similar in character to those present in the contents of the case were made up, sterilized and inoculated with the various forms of organism isolated. This experimental work was done with the three forms of bacteria which were present on repeated culture experiments.⁷

The food mixtures used were solutions of glucose and peptone. The test solutions, having been sterilized and found by tests to be free from alcohol and organic acid, were inoculated and placed in gas test tube at 37° C. and tested at various periods up to forty-eight hours to detect the evidences of fermentation, gas formation, or alcohol or organic acids.

As a result of these experiments it was found that each of the three forms of organism isolated possessed the capacity to produce in the food mixture some decomposition products similar in nature to those abnormal products found in the fermenting contents from which the bacteria were isolated.

The action of the several forms of organisms showed considerable variety.

All three formed gas (CO₂) and alcohol at some stage of the fermentation and all formed some kind of organic acid.

The specific action of each organism may be seen from the accompanying table. As you can see from this, when the products of each organism are combined we have the whole collection of abnormal organic products which are found in our contents.

TABLE.

1. *Coccus* in 100 c.c. neutral carbohydrate-proteid solution for 24 hours produced — gas 50 cc.
Alcohol.
Lactic acid (a trace).
Acetic acid.
Total acidity = 44 cc. decinormal soda in 100 c.c.
Total free (organic) acid = 14 c.c. decinormal soda in 100 c.c.
2. *Short bacillus* in 100 c.c. solution for 24 hours produced — gas 40 cc.
Alcohol.
Butyric acid.
Acetic acid.
No lactic acid.
Total acidity = 30 cc. decinormal soda in 100 cc.
Total free acid = 10 cc. decinormal soda in 100 cc.
3. *Long bacillus* in 100 cc. solution for 24 hours, produced — gas 20 cc.
Alcohol.
Lactic acid (much).
Acetic acid.
Total acidity = 40 cc. decinormal soda in 100 cc.
Total free acid = 16 cc. decinormal soda in 100 cc.

Control solutions of the food mixtures showed none of these abnormal products and no gas formation under the same conditions.

We have thus in our case determined a genesis of the pathological fermentation present by the experimental method. That is, we have, to use the traditional phraseology, isolated certain

definite organisms repeatedly from a contents, grown these in pure culture, and produced by their inoculation to sterilized food mixtures an infection similar in character and producing similar fermentation products to that found in our original case.

Also we have determined the special ferment action of each of the three organisms present.

Of course, it does not follow from this work that the organisms isolated are the whole cause of the fermentation in our case. Also, in this work the complete fermentation process has not been investigated. We simply determined the fermentation by the presence of certain abnormal decomposition products and reproduced the fermentation which will form these products.

This work is sufficient, however, to serve as an experimental demonstration of pathological fermentation in the body and to give us a fundamental understanding of the process, as it was produced in our case, serviceable for clinical instruction, and it was to obtain a simple scheme of demonstration of this subject for use in medical instruction that this work was undertaken.

Further investigation of the subject — consisting of the identification and study of the properties of the bacterial ferments isolated in this case; their action in varying strengths of free hydrochloric acid; their growth and products in various food substances, as pure carbohydrate or proteid solution; and the influence of various so-called disinfecting drugs upon their activity — will be reported in a late article.

I wish to express my thanks to Prof. Harold C. Ernst for assistance in this work, a part of which was done in his laboratory.

INTERNAL MEDICINE, TO WHAT EXTENT REQUIRED OR ELECTIVE IN THE MEDICAL COURSE?¹

BY S. G. BONNEY, A.M., M.D., DENVER, COL.,

Dean and Professor of Medicine, Denver and Gross College of Medicine.

In order to more clearly define the applicability of the elective system to internal medicine it is almost necessary to consider first its general relation to a medical course and to review briefly the trend of medical educative thought.

The sociologic and economic conditions of the country do not at present, as formerly, require a large number of physicians to supply from time to time the needs of the smaller communities. There is on the contrary an appeal for relief from the incubus of the insufficiently prepared practitioner, in order that more encouraging inducements may be offered to the type of the educated physician.

From a strictly business standpoint these inducements to spend years of preparatory study are now becoming not particularly attractive to those contemplating general medicine in view of the active competition incident to the overcrowding of the profession. Failure to remain

¹ Read before the American Academy of Medicine in Washington, May 12, 1903.

⁷ *Sarcina* were obtained but once in culture. They were present in numbers in the sediment in the first specimen of contents only. The ferment action of this form of bacteria has been studied by Coyon (Contribution to the Study of the *Sarcina Ventricula*, *Compt. rend. de la Soc. de Biol.*, Dec., 16, 1899). He found that *sarcina* in pure solutions of peptone formed acetic and formic acids and some butyric acid. In carbohydrate solution they formed acetic, formic and lactic acids.

in medical practice is said to attend the efforts of nearly one-third of all graduates in recent years.

Despite the recent advances in medical teaching, consisting in part of more rigid requirements for admission, the lengthening of the period of study and the enlargement of the curriculum, all tending to impose legitimate restrictions upon the number of students, and notwithstanding, also, the well-known uncertainties of success in practice, there is, nevertheless, no material diminution in the number of young men willing and anxious to undertake the laborious task of systematic medical study.

This implies a certain change in the motives and aspirations of the more liberally educated medical students of to-day, some of whom are induced to begin the study of the purely scientific aspect of medicine, with its opportunities for original research and investigation, while others are attracted early to the possible attainment of special knowledge and skill in certain departments, with the hope of subsequent contribution to the science of medicine, rather than the acquirement of a large general practice.

These natural tendencies in students have been further influenced by necessary and progressive changes in the course of medical instruction.

As a result of the greatly enlarged curriculum and the enormous increase of medical knowledge, the student is brought to a realization in the beginning of his career that he will be utterly unable to acquire even a superficial knowledge of all branches, and that he may hope to attain a degree of proficiency only in a small proportional part of his profession.

The inevitable result is an appreciation of the necessity for specialization in some form. In spite of the admitted objections to the greater development of specialism, the fact remains that it is distinctly in accord with popular and professional demand. A high degree of special attainment based upon broad fundamental knowledge has ever been the chief factor in advancing the science and art of medicine. Save in the remotely settled districts, the day of the general practitioner in his ordinary acceptance is nearly at an end, and in his place are to be found men, who, if they are less courageous, less self-reliant than the time-honored country doctor, are, nevertheless, more cognizant of their limitations.

To encourage intelligent specialism, to afford an opportunity to excel in certain departments, and at the same time to guard against superficial and disproportionate work, constitutes an important province of the modern medical school.

To this end a full interpretation of the elective system has been offered, not with a view of aiding premature specialization, but more to permit an early beginning of a thorough preliminary preparation leading to subsequent advanced work either in internal medicine or other specialties.

The elective system may be defined as that method of instruction which permits the exer-

cise, under a supposedly wise direction, of the student's choice of study according to his conception of his peculiar needs and purposes and his inherent adaptability for certain work. That a flexible curriculum is correct in principle and has been shown by experience to be a distinct advance in colleges of liberal arts and preparatory schools, no observer of pedagogic conditions will deny. This, however, in view of the greater responsibility involved in medicine, does not necessarily constitute evidence in favor of its general adoption as a system of medical education.

It may be said to possess definite advantages in certain institutions, and be capable therein of its most complete and satisfactory elaboration, according to the size, facilities and purposes of the school. Manifestly precisely similar conditions may not be in force in other colleges, and an equal observance, therefore, of the elective system rendered impractical, or if attempted to the same degree productive only of harm.

It follows that the extent of the applicability of the system to any school must vary according to the peculiar scope and working ideals of the institution. It is recognized that the purposes of some of the modern university medical schools are much more comprehensive than merely to educate doctors. The preparation and training of practical physicians, as exemplified in undergraduate instruction, forms but a single integral part of their real mission or ambition. Their energies are devoted in part to the rendering of post-graduate instruction, the pursuit of original research on the part of the professors and selected students, the investigation of new discoveries and new phases of medical learning and to the possible enlargement of the practical scope of pure science. It is in these institutions that the elective system is of the utmost advantage in offering opportunity for the attainment of the highest degree of technical learning, and is to be commended in its fullest interpretation, if practised under the restraining, governing and advisory counsel of the proper officials of the faculty. Such institutions are scarcely to be subjected, however, to the same principles of thought accorded to the medical school proper, whose sole object is to shape the early education of working doctors. Even in such institutions the elective system may be said to present certain features of advantage if applied with discrimination to the latter portion of the course, presupposing a thorough preparation in the required fundamental studies, and subject in each instance to the well-considered approval of the medical authorities. The degree to which such satisfying result may obtain must vary according to the peculiar conditions in force in each institution, thus rendering any school in this respect a law unto itself. The size of the school, the number of students, the amount of endowment and the proportionment of electives, afford no reliable measure of its real efficiency. A small school is not necessarily of low standard, provided it possesses ample laboratory and hos-

pital facilities, and embraces in its faculty men of sufficient preliminary education, of ripe experience and possessed of proper enthusiasm and high ideals. In like manner it is not simply the method or system of instruction, elective, required, didactic or clinical, that determines in full the career or usefulness of the student, as much as the manner in which the subject is interpreted and the degree of inspiration awakened by the instructor.

The practical utility of the elective system varies not only with reference to the institution where it is employed, but also according to the extent of its application to the various departments. As practiced in a few institutions it permits not only the choice of the subject, but of the instructor as well, and the manner in which instruction shall be given.

What are some of its recognized general advantages in a well-balanced and duly proportioned course of instruction?

I. The adaptability of the particular study to the peculiar requirements and mental receptivity of the student based on the known divergence in character and degree of individual capacity.

II. The consequent increased interest on the part of the student in not being compelled to devote valuable time to some irrelevant, and to him apparently unimportant branch.

III. The greater degree of technical efficiency attained by those anticipating a specialty through the additional time afforded for such preliminary preparation.

IV. The improved opportunities for observation and study afforded to those contemplating general medicine in being relieved of too rigid requirements in a few of the distinctly refined specialties.

V. The shortening of the period of time demanded in preparation for practical work, this not to imply, however, the completion of special education in a four years' course.

VI. The inspiration and incentive derived on the part of the instructor, from the fact that his students are at once earnest and enthusiastic, and that he himself is given immediate active recognition.

VII. The opportunity afforded in the larger institutions for the more intimate contact of instructor and student. This closer association and exchange of thought incident to the smaller colleges is of great utility in the imparting of knowledge.

These general advantages of the elective system, though scarcely worthy of detailed elaboration, may obtain in all instances if under the actual and not nominal supervision of a board of control.

There are objections, however, to be made and answered as to the practical employment of the system. The basis of these objections is found to exist purely through a possible laxity or carelessness on the part of the faculty in the exercise of their advisory, or, if necessary, arbitrary function.

I. The necessity exists on the part of the faculty for infinite patience and time in the deliberate consideration of each student's needs and purposes in order to ensure a proper selection of study. This is sometimes difficult of practical attainment, and demands that the work of review and counsel be apportioned to a duly constituted committee who shall be held responsible for results.

II. There is a possibility of error in the choice of method of instruction, the tendency being perhaps to neglect didactic and recitation teaching for the apparently more natural or practical instruction at the bedside. Here the text is found in the patient rather than the disease. While this constitutes the essential thought in actual practice, it is insisted that its proper judicial fulfillment could not be there attained, save by a course of preliminary instruction relative to the disease itself. The student is enabled to profit by the clinical work as illustrative of what has been previously acquired from the comprehensive and well-rounded lecture or recitation. The bedside teaching develops careful methods of examination and closeness of observation, besides emphasizing in a practical way the lessons of the didactic lecture and textbook. It should be carefully guarded, therefore, that in the student's choice of method each co-ordinate branch of instruction be given within certain fixed limits its due and justly accorded place.

III. The selection of a prospective specialty may be made at too early a period in the course of medical instruction, this involving the possibility of an unwise choice before the student has had sufficient opportunity to properly appreciate his own inclinations and special fitness.

As a matter of fact, however, the student is usually prepared to judge somewhat as to his tastes and desires relative either to scientific or practical work upon the completion of his required fundamental studies. If teaching of scientific subjects or laboratory investigation is selected as the most suitable field for future work, the decision is better made then than at the time of graduation. If a course of special practical study is avowedly instituted in the midst of his period of undergraduate instruction, it is certainly destined to result more satisfactorily if pursued under the direction of the faculty than if practiced as formerly, according to the fancies and prejudices of the student, who has always been found to entertain notions of his own concerning the line of work he is supposedly designed to follow.

IV. The likelihood is suggested that measures looking toward too early specialization may produce superficial and embryonic results. Should the training and instruction in special work preparatory for practice be permitted to end upon graduation, against which possibility there is unfortunately no distinct remedy, the objection is only too well sustained. If, however, post-graduate work is insisted upon as a *sine qua non* before entering upon special practice, it must follow that the selected grouping of studies in

undergraduate instruction has only served to render more thorough and complete the preliminary preparation for specialism.

It is evident that a properly regulated course of electives constitutes one of the most conspicuous advances in modern medical teaching. Its degree of usefulness varies according to the extent of its application and control peculiar to each department of a medical course.

How far shall this apply to internal medicine?

The relation of internal medicine to the elective system is radically different from that of all other co-ordinate branches of medical instruction, in that it occupies a position singularly unique and distinctive in its scope and requirements. Its practical working basis may be said to consist of a modified form of individual and original research supplemented by inductive clinical reasoning. It is not even an applied science in the sense of the suggested assumption of fixed definite evidence or demonstrable truth. Its sphere of action may be regarded rather as a thinking, reasoning empiricism, involving speculative deductions along the projected lines of laboratory and pathological investigation, extended to the border limits of actual experience. In the practice of internal medicine the cases are not presented in classified form, catalogued and indexed, but rather furnish in themselves the source and inspiration for needful study and detailed investigation, in order to harmonize apparent differences and properly elucidate the relations of perplexing complications.

Rational medical interpretations are directly resultant upon the closeness of the observations, the accuracy of the premises and the soundness of the logical reasoning, rather than upon the application of the known laws of pure science, or resource to a mental accumulation of authoritative data.

The field of knowledge of internal medicine may be said to comprise an enormous mass of discrete, disordered and unsettled medical information, to which are added the confusing results of original research, new discoveries and fresh observations. The correct expounder of changing medical opinion must possess, above all, the attribute of experienced clinical wisdom, not to be obtained through the possession of the highest degree of technical knowledge nor the retention of a great mass of precise facts, capable of laboratory demonstration, but rather acquired through proper methods of observation, suitable habits of thought and processes of reasoning. These are accorded in a satisfying degree only to the well-balanced and judicial mind, disciplined thoroughly through the medium of an education by no means entirely technical. The ability to select scientific facts with wisdom and discrimination, and to interpret them with accuracy, to recognize error and pretence, to form rational conceptions and to exercise intelligent conservative judgment, requires at present, no less than formerly, a degree of broad and liberal culture in its fullest sense as supplementary to a natural mental endowment.

The proposition is now advanced, Can this intensely practical and vitally important branch of medical education be justly subjected to the elastic principles of the elective system? The question may be said to apply, first, to those contemplating internal medicine, and, secondly, to those anticipating special work. For the future practitioner in internal medicine it must be apparent that the most complete and the best proportioned system of preparatory education is none too good. He has never been trained too thoroughly. It is also insisted that the teaching faculty is by far a better judge as to what should constitute a comprehensive and well-rounded course of instruction in this department. The teaching of internal medicine comprises such various subdivisions of the subject, such diversity of method and such a large staff of instructors, as to allow, under the elective system, a very wide latitude as to the relative amount of attention assigned to the several collateral branches. It is easy to conceive how a student might elect certain of these and be given credit for the required amount of time in internal medicine, and even pass brilliant examinations, yet have sadly neglected other equally important portions of the work.

To preclude this possibility the student should be compelled to devote a certain definite time to each of the various methods and means of instruction, none of which are entirely without their proportionate value. The fact that there exists a wide difference of opinion among teachers of medicine as to the best methods of imparting knowledge to senior classes affords no justification in itself for permitting students to select the manner in which to pursue the study of given subject, but rather suggests the wisdom of demanding at least a degree of familiarity with all branches of the department. A well-balanced and required system of didactic, recitational and bedside instruction, with original conference work according to the seminar method, offers to students the best that can be afforded in undergraduate work.

While the elective system offers opportunity to special students for original and advanced work in medicine, the necessity and practical advantage of this is hardly apparent. The prescribed course during the four years in this department of the modern medical school offers a sufficient degree of advanced study if properly taken advantage of to satisfy the actual demands of the most exacting student. If more than this be attempted along certain lines of undergraduate instruction in medicine, it must be at the expense of other work in the same branch, or else through the sacrifice of even a superficial attention to the so-called specialties. The educated physician in internal medicine should possess at least a general knowledge of the special branches. In view of these considerations there does not seem to exist good and sufficient reason to justify the application of the elective system in internal medicine to those contemplating general medicine.

To what extent shall the prospective specialist be permitted to exercise his prerogative under the elective system as applied to internal medicine before graduation?

It may, perhaps, be the opinion of some medical educators that a certain given course for such students be offered as a minimum requirement, and that by this means more time be afforded for work in their chosen field or for original research. To this, however, objection is here made on the following grounds:

I. That expert practical knowledge in any specialty presupposes and demands a good working familiarity with the theory and practice of medicine, and this is not to be learned any too thoroughly in a completed system of undergraduate work.

II. That the finished work in any specialty should never be attempted in a medical school regardless of its scope or facilities, the only field for the attainment of a sufficient degree of special knowledge to justify practice being found in post-graduate work reinforced by clinical experience.

III. That the demand for original research among undergraduates is more fancied than real, the actual purpose of the student at this time being to absorb much, rather than to attempt to contribute a little.

IV. That in view of the uniformly earlier attainment of social, professional and financial success of the specialist, and greater ease of living, the law of compensation justly requires a much longer period of earnest studious preparation.

V. That the present overcrowding of the profession morally necessitates the imposition of rigid restrictions to graduation as well as to admission and the possession of the highest possible degree of proficiency in order to compete successfully with those unhandicapped by knowledge or conscience.

For these reasons there does not appear in the interests of the would-be specialists any especial necessity for the application of the elective system to this department.

It is hoped that these mere suggestions may sustain the thought that a consistent regard for the highest ultimate welfare of all students and practitioners of medicine requires that the elective system, although of great recognized value as applied to a portion of the course of instruction, yet should bear no considerable relation to the study of internal medicine in American medical colleges.

OBSERVATIONS ON THE IODINE REACTION IN CHILDREN.

BY CHARLES HUNTER DUNN, M.D., BOSTON.

THESE observations were made chiefly with the view to adding to the data already accumulated, on which the diagnostic value of the iodine reaction is based, and also with a view to determining whether the reaction in the diseases in children corresponds with that of similar conditions in the adult. For this purpose a test

was made of the iodine reaction in the blood of every child immediately upon admission into the Children's Hospital during a period of three months, and also in all cases where any fresh disease developed during the child's stay in the hospital.

The technique employed was described by Drs. Richard C. Cabot and Edwin E. Locke in an article in the *Journal of Medical Research*, 1902, Vol. vii, No. 1, and further described by Dr. Locke in the *Boston Medical and Surgical Journal* of Sept. 11, 1902.

In addition to merely noting the presence or absence of the reaction in each case, an attempt was made to estimate the per cent of leucocytes showing the reaction. The figures give percentages of the whole number of white corpuscles noted, not of the polymorphonuclear neutrophils alone. In estimating these percentages, from one hundred to four hundred leucocytes, according to the presence and amount of leucocytosis, were counted, and of these, all leucocytes showing a distinct reaction, no matter how slight, were counted in.

The reactions were further classified according to the intensities of the reaction in each individual leucocyte. In cases in which only a brownish discoloration was present the reaction was classified as slight (Sl.). In cases in which, in addition to such discoloration, distinct but small brown granules were visible in any of the corpuscles, the reaction was classified as average (Av.). In cases in which many large brownish granules were observed in any of the cells the reaction was classified as marked (M.), and where any cells were observed in which the large granules were so numerous as to coalesce in brown masses giving a deep brown color to the protoplasm, the reaction was classified as very marked (V.M.).

In addition to the single observation made on each case admitted to the hospital, in certain diseases, notably pneumonia, typhoid fever and cerebro-spinal meningitis, further observations were made during the course of the disease, with a view to determining the frequency and intensity of the reaction in the various stages and the approximate time of its disappearance. Also, for purposes of comparison, a count of the white corpuscles was always made at the same time that the blood was taken for reaction.

LOBAR PNEUMONIA.						
Case.	Age.	Stage of Disease.	Reaction.	Intensity.	% Cells Affected.	White Count.
1	4 years	7th day	+	V. M.	80%	21,400
2	7 years	3d day	+	M.	88%	30,000
3	9 years	4th day	+	M.	84%	13,600
4	8 years	5th day	+	M.	80%	30,000
5	17 months	6th day	+	M.	80%	80,100
6	8 months	6th day	+	M.	80%	28,000
7	21 months	2d day	+	M.	74%	60,000
8	5 years	7th day	+	M.	72%	28,200
9	19 months	2d day	+	M.	72%	44,800
10	3 years	2d day	+	M.	70%	21,800
11	2 years	8th day	+	M.	70%	10,700
12	6 years	3d day	+	M.	66%	7,000
13	9 years	2d day	+	M.	46%	31,000
14	2 weeks	4th day	+	M.	30%	
15	4 years	4th day	+	Av.	80%	28,600
16	4 weeks	5th day	+	Av.	76%	19,000
17	10 months	9th day	+	Av.	70%	10,400
18	2 years	4th day	+	Av.	60%	20,300
19	6 years	2d day	+	Av.	54%	22,000
20	7 years	4th day	+	Av.	50%	18,000
21	2 years	4th day	+	Av.	30%	29,300
22	7 years	3d day	+	Av.	48%	19,100