Resumido por el autor, A. G. Pohlman.

Sobre el empleo de un simple método gráfico para anotar las relaciones de los cortes seriados, particularmente útil para la enseñanza de la Embriología.

El presente método gráfico para demostrar las relaciones de una serie de cortes de un embrión es simplemente un modo conveniente de anotar los niveles en los cuales pueden encontrarse determinadas estructuras. Para conseguir este fin se proyectan los cortes que representan un intervalo de 100 micras sobre papel rayado con intervalos de 2 mm. ayudándose de una guía en forma de escalera con el fin de indicar la sección y fila en cada porta-objetos. Esta proyección representa el espesor de los cortes seriados aumentado veinte veces, y la posición de una estructura determinada en un porta-objetos o en un cierto número de ellos puede indicarse por medio de una línea o marca cualquiera. El objeto de este método gráfico es suministrar la información necesaria sobre una serie de cortes de un embrión de un modo más accesible al estudiante y hacer también más accesible para el instructor la corrección de las observaciones. Este método es también aplicable para anotar observaciones en los trabajos de investigación.

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THE USE OF A SIMPLE GRAPHIC METHOD OF RECORDING THE RELATIONS IN SERIAL SECTIONS. PARTICULARLY FOR USE IN TEACHING EMBRYOLOGY.

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FOUR CHARTS

Embryology is conceded to be one of the most difficult courses in the medical curriculum, and this may be true for a number of reasons: first, because of the position it occupies in the medical schedule; secondly, because the embryology text-books are descriptive, detailed, and therefore more or less deadly reading; thirdly, because the substance of the course involves a more or less general knowledge of the morphological relations before the student is informed regarding the end-product of the system he is studying; fourthly, because a study of serial sections is imperative and demands the ability of constructing two dimensional pictures into a three-dimensional whole; fifthly, there appears to be a fear in the minds of most teachers that the student will not 'cover the entire subject' in the time allotted to it, and, lastly, many of the teachers of embryology are not sufficiently concerned with the pedagogy involved in so complicated a subject. It may be well to consider some of these topics in the reversed order.

What is true of the pedagogy in embryology, or the lack of it, may hold true of all of the medical subjects and indeed all of the higher branches in learning. The teacher is apt to confuse information with education and, because of his experience in his particular branch and his acquired ability to digest the facts, believe his exposition to be as clear as plate glass. He may come to regard his students as more and more hickory-pated because the same fool questions are asked year after year with

sickening regularity. The student, however, may not appreciate and digest the facts so readily because of his inexperience and because this one particular course is not the only one he is attempting to pigeon-hole in his gray matter. The student may regard these so-called 'self-evident' facts as by no means transparent and may come to look upon his instructor as a sort of human squid elected to make inky the otherwise clear and limpid fountain of knowledge. Embryology is not easy to acquire and the learning is beset with many pitfalls for the unwary. It may perhaps be a trite suggestion that each man look into his methods of teaching with the same zeal shown in his research and see if it is not possible to make the subject more interesting. Let the psychic juice of interest be wanting, and even the most delectable mental pabulum will neither be digested nor assimilated. The processes in embryology, in so far as we understand them, are mysteriously simple, and do we not make a great mistake in our attempts to make tangible that which is quite beyond our comprehension!

The fifth point mentioned is also one in which embryological teaching is not the only sinner. Each man believes his course is important, if not most important, and once given this attitude it is very simple to make the medical student swallow the entire sheaf in order that perchance a few of the grains of truth will stick. The success in imparting the general fundamental principles underlying the development does not include the fatness of the text-book with its dreaded assignments nor the richness in armamentarium in models, series, injected and cleared specimens, and what not. The very accessible facts may be rendered the more inaccessible by placing a halo about them and by saying, "In this way only may the relations be understood." A maximum of material must be investigated in the allotted time, but with a minimum of detail so that the facts themselves may not be made too obscure. Do we overload our students with the number of series? Are the series cut at a maximum rather than at a minimum thickness? Do we require our students to spread over too large a territory and obtain as a result the mere smattering of this, that, and the other system?

Are we afraid that the practical thing is a thing to be avoided in a subject of purely theoretical value, or do we remember that the practicability of the thing is merely a reflection of the theoretical thoroughness? Do we ourselves always know the theoretical and fundamental basis of the things we teach, or do we conveniently refer to the text and say, "It is so written?" It is true that one can make a student study, but one cannot make him think. Spoon-feeding is probably the worst form of instruction, but on the other hand may not the babe, no matter how hungry, go to sleep over his bottle if the contents is made too inaccessible?

The fourth point made was the inability of the student to resolve two dimensional pictures in the series into the three-dimensional whole. This ability seems to be readily developed in some, and in others it is well-nigh impossible to acquire. It is necessary that the student draw sections in order that his information may be accessible to himself as well as to his instructor. Drawing, however, is a sort of reflex from the eye quite comparable to the stenographer's reflex from the ear and does not necessarily imply information. Drawing in some courses is like the busy work in the kindergarten. It helps to rivet the attention of the student on his work and makes for peace in the class-room. It is a good thing and it may also be overdone. To gain the same end-results as accomplished in the alleged artistic efforts of the students and incidentally to delegate the major part of the work above the region of the cerebellum, the following scheme was tried and is presented without prejudice.

The objection to the usual series issued to the student is that they are of too many forms and of far too many sections. I suggest the study of one form, the pig, and leave it to the instructor to use other forms where they show particular points of interest. I would also recommend that the details of maturation, fertilization, cleavage, gastrulation, and the varieties of germ-layer formation be delegated to the preparatory course in the premedic years, preferably in the department of zoology. The course of embryology in the medical school should be largely one of organogenesis.

Two series of pigs should be selected, one of from 9 to 12 mm. and the other from 14 to 18 mm. greatest length. The embryos may be stained in bulk, embedded in celloidin and cut cleared in xylene-cedar oil or xylene-castor oil after the Fish-Gage formula. The larger ones may be cut at 50μ and the smaller ones at 33μ . While sections of this thickness are not to be recommended for research purposes, it is well to employ them for students, because they are too thick for the satisfactory use of an objective of over 16 mm. because the sections may be rescued if a slide is cracked or broken, and because the number of sections is reduced materially.

Carmine, paracarmine, or alum cochineal serves the purpose of a bulk stain; the latter perhaps better than the former two. It is well to have a range of embryo sizes varying from 9 to 18 mm. rather than giving out two series of more or less definite developmental stage. The student provides himself with the usual physics laboratory cross-section paper, $8 \times 10\frac{1}{2}$, and ruled 18 cm. by 24 cm. in 2-mm. squares. He takes the two series issued to him and marks the sections at 100 intervals with a dot of ink; that is, every other section at 50μ , and every third one at 33μ . The slides are numbered with a Roman numeral, the rows of sections on the slides indicated by a letter A, B, C, D, etc., and the number of dots in each row by Arabic numerals. Thus

Slide I - A - 5
 B - 4
 C - 5
 D - 4

equals 18 dotted sections and the thickness, therefore, of all of these sections, if piled, would equal 1800μ , or 1.8 mm. If each 100μ interval is to be plotted on the graph paper, we must assume a magnification of twenty times. I suggest the use of the stair-case guide shown in the accompanying charts, ruling across for each row lightly, and marking the intervals between the slides with a heavy line. When both embryo series have been transferred into terms of thickness of all sections, times twenty, the student is ready to plot the structures to be observed.

The general idea of this graphic method is very simple. The length, breadth, and the relations of the structures to be shown are entirely eliminated, and all the student does is index the levels at which a given structure is to be found by drawing a line which may be bent into any sort of curve, depending on his particular fancy.

We must remember the line only indicates the level and in structures which are large, and which twist about, only one wall may be indicated. The lines, therefore, in the charts show, for example, the ventral wall of the neural canal, the ventral wall of the descending aorta, the convexity of the upper branchial arches, the concavity of the pulmonary arch, and the point where the lumen of the intestine shows the turning of a corner. If we start with reasonably simple things, like the chorda dorsalis and the ventral border of the neural tube, we establish a sort of string through the entire length of the embryo and demonstrate in what way the tail is bent upon the embryo and upon itself. Once the emergences of the spinal nerves or the extent of the spinal roots are plotted and the position of the tip of the snout shown, the student usually can orient his schematic diagram to correspond with sagittal sections or the pictures of mid-sagittal sections. The method is simple to explain and even much easier to do. I can recommend it heartily as a routine laboratory procedure as well as a method of establishing the position of various structures in the series of embryos of a large collection so that each observer may indicate where the several things which he has studied are to be found. For example, in pig no. 16, 11 mm. the pulmonary artery arises from the last branchial arch in slide no. II, row C, section 4, and the carotid arch is still complete as shown in row A, section 2 of the same slide. The hepatic ducts join the cystic in pig 1, slide III, row A, section 4. This pig is 12 mm. long and shows no tail gut.

By making a master guide for each embryo, any and all sheets of cross-section paper may be used in recording structures, and these observations may be transcribed to the completed graphic representation as indicated in the charts. I have not as yet found two embryos near enough alike to make it possible to confuse one graph with another, and would not hesitate to pick

out of eighty or a hundred unknown graphs the one which would fit the particular embryo slide given me. Changing the embryo number each year avoids all possibility of copying, and the student, once his graphs are made, can readily compare his findings with those of any other student. For example, the carotid arch has disappeared in embryo no. 1, but is to be found in no. 16. One can readily pick out a pig series and the section in the pig where the dorsal limb of the arch is becoming rudimentary. Instead of studying two series, therefore, the student has two series for each man in his class to draw upon for any one point.

I present the accompanying diagrammatic charts, which include all I require of my men, in the hope that this method may prove satisfactory and will make for the elimination of a large amount of the busy-work which detracts from the interest in a course of embryology.

Under Ecto

2, optic cup or eyeball	<i>IE</i> , membranous labyrinth
<i>LD</i> , lacrimal duct	<i>H</i> , hypophysis
<i>J</i> , Jacobson's organ	<i>N</i> , ventral border of neural canal
5, ganglion of trigeminal nerve	<i>T</i> , first thoracic spinal ganglion
7, ganglion of facial nerve	<i>L</i> , first lumbar spinal ganglion

Under Meso

<i>IC</i> , internal carotid artery	<i>U</i> , umbilical artery
<i>EC</i> , external carotid artery	I, II, III, first, second, and third branchial cartilages
<i>RS</i> , right subclavian artery	<i>SP</i> , spleen
<i>LS</i> , left subclavian artery	<i>A</i> , adrenal
<i>H</i> , extent of heart	<i>SG</i> , sex gland
<i>O</i> , foramen ovale	<i>M</i> , Muellerian duct
<i>V</i> , ventricular defect	<i>W</i> , Wolffian body and duct
<i>P</i> , origin of right and left pulmonary arteries	<i>K</i> , kidney and ureter
<i>SM</i> , superior mesenteric artery	

Under Ento

<i>ME</i> , middle-ear diverticulum	<i>L</i> , liver
<i>TM</i> , thymus	<i>G</i> , gall bladder
<i>TY</i> , thyroid	<i>P</i> , pancreas
<i>T</i> , trachea	<i>B</i> , urinary bladder
<i>C</i> , chorda dorsalis	<i>UG</i> , urogenital sinus

The Roman numerals indicate the slide number and the Arabic numerals millimeter intervals or finally the length of the pig computed by multiplying the number of sections in the series by the section thickness.

A

B