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Medical Education

Faculty perceptions of the strengths, weaknesses and future prospects of the current medical undergraduate experimental physiology curriculum in Gujarat, India

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Abstract

Over the past several years, an opinion has emerged in India that the current practical curricula in medical schools fail to meet many of the objectives for which they were instituted. Hence, this study has assessed the perception of physiology faculty members regarding the current experimental physiology curriculum in one Indian state, Gujarat. The faculty were of the opinion that many of the topics currently taught in experimental physiology (amphibian nerve-muscle and heart muscle experiments) were outdated and clinically irrelevant. Therefore, the faculty advocated that duration of teaching time devoted to some of these topics should be reduced and topics with clinical relevance should be introduced at the undergraduate level. The faculty also felt that more emphasis should be laid on highlighting the clinical aspect related to each concept taught in experimental physiology . Moreover, a majority of faculty members were in favour of replacing the current practice in Gujarat of teaching experimental physiology only by explanation of graphs obtained from experiments conducted in the previous years, with computer assisted learning in small groups.

Introduction

A curriculum is defined as a planned learning experience (1). Curricula of medical schools need to be regularly updated to reflect the latest advances in basic science and clinical care in order to improve the attitude of medical students towards the newer trends in medical education (2). The first step in designing a curriculum is to identify and characterize the healthcare problem that is currently being addressed by the curriculum. It is then necessary to determine the gap between the current approach to the problem and the ideal approach to the problem. This process known as 'needs assessment' is one of the key steps in curricular development. It is necessary to take into consideration the current and perceived ideal roles of each of the stakeholders viz.

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patients, medical professionals, health care educators and society in dealing with the healthcare problem (1).

Physiology is one of the foundation sciences for the medical curriculum. It forms the basis of all life sciences. In fact, in the preface to the first edition of their book 'Physiological Basis of Medical Practice', Charles Herbert Best and Norman Burke Taylor wrote in 1938, "The physiologist can play a part in giving the student and practitioner a vantage point from which he may gain a rational view of pathological processes" (3).

In India, physiology is taught in the first year of the medical school of the Bachelor of Medicine and Bachelor of Surgery course (MBBS course- four and a half years plus one year internship). The practical physiology curriculum for the undergraduate medical student in first MBBS includes hematology, basic clinical skills and amphibian experiments. The aim of teaching practical physiology is to facilitate better understanding of the principles of physiology and to inculcate the basics of clinical medicine in the future doctors [4]. Animal experiments were previously being used in physiology departments of all medical schools in India for the training of both undergraduates and post graduates. However, the Government of India has recently issued guidelines to the Medical Council of India (MCI) to discontinue live animal experiments for the training of medical students, and instead use alternatives to animal experimentation (5). Hence, amphibian (nerve-muscle and heart muscle) experiments in many medical schools in India, including all schools in the state of Gujarat, are taught by explanation of graphs obtained from studies conducted in the previous years. The curriculum in experimental physiology in Gujarat includes approximately fifteen topics. These topics are taught in 3-hour sessions in an experimental physiology laboratory which is equipped with the necessary tools to perform amphibian experiments. However, in view of the guidelines issued by the Government of India, each topic or a combination of topics is taught only by explanation of graphs. At the beginning of the class the instructor explains each experiment. The instructor elucidates the principle of the experiment, the method of performing each experiment, the underlying principle of physiology, and also highlights the clinical aspect related to each principle. After completion of this didactic session, students are provided with graphs (obtained from experiments conducted in the previous years or xeroxed from textbooks) and given a practical exercise. The students are then supposed to answer the questions provided in their exercise books. The entire curriculum thus involves about 11 3-hour sessions (for each student) and is completed during the first semester of the two semester first MBBS course in approximately four months.

Curriculum in basic sciences should be designed such that the medical student is imparted knowledge which enables him to become a competent physician (6). Over the past several years opinions have emerged that the practical curricula in medical schools in India have failed to meet the objectives for which they were instituted. Also medical faculty have expressed the opinion that the students are being taught practicals which they will never apply or practice in future (7, 8) and that there is no synchronization with the modern methods and recent advances in biomedical sciences (7). Faculty and students of medical schools in India are also of the opinion that animal experiments should be discontinued, that the curriculum in experimental physiology and pharmacology needs to be updated, that the same understanding of topics could be obtained by using alternative methods and that there is an urgent need to introduce alternatives to animal experiments (9, 10, 11).

The aim of the present study was to assess the perception of physiology faculty members regarding the strengths and weaknesses of the experimental physiology (amphibian experiments) curriculum in the western Indian state of Gujarat, and to suggest ways to improve it.

Methods

To determine the perception of faculty about the strengths and weaknesses of the practical curriculum, a questionnaire was prepared. The study was approved by The Institutional Ethics Committee (IEC)

of Gujarat Medical Education & Research Society (GMERS) Medical College, Gotri, Vadodara. A pilot survey was carried out before the actual survey. The pilot study was carried out in the physiology departments of Medical College, Baroda and Government Medical College, Bhavnagar. From the results of the pilot survey, internal consistency of the questionnaire was calculated.

For the main survey, the questionnaire was sent by post in sealed covers to physiology departments of 14 of the 16 medical colleges in Gujarat. A faculty member was identified in each department to co-ordinate with other members of his/her department. Faculty members were also contacted by telephone and encouraged to fill the questionnaire. Responses were received from 13 out of the 14 colleges, and about 90%(110) of the faculty members responded.

The questionnaire was organized based on the current experimental physiology curriculum and sought the opinion of faculty members regarding :

1) The qualities of the practical curriculum

2) The relevance of topics taught in experimental physiology

3) Areas to be covered in each particular topic

4) The duration of hours devoted to a particular topic.

5) Alternative methods to teach each topic

Opinion was also sought regarding introduction of new topics related to recent advances in clinical physiology.

Qualitative aspects of the curriculum were evaluated on a 4-point Likert scale [1-strongly disagree, 2-disagree, 3-agree, 4-strongly agree]. The contents of the curriculum were also evaluated on a similar relevance scale [1-not relevant, 2-moderately relevant, 3-relevant, 4-extremely relevant]. The respondents were asked about sub-areas to be covered in each particular topic. Opinion regarding duration of hours devoted to a particular topic was sought on an agreement scale [1-Agree, 2-Disagree]. A list of novel topics related to recent advances in physiology was prepared. Agreement regarding introduction of topics was sought on an agreement scale [1-Agree, 2-Disagree]. At the end of the questionnaire, space was provided for additional suggestions to improve the curriculum.

While the respondents did not have to reveal their identity, information was sought regarding the current faculty position held by the respondent and the duration of his/her teaching experience. The respondents were also asked to indicate whether they worked in a government, semi-government or private institution.

Results

From the results of the pilot survey, Cronbach's alpha was calculated for the themes, to judge the internal consistency of the questionnaire (12, 13). The internal consistency was found to be satisfactory. Cronbach's alpha for the various themes was as follows :quality of the current experimental physiology curriculum- 0.73; relevance of the topics-0.89; and for list of topics from recent advances in physiology which could be introduced at the undergraduate level -0.86.

A minimum percentage of 75% was set to indicate agreement on any particular item of all themes (7, 14). Ratings of 1 and 2 on the four-point relevance scale were combined to represent "irrelevant" while ratings of 3 and 4 were combined to represent "relevant". Agreement ratings were combined in a similar fashion; ratings of 1 and 2 indicated disagreement, while ratings of 3 and 4 indicated agreement.

For the main survey, responses were obtained from about 90% (110) of the participants. The following eight qualities were agreed upon by less than 75% of the respondents from the theme "qualities of the current experimental physiology curriculum" (Table I) : 1) The curriculum is in alignment with the learning objectives (61.6%) (2). The curriculum is in alignment

with the teaching-learning methods (59%) (3). The curriculum is in alignment with the assessment methods (59.9%) (4) The curriculum helps better understanding of allied sciences like pathology, pharmacology and medicine (61.1%); (5). The curriculum helps to apply the knowledge to clinical situations (51.2%); (7). The curriculum encourages active learning among student (41%); (8). The laboratory exercise increase critical thinking (48.7%) and (6). The laboratory exercises increase problem solving (41.8%). However, a large majority of the respondents (78.8%) agreed that the curriculum helps the student better understanding of principles of physiology.

The following curricular elements (9/15) were considered relevant by less than 75% of the participants (Table II) : study of appliances (58.2%), nerve-muscle preparation (52.9%), simple muscle twitch (64.2%), effect of temperature on simple muscle twitch (60.2%), effect of increasing strength of stimuli on muscle contraction (62.4%), normal cardiogram of frog (59%), effect of temperature on frog's heart (59%), effect of stannius ligature on frog's heart (59.3%). The participants considered the remaining curricular elements relevant.

Regarding the teaching of each topic, majority of the respondents suggested that there was no need to teach the method of performing the experiment , and that emphasis should be laid on discussion of the relevant concept in physiology and highlighting of the importance of each concept in a clinical setting (Graph I).

Regarding the duration of teaching time allotted to the various topics in experimental physiology, a majority of respondents (>50%) suggested a reduction in the teaching time in case of the following topics viz. genesis of tetanus (51.3%), effect of load on skeletal muscle contraction (53.6%), conduction velocity of nerves in frog (53%), effect of stannius ligature on frog's heart (52.6%) (Table III).

A majority of the respondents (>50%) suggested

TABLE I : Qualities of the curriculum. (Figures indicate the percentage of respondents.)

Sl. No.		*Strongly disagree*	*Disagree*	*Agree*	*Strongly agree*
1.	The curriculum is in alignment with the learning objectives	2.6	34.2	57.3	4.3
2.	The curriculum is in alignment with the teaching-learning methods	12	27.4	48.7	10.3
3.	The curriculum is in alignment with the assessment methods.	9.4	26.5	55.6	4.3
4.	The curriculum helps the student better understanding of principles of physiology	6.8	17.9	62.4	12
5.	The curriculum helps the student better understanding of allied sciences like pathology, pharmacology and medicine.	7.7	33.3	48.7	9.4
6.	The curriculum helps the student to apply knowledge to clinical situations	12	35	44.4	6.8
7.	The curriculum encourages active learning among student	17.1	40.2	33.3	7.7
8.	The laboratory exercise increase critical thinking.	10.3	39.3	44.4	4.3
9.	The laboratory exercise increase problem solving skills	12	45.3	33.3	8.5

TABLE II : Relevance of the topics. (Figures indicate the percentage of respondents.)

Sr. No.	*Topic*	*Not relevant*	*Moderately relevant*	*Relevant*	*Extremely relevant*
1.	Study of appliances	19.7	22.2	46.2	12
2.	Nerve-muscle preparation	14.5	32.5	44.4	8.5
3.	Simple muscle twitch	5.1	30.8	52.1	12.1
4.	Effect of temperature on simple muscle twitch	6	33.3	49.6	11.1
5.	Effect of increasing strength of stimuli on muscle contraction	6	30.8	52.1	10.3
6.	Genesis of tetanus	5.1	17.9	59.8	17.1
7.	Genesis of fatigue	5.1	17.1	59	18.8
8.	Effect of load on muscle contraction	5.1	18.8	58.1	17.9
10.	Conduction velocity of nerves in Frog	9.4	22.2	56.4	12
11.	Normal cardiogram of Frog	12	29.1	48.7	10.3
12.	Effect of temperature on Frog's heart	11.1	29.1	49.6	9.4
13.	Effect of stannius ligature on Frog's heart	10.3	32.5	45.3	12
14.	Properties of cardiac muscle	4.3	21.4	49.6	24.8
15.	Effect of drugs and identification of drugs	5.1	19.7	50.4	24.8

Graph I – Areas to be covered in each topic.

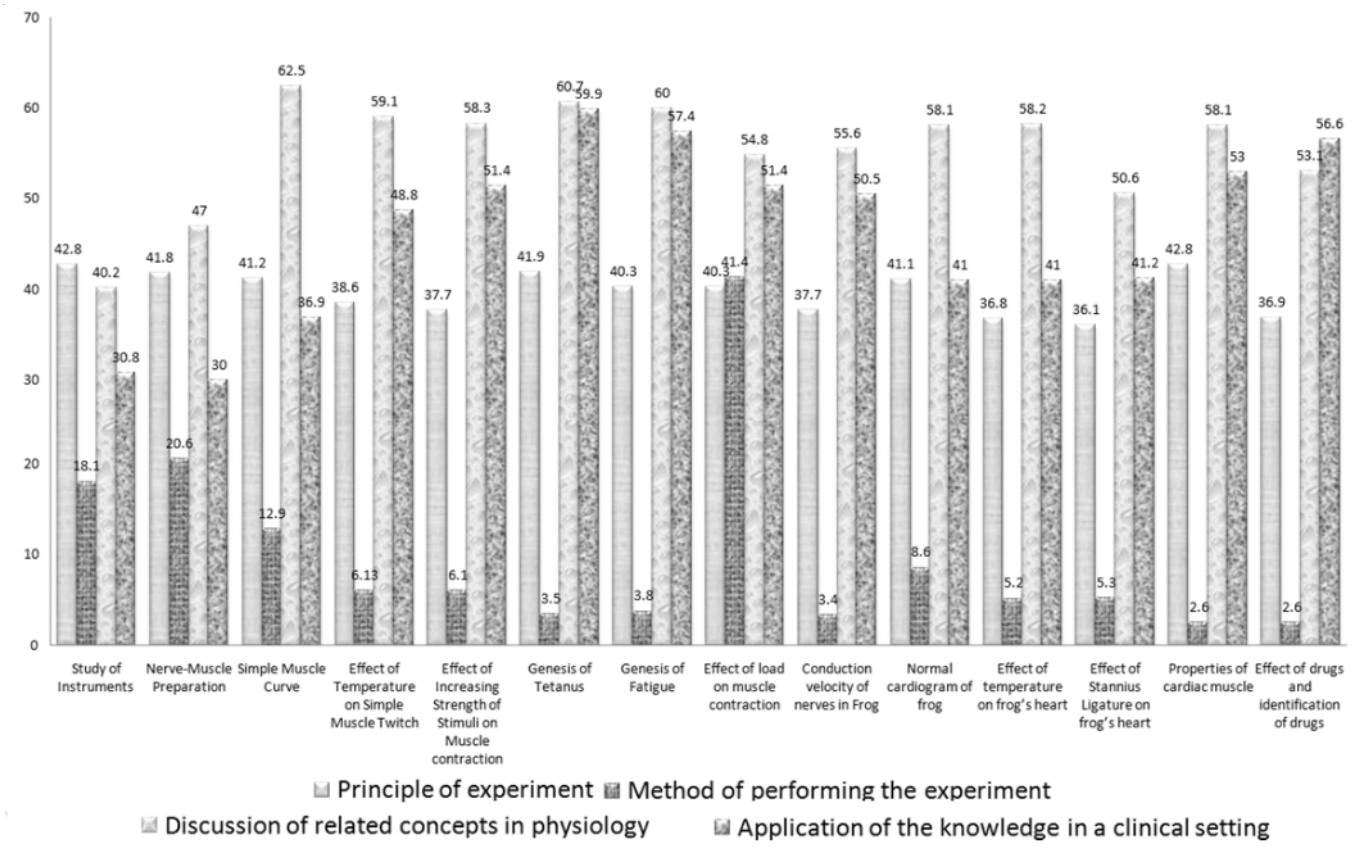


TABLE III : Duration of teaching time devoted to each topic.

Sr. No.	*Topic*	*Teaching time allotted to each topic (in hrs.)*	*Agree (%)*	*Disagree (%)*	*Increase (%)*	*Decrease (%)*
1.	Study of appliances	3	53	42.8	8.5	36.8
2.	Nerve-muscle preparation, simple muscle twitch & Effect of temperature on simple muscle twitch	3	57.3	39.4	10.3	30.8
3.	Effect of increasing strength of stimuli on muscle contraction	1	74.4	22.3	10.3	11.2
4.	Genesis of tetanus	3	36.8	57.4	10.3	51.3
5.	Genesis of fatigue	2	48.7	48.7	9.4	38.5
6.	Effect of load on muscle contraction	3	38.5	56.5	6.3	53.6
7.	Conduction velocity of nerves in Frog	3	35.9	59	9.4	53
8.	Normal cardiogram of Frog + Effect of Temperature on Frog's heart	2	64.1	33.3	8.5	24.8
9.	Effect of stannius ligature on Frog's heart	3	39.3	56.5	6.4	52.6
10.	Properties of cardiac muscle	3	59	36.7	14.5	25.6
11.	Effect of drugs and identification of drugs	6	46.2	46.2	10.3	40.1

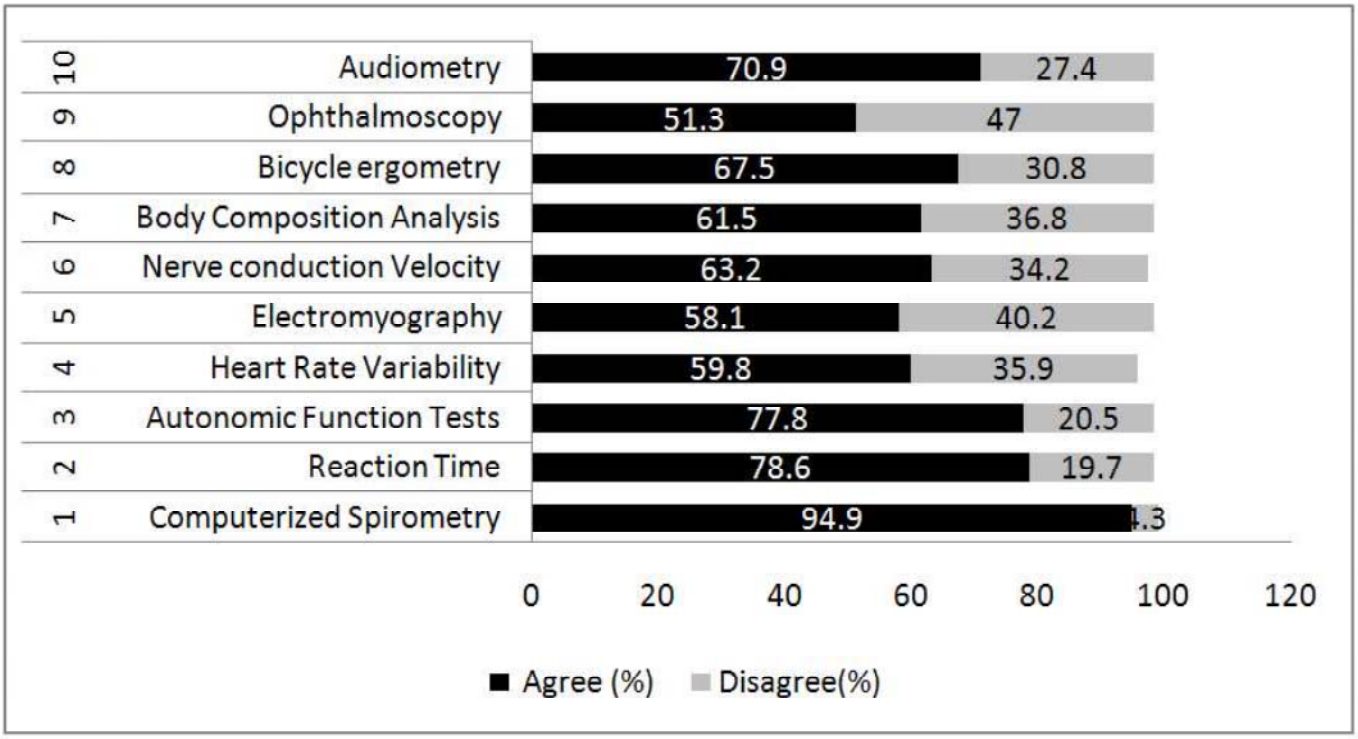
computer assisted learning in small groups as the alternative method to teach amphibian experiments (Table IV). A majority of the respondents (>50%) were also in favors of introduction of the topics related to recent advances in physiology (Graph II).

Respondents gave a number of suggestions to improve the curriculum, which broadly could be categorized as : introduction and emphasis on clinical physiology, introduction of case based learning and doing away with amphibian experiments entirely.

TABLE IV: Alternative methods to teach each topic.

Sr. No.	*Topic*	*Computer assisted learning in large group (lectures) (%)*	*Computer assisted learning in small group (%)*	*Any other suggested method (%)*
1.	Study of appliances	18.8	65	12.8
2.	Nerve-muscle preparation	19.7	69.2	8.5
3.	Simple muscle twitch	21.4	70.9	5.1
4.	Effect of temperature on simple muscle twitch	24.8	67.5	5.1
5.	Effect of increasing strength of stimuli on muscle contraction	20.5	71.8	5.1
6.	Genesis of tetanus	18.8	75.2	5.1
7.	Genesis of fatigue	18.8	76.1	3.4
8.	Effect of load on muscle contraction	18.8	76.9	3.4
9.	Conduction velocity of nerves in frog	20.5	74.3	4.3
10.	Normal cardiogram of frog	21.4	71.8	5.1
11.	Effect of temperature on frog's heart	24.8	67.5	6
12.	Effect of stannius ligature on frog's heart	20.5	70.9	6
13.	Properties of cardiac muscle	21.4	75.2	3.4
14.	Effect of drugs and identification of drugs	17.1	76.9	5.1

Graph II – Topics from recent advances in physiology which could be introduced at the undergraduate level.



Discussion

The aim of the practical physiology curriculum is to provide the students with necessary understanding of physiological principles that will enable them to be good practicing physicians (4). However, the faculty members were of the opinion that the current experimental physiology curriculum fails to fulfil many of its objectives. Though the majority of the faculty agreed that practicals in experimental physiology enable better understanding of the principles of physiology, they felt that experimental physiology did not help them better understand allied sciences like pathology, pharmacology and medicine. Faculty were also of the view that the current curriculum

failed to encourage active learning; and it also failed to promote critical thinking and problem solving. This corroborates with other studies done in India, which suggest that practical curricula fail to meet their objectives and lack the qualities of critical thinking and problem solving (7, 15).

Many of the topics currently taught in experimental physiology were considered 'not relevant' or only 'moderately relevant' by a large number of faculty members. There should an explicit connection between the knowledge gained in the basic sciences and the clinical problems (6). However, there are certain topics currently being taught in the experimental physiology curriculum which have no clinical relevance. Doctors who were interviewed several years after their graduation have held similar views. They complained that though what they learnt in the pre-clinical part of the medical course gave them a good background knowledge, they had also learnt too much irrelevant knowledge in those areas (16). Thus, our study substantiates the view that practical curricula in medical schools in India are "outdated and obsolete, and have failed to achieve the objective for which they were instituted" (8).

A majority of faculty members were of the opinion that while teaching each topic, there is no need to explain the method of performing each experiment; however, the instructor should focus on teaching the relevant concept in physiology and also highlight the importance of each concept in a clinical setting. Also a majority of the faculty members were of the opinion that the duration of teaching time currently allotted to some of the topics should be reduced. Faculty members and students in other studies have expressed similar views (9, 10). It may be noted that the duration of 1st MBBS in Indian medical schools has been curtailed to one year from the previous one and a half years (4). Hence, time is of essence. Also a vast majority of faculty members agreed that newer topics from recent advances in physiology like computerized spirometry, autonomic function tests, electromyography, etc. should be introduced at the undergraduate level. It may be concluded that the faculty members were strongly in favor of decreasing the time allotted to certain topics in experimental physiology and using the additional spare time for topics with clinical relevance. This corroborates with other studies done in India which suggest that practical curricula in basic sciences should be made clinically relevant, and that outdated and clinically irrelevant topics should be culled (7, 15).

Majority of the respondents favored introduction of computer assisted learning in small groups as an alternative to the current practice in Gujarat of teaching amphibian experiments only by explanation of graphs obtained from actual experiments performed in the previous years. Research has shown that the use of alternatives to animal experiments in undergraduate medical education (computer assisted models, etc.) can circumvent most of the problems associated with animal experiments, whilst achieving equivalent learning outcomes (11). The faculty should be apprised of the various alternatives to animal experiments, the hardware required, the cost and the availability of the alternatives. These alternatives should be validated against the 'gold standard' animal test (17). Also faculty should be provided with training in the newer techniques through workshops, which will greatly assist in implementing the newer techniques (18).

The main finding of this study is that faculty feel that the current experimental physiology fails to meet many of the objectives of the course, and that most of the topics are outdated and clinically irrelevant. The faculty are of the opinion that emphasis should be laid on highlighting the application of the principles of physiology in a clinical setting. The faculties also advocate a reduction in the teaching time allotted to some of the topics. The faculty are in favor of introduction of computer assisted learning in small groups to replace the current practice of teaching experimental physiology in Gujarat with graphs, and also agree that many newer topics related to recent advances in experimental physiology should be introduced at the undergraduate level.

Thus, the present study carried out in Gujarat provides a 'needs assessment' for reforming the current experimental physiology curriculum. It upholds the view that there is an imperative need to implement

radical changes in the experimental physiology curriculum which should be in consonance with patient care for the doctors of tomorrow to render better health service. The limitation of this study is that it represents the perception of faculty from only one Indian state, Gujarat. However, the questionnaire of the present study can be used to seek the perception of faculty members across India. This can then be used as a guide to realign the practical physiology curriculum with the innovations in clinical medicine. This will take ' physiology from bench to bedside', and truly inculcate the basics of clinical medicine in tomorrow's physicians of first contact.

Disclosures

No conflict of interest, financial or otherwise.

Author contributions

Both SP& CS have contributed equally to the design and execution of the study. CS has contributed towards the compilation of the results. SP has drafted the manuscript. SP and CS have edited and finalized the final draft of the manuscript.

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