechanisms behind gastric acid secretion are described variously from book to book. However, up to the year 2000, 574 research articles and reviews have been published on the various aspects of the ECL cells. The role of the ECL cells in the regulation of the acid secretion has been well demonstrated for more than 20 years. The fact that the textbooks are out of date cannot be explained by the time required to write and publish them. Therefore, we question whether or not the current textbooks are good enough for physiology education and suggest both teachers and students read not only the textbooks, but also utilize the other sources such as the Internet to find and fill the gaps between the textbooks and literature. This is one of the approaches of problem-based learning.

Key words: Internet; problem-based learning; literature; textbook; enterochromaffin-like cells; gastric acid secretion

In 1822, 19-yr-old Alexis St. Martin was accidentally shot in the upper abdomen. He survived afterward but lived with a permanent gastric fistula. Through the fistula, Dr. William Beaumont observed that the stomach produced a large quantity of HCl that was turned on/off rather than being secreted continuously (4). Since then, the physiology of the gastrointestinal tract, particularly the gastric acid secretion, has been one of the earliest and most studied subjects in modern medical research and education. Therefore, we followed up the progress of research with respect to the physiology of the stomach as an example to evaluate the quality of current textbooks.

In the early 20th century, it was postulated that endogenous bioactive substances, gastrin and/or histamine, stimulate the parietal (oxyntic) cells to secrete acid (6, 10–12, 15).
that gastrin is produced and released from the G cells in the antrum and that histamine is produced and released from the so-called enterochromaffin-like (ECL) cells in the oxyntic mucosa of the stomach. Gastric acid is produced by the H⁺,K⁺-ATPase (so-called “proton pump”) located in the canalicular membrane of the parietal cells (9, 18, 23). However, by searching the textbooks that were published during the last 10 years for medical education, we are surprised to find that the ECL cells are missing in most textbooks (~85%). In contrast, by searching the literature, the ECL cells were described already in 1966, and the significance of these cells has been studied and reviewed since then (5, 8, 13, 22).

Although it has often been noted and/or excused that textbooks lag behind progress in the field, it seems difficult to accept the fact that the most current textbooks have not included the knowledge that has existed for more than 20 years. The fact that the textbooks are out of date (>10 yr) cannot be explained by the time required to write and publish them. Therefore, we question whether or not the current textbooks are good enough for physiology education.

The ECL cells in textbooks vs. literature. We have searched 70 relevant textbooks that were published after 1990. Fifty-nine of seventy textbooks that are used by medical students and teachers do not contain information on the ECL cells. For instance, in the textbooks of cell biology (1), physiology (19), pathology (17), medicine (7), and oncology (14), the functional significance of the ECL cells is almost missing (Table 1). Due to the lack of knowledge about the ECL cells, the mechanism behind gastric acid secretion and the consequences of long-term treatment with acid inhibitors are described variously from book to book. Some books propose that histamine is produced by “histaminocytes,” mast cells, or mast-like cells within the lamina propria. Some books even state that histamine does not play any role normally in the regulation of the acid secretion. In contrast, from the Internet (mainly MEDLINE and PubMed), with the key words being ECL cells and/or enterochromaffin-like cells, we found that 574 articles (including original articles, reviews, and books) have been published since 1966 on the various aspect of the ECL cells (Fig. 1).

The importance of the ECL cells. The ECL cells can be defined as cells of closed type located in the oxyntic mucosa of the stomach; with typical cytoplasmic electron-dense granules/vesicles; producing and secreting histamine; and responding to gastrin with activation and growth. The physiological significance of the ECL cells can be expected to reflect the nature of their products. It has been well demonstrated that gastrin stimulates ECL cells to mobilize histamine and to activate the histamine-forming enzyme histidine decarboxylase. With time, gastrin stimulates the syn-

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<td>Frequency of reference to the ECL cells in the textbooks</td>
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<td>Subjects</td>
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Selected references are given. *, References that mention the ECL cells.
theses of proteins and DNA, resulting in ECL-cell hypertrophy and hyperplasia. The action of gastrin on ECL cells is known to be mediated by CCK-2 (previously referred to as CCK-B/gastrin) receptors (8). It has been widely accepted that histamine from ECL cells (but not mast cells) plays a central role in controlling the parietal cells to secrete acid (2, 8, 21). This is the so-called gastrin-ECL cell-parietal cell axis behind the mechanism of gastric acid secretion. Potent antisecretagogues, such as H₂-receptor antagonists and proton pump inhibitors, have been widely used during the last 30 years (e.g., ranitidine) and 15 years (omeprazole). An increased incidence of gastric carcinoids, which was later identified as ECL-cell tumors or ECLomas, was noted in the murine stomach after long-term treatment with these acid inhibitors. In view of the known trophic effect of gastrin on ECL cells, the stimulus behind the development of ECL-cell tumors is hypergastrinemia rather than achlorhydria. Thus the effective inhibition of gastric acid secretion abolishes luminal acid feedback inhibition of the antral G cells and leads to hypergastrinemia, which, in turn, stimulates ECL cells, resulting in first diffuse ECL-cell hyperplasia and, later, focal hyperplasia with multiple micronodules and finally carcinoid tumors (8, 22).

Concluding remarks. The rationale that we took the ECL cells as the example is not only because they play a key role in the regulation of acid secretion particularly, but also it deals with the physiology of the stomach in general, which has been one of the earliest subjects of research and education for more than 100 years. In the present study, by comparison between textbooks and literature, we found that such important and well-documented knowledge that has existed for more than 20 years has not been introduced into most current textbooks for medical students. It might be inferred that the problem of lack of such knowledge in the current textbooks could be extended to other issues as well. There is no doubt that the editors and authors of the textbooks should be responsible for providing updated knowledge. Although the “information era” should have reduced this lag, the role of the lecturer always has been to update and clarify existing published knowledge. Taking advantage of the Internet (e.g., searching the articles in http://www.ncbi.nlm.nih.gov:80/entrez/query.fcgi?db=PubMed), both teachers and students will be able to find and fill the gaps between the textbooks and literature. This is one of the approaches of problem-based learning.

This work was supported by the Medical Faculty of the Norwegian University of Science and Technology, Trondheim, Norway.

Received 13 November 2000; accepted in final form 26 February 2001

References