2/15 DRAFTS - ARTICLES UNDATED, 1955
What is Kinesiology
Creeping
Klapp's Creeping Method

Dr. Rudolf Klapp was born in 1873 in Arolsen/Waldeck, Germany. He began his medical training in 1893 at the University of Würzburg and received his Doctor of Medicine from the University of Kiel. For many years he worked as assistant to Dr. August Bier, well-known German Surgeon.

The first notes on the treatment of deviations of the spinal column date back to 1904 when R. Klapp was Chief of Medicine at the University of Bonn. In 1907 R. Klapp became Chief of Surgical Services at the University Polyclinic in Berlin. R. Klapp died in 1949. The difficulties encountered during and after the war prevented him from publishing a complete and detailed description of his Creeping Method. The only printed material available was an article headed "The Functional Treatment of the Scoliosis".

The present book was written in memory of Dr. Klapp by his co-worker Dr. Bernhard Klapp and two of his pupils, members of the School for training teachers of Gymnastics for the Sick, affiliated with the Department of Surgery at the University of Marburg, Germany. A great deal of credit for the development of the Creeping Method is given to the highly trained teachers at various training schools.

The book is written in two parts, Part I, by Dr. Bernhard Klapp, includes historical notes, anatomical considerations, nomenclature and classification of scolioses; diagnostic, prophylactic, therapeutic possibilities and specific applications to fractures of the spine, tuberculosis and poliomyelitis. Part II, written by Miss Ida Biederbeck and Miss Ingeborg Hess contains the detailed technical descriptions and indications of application of a considerable number of selected creeping activities.
R. Klapp's concept of the prophylactic and therapeutic approach to deviations of the spinal column originates with a little story that dates back to his early years of practice. Meditating over his problem, one day while visiting his chicken farm, he was wondering if the two-legged chickens, though only half-erect, ever developed a scoliosis. He visited a poultry dealer and asked if there are crooked chickens. The answer was yes, and Dr. Klapp offered to pay double the price for every crooked chicken they could furnish him. After a few days Klapp withdrew his offer, because he was swamped with scoliotic chickens.

Dr. Klapp concluded that the chicken, one of the few two-legged domesticated animals develops scoliosis while none of the four-legged animals did. While watching his dog walking and running around, he noticed that the crossed quadruped gait provided for extensive lateral flexion of the spinal column. Dr. Klapp further concluded that the horizontal position of the spinal column not only prevented the formation of a scoliosis but at the same time offered excellent opportunities for mobilization and strengthening of the column and its soft tissues.

A scoliosis is defined as a permanent lateral deviation in contrast to those which are correctible either on command or through positioning. Soft tissue changes, even including early changes of the intervertebral discs, in the absence of bony changes are referred to as "Postural Weakness". Soft tissue changes occur when an imbalance exists between "Load Capacity" and "Load". There is an early muscular imbalance in the human between the erector spinae group and the longitudinal component of the abdominal musculature in favor of the latter group. The back musculature, weaker by nature, is brought to further disadvantage by working on shorter lever arms, thus fatigueing more rapidly. This biological imbalance is expressed by R. Klapp as the "Orthogenetic Insufficiency of the Upright Position". Rapid growth is considered an important etiological factor for development of internal mechanical stresses.
Lateral deviations of the spinal column, which are favored by rapid growth, may be traced to the oblique pull of the short back muscles as well as the oblique pull of the retractor of the shoulder blade and the pectoral muscles. Torsion or rotation of the spinal column may be seen in the normal. But during states of fatigue the spinal column tends to fall in a spiral course towards the points of passive resistance. This spiral collapse is determined by the relatively more fixed spinous processes and the relatively less fixed vertebral bodies. In a sciotic spine rotation becomes increasingly marked, leading to severe irreparable torsion of the skeleton, i.e., the vertebral bodies. The vertebral bodies become crowded on the concave side. Since the small intervertebral junctions allow for a limited amount of escape from overloading and increasing pressure, the bodies tend to move towards the convex side of the curve which brings the spinous processes towards the concave side. The increased pressure on the concave side further inhibits epiphyseal growth of the bodies, thus contributing to the formation of wedge vertebral bodies. In the sciotic arch, therefore, the vertebral bodies show a more marked deviation than do the spines. The wedge-shaped bodies by narrowing the intervertebral foramina may lead to root pain.

The musculature of the convex side remains, in most instances, active, attempting to counteract the increasing pressure on the convex side. Histologically the convex side is usually somewhat hypertrophied, while the concave side shows distinct atrophy.

Of the various etiological factors responsible for the formation of abnormal spinal curvatures rarely one single factor can be held responsible. Among the predisposing conditions constitutional weakness of the supporting tissues is considered a frequent concomitant.
However, Klapo concludes, scoliosis is not possible without the upright position of the body.

The prophylactic and therapeutic possibilities are based entirely on this orthogenetic principle. No scoliosis without upright position and no prevention or improvement without the quadruped position. The benefits of the horizontal position of the spine are three-fold. 1. It is a position of rest. 2. It is a safe position. 3. It is a position which lends itself well for vigorous therapeutic activities.

The authors do not claim that the Creeping Method is the only successful one, nor do they deny the need for supplementary procedures in severe cases. They do not claim to cure scoliosis nor do they report “success stories”. But they do believe that a tendency towards abnormal curvatures in the child can be influenced favorably, that existing curvatures can be improved and be prevented from progressing.

The Creeping Activities are divided into three basic phases.

1. Active mobilization of the spine; 2. Corrective activities; 3. Stabilization, leading to a "muscle corset".

The activities are carefully prescribed and supervised by the physician according to the individual’s needs. One year of intensive therapy is considered the minimum for the average patient. Dr. Klapp dreamed of establishing homes for children with postural weakness which would provide a quadruped life for the child for at least three to four months. One such home has been in use near Berlin since 1926 and another one since 1927, both had to be discontinued during the war. Great emphasis was placed on adequate rest periods during this rather strenuous life. The child’s knees, hands and toes are protected by heavy felt pads which are used routinely for all patients during their activity periods.

After the initial intensive treatment period the child is usually treated ambulatory.
Parents are instructed carefully not only in the supervision of the home exercises activities but also in regard to the purpose and goal of the method.

Group therapy is used, but groups are small and selected according to their needs. Individual attention always remains the keynote.

Dr. Klapp believes there are three periods in the child's development which tend to favor development of abnormal spinal curvatures. The first is the period when the erect gait is first attained, the second is during the period of second dentition and the third one during puberty. Ambitious parents are warned not to shorten the natural period of creeping and to force the child into the erect position before he is ready for it.

Part II describes in detail a series of selected, progressive creeping activities. Starting position, mode of progression, modifications and purpose are given for each activity. The indications of an individual activity may be a generalized one, as strengthening all trunk and shoulder girdle muscles, or may be highly specific for an individual scoliosis. The activities are illustrated by very excellent photographs which almost speak for themselves. The crossed quadruped gait on hands and knees represents the basic starting position for all activities. During locomotion each step ends with an active torsion of the trunk to one or the other side in alternation. Activities may be symmetrical or asymmetrical according to the need of the patient. The trunk as a whole or in part may be held high, medium or low, arms may be flexed or extended at the elbows, which allows for vigorous strengthening of the musculature of the entire upper extremity. Both during stance and progression one or the other lower extremity may be forcefully extended, thus bringing the musculature of the pelvis and lower extremity into vigorous activity. It is impossible to describe the dynamics of these activities in words. It is a method that
can be fully appreciated only when demonstrated.
The photographs accompanying the descriptions deserve special mentioning. They
deshow a degree of precision in the execution of activities position 9 of
the body. relation of body parts to each other and balance between tension
and relaxation which is rarely seen, taught or appreciated by physical therapists
in this country. The basic positions and activities lend themselves to an
almost unlimited amount of variations applicable to the needs of almost all
physically disabled. However, in order to be able to teach Klapp's creative
method successfully the writer believes that the teacher must be an expert in
this method himself. In The teaching of therapeutic activities, Klapp states,
requires "functional thinking" which is unattainable only through the functional experience on one's own body.

To anyone keenly interested in the prevention and alleviation of
abnormal curvatures of the spine this book may open up a horizon of un-tried possibilities. The method is not new, but has been given little
attention in this country. The activities described are thoroughly
convincing in their usefulness for a great variety of patients. The limitations
are obvious if one thinks of the severely paralysed patient. Klapp's activities,
however, offer opportunities for truly strenuous exercises done without the
use of expensive apparatus. The medicine ball, the wand and parallel bars are
the only type of equipment used and if used, it is always the precision of the
exercise itself, the positioning of the body, proper weight distribution and
repetition which make these activities extremely strenuous and consequently
useful for the purpose of causing hypertrophy of muscles. The fine balance
between active mobilization, correction and stabilization in alternation and
progression is one of the most outstanding features of this method.

Dr. Rudolf Klapp was born in 1879 in Arolsen/Waldeck, Germany. He began his medical training in 1899 at the University of Würzburg and received his Doctor of Medicine from the University of Kiel.

The first informal notes on the treatment of deviations of the spinal column date back to 1904 when R. Klapp was Chief of Medicine at the University of Bonn. In 1907 Klapp was appointed Chief of Surgical Services at the University Polyclinic in Berlin. Klapp died in 1949. A busy life and two wars interrupted his work kept him from publishing a complete description of his Creeping Method. The only printed material available at the time of his death was a small book, "The Functional Treatment of Scoliosis".

The present book was written in memory of Dr. R. Klapp by his co-worker Dr. Bernhard Klapp and two of his pupils, instructors at the School for training Krankengymnastinnen (gymnastics for the sick) at the University of Marburg. The book is in two parts. Part I, by Dr. Bernhard Klapp includes historical notes, anatomical considerations, nomenclature and classification of scolioses, diagnostic, prophylactic and therapeutic possibilities. Part II, by Ella Biederbeck and Ingeborg Hess contains detailed technical descriptions and indications for application of a number of selected creeping activities.

Dr. Klapp's concept of the prophylactic and therapeutic approach to deviations of the spinal column originates with a little story that dates back to his early years of practice. Meditating over the problem of the scoliotic spine, one day while visiting his family's chicken farm he was wondering whether the two-legged chickens, though
though only half-erect, would develop a scoliosis. He visited a poultry dealer and asked if there are crooked chickens. The answer was yes, and Klapp offered to pay double the price for every crooked chicken they could deliver. After a few days Klapp had to withdraw his offer, he was swamped with scoliotic chickens. Klapp concluded that the chicken, one of the few two-legged domesticated animals develops scoliosis while none of the four-legged domesticated animals do. While watching his dog walking and running around he noticed that the crossed quadruped gait provided for extensive lateral flexion of the spinal column. He further concluded that the horizontal position of the spinal column not only prevented the formation of a scoliosis but at the same time offered excellent opportunities for mobilization and strengthening of the entire trunk.

A scoliosis is defined as a permanent lateral deviation in contrast to one which is correctable either on command or through positioning. Soft tissue changes, including early changes of the intervertebral discs, in the absence of bony changes are referred to as "Postural Weakness". Soft tissue changes occur when an imbalance exists between "load capacity" and "load demand". There is an early muscular imbalance in the human between the erector spinae group and the longitudinal component of the abdominal musculature in favor of the latter group. The back musculature, weaker by nature, is brought to further disadvantage by working on shorter lever arms, thus fatiguing more rapidly. This biological imbalance is expressed as the "Orthogenetic Insufficiency of the Upright Position".
Lateral deviations of the spinal column may be traced to the oblique pull of the short back extensors as well as the oblique pull of the retractor of the shoulder blade and the pectoral muscles. Torsion or rotation of the spine may be seen in the normal. During states of fatigue the spinal column tends to fall in a spiral curve towards the points of passive resistance. This spiral collapse is determined by the relatively more fixed spinous processes and the relatively less fixed vertebral bodies. In a scoliotic spine rotation becomes increasingly marked, leading to severe irreparable torsion of the skeleton, i.e. the vertebral bodies. The vertebral bodies become crowded on the concave side. Since the small intervertebral junctions allow for a limited amount of escape from ov rodding and increasing pressure, the bodies tend to move towards the convex side of the curve which brings the spines towards the concave side. The increased pressure on the concave side inhibits enchysseal growth of the bodies, thus contributing to the formation of wedge shaped vertebral bodies. In the scoliotic arc, therefore, the vertebral bodies show a more marked deviation than do the spines. The musculature of the convex side remains, in most cases, active, attempting to counteract the increasing pressure on the concave side. Histologically the convex side is usually somewhat hypertrochized, while the concave side shows distinct atrophy.

Of the various etiological factors responsible for the formation of abnormal spinal curvatures rarely one factor is responsible by itself. Constitutional weakness of the
supporting tissues is considered an important contributing factor. Nevertheless, a scoliosis will not occur without the upright position of the body.

The prophylactic and therapeutic possibilities are based entirely on the orthogenetic principle. No scoliosis without the upright position and hence prevention or alleviation are possible only in the quadruped position. The benefits of the horizontal position of the spine are threefold: It is a position of rest; It is a safe position; It is a position which lends itself readily for vigorous therapeutic activities.

The authors do not claim their method to be the only successful one, nor do they deny the need for supplementary procedures in severe cases. They do not claim to cure scoliosis nor do they report success stories. They are convinced, however, that a tendency to formation of abnormal curvatures in the child can be influenced favorably and that existing lateral and antero-posterior curvatures can be improved and can be kept from progressing further.

The creeping activities are divided into three basic phases: The active mobilization of the spine; Specific corrective activities; Active stabilization leading to a "muscle corset". All activities are prescribed by a physician according to individual needs. One year of intensive therapy is considered the minimum duration for the average patient. The ideal therapeutic program is carried out in a home for children with postural weakness where the child lives a quadruped life for a period of three to four months. During
this intensive treatment period emphasis is placed on ade-
quate rest periods. The child's knees, hands and toes are
routinely protected by heavy felt pads. Ambulatory treatments
are given at least three times a week. Parents are instructed
carefully not only in the supervision of the activities at
home but also in regard to the purpose and goal of the
method. Group therapy is used, but groups are small and
selected according to similar needs.

Dr. Klaap believes there are three periods during
the child's growth process which tend to favor development
of abnormal spinal curvatures; during the attainment of the
upright gait; during the period of second dentition; during
puberty. Ambitious parents are warned not to shorten the
natural creeping phase of the small child.

Part II describes in detail a series of selected
progressively arranged creeping activities. For each activi-
ty is given the starting position, mode of progression,
modification for individual purposes and indication.
Each activity may be used for general mobilizing or strengthen-
ing purposes or may be modified for a highly specific case.
The activities are illustrated by very excellent photographs
which almost speak for themselves. The crossed quadruped
gait on hands and knees is the basic starting position.
During locomotion each step is finished with an active torsion
of the trunk to one or the other side in alternation. The
activity may be symmetrical or asymmetrical. The trunk as a
whole or in part may be held high, midum or low, arms may be
flexed or extended at the elbow. This provides during loco-
motion for vigorous arm activities. The lower extremity also is brought into active participation by unilateral extension without support. It is impossible to describe in words the dynamics of these activities. It is a method that can be fully appreciated only through demonstration. The photographs deserve special mentioning. They show a degree of precision in positioning of the body, relation of parts of the body to each other and balance between relaxation and tension which is rarely seen, taught or appreciated by the physical therapist in this country. The basic positions and activities lend themselves to an almost unlimited amount of variations applicable to the needs of almost all physically disabled. However, in order to be able to teach Klapp's creeping method successfully the reviewer believes that the teacher must be an expert in the method himself. Teaching of therapeutic activities, Klapp states, requires "functional thinking". Only functional experience on one's own body can develop this ability.

To an one interested in the prevention and alleviation of abnormal curvatures of the spine or functional limitations of the trunk and shouldergirdle this book may open up a new horizon of untried possibilities. The method is not new, but has been given little attention in this country. The activities described are thoroughly convincing in their usefulness for a great variety of patients.
The limitations are obvious if one thinks of the severely paralysed patient. Klapp's activities, however, offer opportunities for truly strenuous exercises done without the use of expensive apparatus. The medicine ball, the wand and Klapp's special parallel bars are the only type of equipment used. But even with the use of this equipment it is only through precision in positioning and weight distribution that these activities become sufficiently strenuous to produce hypertrophy of the musculature.
The limitations are obvious if one thinks of the severely paralysed patient. Klapp's activities, however, offer opportunities for truly stenuous
WHAT IS KINESIOLOGY?

It was at the occasion of the first institute for physical therapy instructors that this question was raised. The "Institute on the Correlation of Basic Sciences with Kinesiology", held at the Continuing Center of the University of Iowa, was a historical event in the development of our profession.

Only on rare occasions in the past have a group of teachers of our profession come together to discuss in detail the quality and quantity of teaching in a specific subject area. The life center of any profession and its schools and the major burden of responsibility for establishing and maintaining high standards of service rests with its teachers. Our schools have grown in number and capacity to a degree that systematic re-evaluation of our standard curriculum has become a professional obligation. Not only the growth of our own profession obligates us to re-evaluate our objectives, the growing and rapidly changing concepts of medical and social thinking and practice force this obligation on us. We no longer represent a new profession primarily engaged in proving itself; we have become an important and recognized member of a team of professions working toward the common goal of medical, psychological, social and vocational restoration of the disabled. This is the time for us to ask ourselves how useful are we? Do we become increasingly useful in the field that we claim as our specialty? And, do we show signs of growth as a specialty? We, as teachers, have perhaps been particularly aware and particularly proud of the untiring efforts and achievements of our administrative and professional leaders. But, also as teachers, we have our very special problems to solve. The occasion of this workshop may have been the beginning of an awareness for the need of forming a
sub-specialty in our profession, that of the teacher in physical therapy.

The choice of the topic for the first workshop was made by majority vote and may well be an indication of the significance of this topic within our total curriculum and thus within our professional work.

In an attempt to define the concept and the scope of the subject matter, it becomes clear from the beginning that a dictionary definition of kinesiology does not readily lend itself as an introduction to the analysis of the topic. Kinesiology is commonly defined as the "science of human motion". One is immediately tempted to raise the question, "What constitutes a science?" and "Are we dealing with one science only?". We are dealing with the living human body, its structure, its function, and we are dealing with "motion", a concept defined by universal laws within the realm of physics. However, if we are willing to compromise and accept the definition that "kinesiology is the scientific study of human motion", its origin can be traced to the beginning of scientific thinking and its history becomes part of the history of medicine.

The tracing of historical events is an essential and indispensable preparation for scientific investigation as well as for scientific teaching. We learn to see how sciences and scientific events develop and grow from one another and with one another. Both the investigator and the teacher will learn to see that the tools for investigation and the roots of a subject matter lie within intrinsic correlation between several different areas of scientific study. To prepare a logical and meaningful presentation of a subject matter we must recognize the roots and be willing to borrow the tools. To the teacher who is interested not only in the scientific but also in the dramatic aspects of his art, facts and textbook knowledge may become an expression of human genius, human struggle and achievement.
The purpose of this brief survey of historical events, which are only samples of scientific investigation and investigators in the field of human motion, is primarily to create interest and perhaps to stimulate curiosity rather than to present a complete history of our topic.

On this journey through the past we will have only a quick look at five major periods. These are: I. Ancient Greece, II. The Renaissance period, III. the 19th century, IV. the first half of the 20th century, and V. the present.

Ancient Greece

Scientific thinking, according to the historians, was first practiced by the ancient Greek philosophers and scientists. Hippocrates (460-370 B.C.), the outstanding symbol of that period, freed the art of medicine from supernatural spirits and placed its responsibility squarely on man's shoulders. He, himself, only reported that he could perceive with his senses--see, hear, feel or smell--without adding emotional or speculative interpretations to facts. When he drew conclusions, they were based on what he had perceived. When he was puzzled and could not comprehend, he very frankly said "I do not know". Hippocrates was primarily a bedside physician rather than a research scientist. But as a bedside physician he introduced the art of diagnosis based on living anatomy and physiology. As is well known, he also introduced the gentle, humane and sincerely ethical approach into the art of healing.

The great research scientist of the Ancient Greek period was Aristotle (384-322) who was about 16 years old when Hippocrates died. Ancient Greek culture was at its height at this time, in all areas of human endeavor and particularly in regard to the investigation of the human mind and the human body. The Greek enthusiasm for athletics, sports, and gymnastics was part of their philosophy of developing the human being as a whole to optimal functional capacity. It took 2000 years for this concept to be revived.
Physical and mental gymnastics were practiced in the Greek gymnasion and were considered of equal importance to optimal development. The Greeks were aware of the fact that a healthy, happy mind was more likely to develop in a healthy body. They utilized exercises for therapeutic purposes as well as for the sake of bodily development. Aristotle, the universal scientist, left his mark in practically every major science then known to man. Among these were: mechanics, physics, mathematics, chemistry, botany, zoology, physiology and psychology. Among his many scientific works, he wrote a treatise on "Parts of animals, movements of animals and progression of animals". In it he said: "Athletes jump further if they have weights in their hands than if they have not; and runners run faster if they swing their arms, for in extension of the arms there is a kind of leaming upon the hands and wrists." In the same treatise he also describes the action of muscles and uses geometrical analysis. The act of "muscular flexion" he defined as a change from the straight line to an angle and noted that without this flexion there could not be forward progression, such as walking and swimming. This, for the first time, implies the thought of transformation of rotary into translatory motion. It may entitle Aristotle to be called the father of kinesiology. Aristotle also was the creator of the sciences of biology, embryology and comparative anatomy.

Ancient Greek culture was at its decline towards the last century before Christ. Its last great representative or rather the last great representative of Greek medicine was Claudius Galen (131-201). Galen was among those who shifted the geographical center of attention from Athens to Rome. He brought Greek medicine to Rome, which explains the mixture of Greek and Latin in medical terminology. Galen was a rather eccentric but extremely colorful personality with a brilliant intellect. He was the greatest anatomist and physiologist of his time and a truly systematic scientist. Perhaps, partly
due to his personality and only in part due to his genius, Galen discovered remained the final word in medicine for the next 1300 years. One of the most astonishing facts of scientific history, Galen did a great deal of dissection, but only on the animal body—mainly the pig, goat and also the macaque ape. His description and analysis of the ape's hand leaves very little room for additions when compared with present day knowledge of the human hand. Contrary to common belief, neither the abductor pollicis brevis nor the opponens pollicis are missing, nor very different in function. The main difference is the location of the palmaris brevis. Galen saw two human skeletons, which were on exhibit in Alexandria. He, therefore, urged all those who intended to study osteology to make a trip to Alexandria. There was not a single human skeleton available in Rome in spite of the bloodthirsty practices of the Romans.

With the decline of the Greek culture and the increasing influence of the Roman culture, the high ideals related to physical development of the human body degenerated to showmanship. Professional athletes were looked down upon by the intellectualists as exhibitionists with a "lot of muscle and no brains." Athletics was no longer an educational process but had become merely a source of public amusement. "Spectatoritis" had become a public disease in Athens as well as in Rome. Selling physical performance was apparently not intrinsic to the scientific approach to the study of human motion. However, Galen's genius as well as thirst for knowledge made it possible for him to make very significant and permanent contributions to both osteology and physiology. He was the first to relate physiology to human motion and wrote an essay on "The movements of the muscles." In it he spoke of agonists and antagonists, in regard to active contraction and passive lengthening. He referred to "tenss" when describing the muscular action needed for the maintenance of a position. He
introduced the terms Diathroisis and Synarthroisis and created most of the terminology used today in anatomy. Galen was the first anatomist who investigated the function of the diaphragm in the living animal by vivisection. He described its isolated action correctly, a knowledge which was forgotten and rediscovered by experimentation only 150 years ago by Panemone. In spite of Galen's genius there was a significant difference in his approach to science from that of the Hippocratic approach. Hippocrates was a "modern" scientist in the sense that he acknowledged limitations and left the unknown for future generations to study. Galen had set himself up as the final and complete authority. He did not question his own statements nor would he allow anyone else to do so.

With the advent of Christianity as a philosophy of life, interest in the human body declined and eventually fell into complete disregard. No outstanding scientific discoveries were made in the field of medicine until the beginning of the Renaissance period. During the Middle Ages Galen's work was the medical "bible" in Europe. The authoritative influence of the church was reflected in the acceptance of book knowledge as the final unquestionable source in science. The study of anatomy during the Middle Ages consisted primarily of studying and translating Galen's work, a task which was mainly the responsibility of the monasteries. Ancient Greek science and thinking, however, was preserved for future generations by the Arabians who were the true scientists of the dark Middle Ages. They translated Greek manuscripts into their own language and, eventually, when Greek science was brought back to Europe, it was in Arabic disguise and had to be translated by Christian scholars from the Arabic translations of the Greek into Latin.

Gradually the Middle Ages awakened from their "scientific sleep" which was noticeable in statements like the one made by an otherwise little known French
physician who proclaimed—"God could not possibly have exhausted all his
creative power in making Solan." This marked the beginning of recovery from
the authoritative influence on science.

The little known French physician was right in his prediction when the
most brilliant of all scientists and perhaps of all human beings appeared on
the scene during the early Renaissance period. His name was Leonardo Da Vinci
(1452-1519).

The Renaissance brought an astonishing not only of science but also of art.
Some of the great Renaissance artists — Michelangelo, Raphael and Durer
among them, began to study the human body very closely. They realized the
need for having an accurate knowledge of the human skeleton and the musculature;
and, therefore, began to dissect the human body. The human endeavor was still
difficult to obtain at that time and frequently the artist was forced to play
the role of a "grave-rober." Also, endeavors were not embalmed at that time.

These artists developed an interest in the human body which went far beyond the
need for artistic representation. Among these was Leonardo Da Vinci. According
to historians, Leonardo was the greatest artist, the greatest engineer and the
greatest biologist of his time. Robinson, in his "Story of Medicine" says
apologetically: "These superlatives undoubtedly sound unscientific to a modern
car, but how else can we describe Leonardo Da Vinci?" He continues: "We know
no other individual who was both a creative artist and experimental scientist
of the first rank. We must pronounce him the most versatile and intellectually
fertile of all the men." Leonardo Da Vinci was the first "modern"
dissector of the human body. He, himself, dissected hundreds of bodies purely
for the purpose of acquiring knowledge. He was the first one to draw accurate
pictures of his dissections and he utilized dissection and demonstration for
teaching purposes. Leonardo Da Vinci created the spirit of "modern" science
with these words: "I do not understand how to quote from learned authorities,
but, is an much greater and more estimable matter to rely on experience. They
scorn no who as a discoverer; yet how much more do they deserve censure who have never found out anything, but only recite and blame forth other people's works. These who study only old authors and not the works of nature are stepsons, not sons of nature, who is mother of all good authors."

To his prospective pupil he had this to say:

"O searchers of this our machine, you must not regret that you impart knowledge through the death of a fellow creature; but rejoice that our Creator has bound the understanding to so perfect an instrument... And if you have love for such things you may be prevented by naives; And if this does not hinder you, you may be prevented by fear of living during the night hours in the company of those quartered and slayed corpses, hideous to look at; And if this does not deter you, perhaps you lack the good art of draughtsmanship, which is essential for such demonstrations; And if you have the art of drawing, it may not be accompanied by the sense of perspective; And even if it is, you may lack the order of geometrical demonstrations, and the method for calculating the forces and strength of the muscles; Or perhaps—you lack patience, so that you will not be painstaking..." And Leonardo da Vinci concludes: "As to whether all these things have been in me or me, the hundred and twenty books written by me will furnish sentence, you or me, for in these I have not been hampered by avarice, or by negligence, but only by time."

As is well known, Leonardo da Vinci's genius was capable not only of drawing the living human body in motion but also the semi-dissected body, showing the actions and relationships of muscles as they are caught momentarily during a dynamic act of motion. This art unfortunately has never been continued since.

Leonardo da Vinci's scientific works remained in manuscript form and were hidden from the world until quite recently. He planned to write a text on this Anatomy but he was never accomplished.
The task of writing the first scientific textbook on Anatomy, based wholly on dissection was left to the man who is considered for this task the founder of "Modern Anatomy", Andreas Vesalius (1514 - 1564). It is very likely that Vesalius never saw Leonardo Da Vinci's drawings, but the spirit of the time is evident in his work. His famous book, "The Fabric of the Human Body" contains an abundance of plates which picture in the true spirit of the Renaissance the anatomy of the living, as Leonardo Da Vinci had seen it. He pictures muscles in a state of contraction and almost invariably suggests movement and activity, even expression. Basically Vesalius's Anatomy was complete, and only relatively minor corrections and additions have been made since. It is interesting to note that interest in human anatomy was expressed originally almost purely in terms of the living body. Then Anatomy became a descriptive science which investigated and recorded the most minute structural details without relating these to their functional significance and eventually, mainly during our own century, anatomists returned to the interpretation of the living human body.

Rapid progress was made in many sciences during the Renaissance period, among these were physics and mathematics.

Galileo, the famous astronomer and mathematician, (1564 - 1642) deserves mention here because he was the first one to give mathematical expression to mechanical events. Whether one feels a personal sense of gratitude to Galileo for this discovery or not, without this important scientific step, physics would not exist.

Galileo's genius intrigued many scientists of his time and among these was one who deserves a special place in our historical survey. He was an Italian physician by the name of Girolamo Ferralli (1630-1679). Ferralli utilised Galileo's formulae to give mathematical meaning to the events of the animal
body. To his contemporaries he was known as the "mechanologist". Charles Singer, in "A Short History of Medicine" states: "that department of Physiology which deals with muscular movements and with mechanical principles was effectively founded, and largely developed by Borelli". According to Arthur Steindler, Borelli may be considered the "father of modern bio-mechanics". Steindler also states that: "The essential feature of kinesiology is that it treats all motor functions, normal and abnormal as mechanical events". If we accept this definition, then Borelli may be considered "father of Modern Kinesiology". Borelli wrote on the mechanics of muscle action, on equilibrium and the center of gravity, on the relation of muscle force to the angle of application and the relation of the moments of rotation to actual lever arms in the animal body. By stating that "falling forward is prevented by the extensor muscles, while the flexor muscles are at rest", Borelli foretold Sherrington's law of reciprocal action.

The next important discovery of major significance for our subject matter was made by Luigi Galvani (1737-1798), who observed that muscles contract when in contact with certain metals. This discovery made Galvani the founder of Electro-physiology and made it possible for the great Swiss physiologist Albrecht von Haller (1708-1737) to develop the doctrine of irritability and excitability of muscle tissues.

Nineteenth Century.

With the beginning of the 19th Century we approach modern times with their characteristic symbol of specialization. By now, the ground work was laid in most basic sciences - physics, mathematics, biology and even medicine. The most important events from now on are based on more and more detailed investigations in smaller and smaller areas. Whether by genius, or by accident, some of the apparently most minute discoveries led to the most far-reaching developments within the sciences and revolutionized medical concepts and the mode of living.
The amazing productivity 19th century brought with it developments in three areas of major interest to the biomechanics, electrophysiology, and physical education.

During the latter half of the 19th century the geographical focus changes from Italy to France and Germany. The 19th century had introduced to the world a new philosophy of life and a new concept of the human being expressed in philosophy, art and literature. Jean Jacques Rousseau (1712-1778), the great French proponent of the period of enlightenment had made his plea for "Return to nature" which was followed by a revival of interest in the long forgotten beneficial effects of physical exercise. Rousseau also objected to the concept of a child as an "adult in miniature form."

The man who is credited by historians as having created the term "Orthopaedics" (straight child) Charles-André (1692-1769), is said to have been one of the first who fully grasped the role of the muscles as body builders. He used exercise and good posture training as prophylactic as well as curative measure. Andry recognized that both rest and activity had therapeutic value, but that frequent rest was stressed too much where activity would have been more effective. Among interesting observations made by Andry are these: "{explanation of the spine does not always proceed from a fault in the spine itself, but is sometimes owing to muscles of the fore-part of the body being too short, whereby the spine is rendered crooked, just as a bow is made more crooked by tying its cord tighter.} Also, "the tendon which goes from the calf of the leg to the heel is sometimes so short that the person is obliged to walk upon the fore-part of his feet, without being able to set the heel to the ground. Children are sometimes born with this defect, and sometimes they come by it afterwards. In either case it may be cured, provided the shortness does not proceed from any violent cause which has absolutely
maintained the tension, such as burning after birth, or any other accident after birth that is capable of rendering this shortness incurable." Anisy thoughtfully reminded his contemporaries that "as a child grows, his clothes must be made larger...".

Rousseau's philosophy and the gradual development of concern over the specific medical needs of the growing child were probably contributing factors in the pioneering work of Henry Ling (1774-1830), the great Swedish physical educator. Ling was the first to introduce anatomy and physiology into the field of physical education and succeeded in introducing physical education into the public school system of his country in 1821.

Of similar influence in Germany was Frederick John (1776-1859), the "German father of gymnastics". Physical education was introduced into the German public school system by John in 1842. The turn of the century brought both Swedish and German methods of physical education into the public school system of this country. W. P. Bown wrote the first text for physical education teachers, "Scientific Physical Education" in 1929.

The field of bio-mechanics received its most important contributions from German investigators. It is likely that some of the interest was stimulated through the growing enthusiasm with which physical education was received in Germany. Among the outstanding investigators are the Hoher Brüllgen (1775-1875) including, who collaborated on extensive studies of the dynamic action of muscles and the mechanics of locomotion. A generation later, Bormann and Fischer published their classical studies on locomotion and the center of gravity. They created the term "normal posture" a military position in which the weight line intersected the base of support at a point perpendicular to the center of the ankle joint. Strecker and Rudolph Fischer, authors of the classical textbook on "Neuro and Joint Mechanics", made detailed mathematical analysis of joint movements. One other outstanding German
anatomist, E. Haliot, the author of *Phantasmae Anatomicum*, 1556, may well be considered one of the most outstanding teachers in living anatomy.

In the field of electro-physiology, the most outstanding investigators are found mainly in France and England. Among them are the names of E. Dubois-Raymond and C.J. Sherrington. There is one physiologist whose name stands out for his specific contribution in the field of the scientific study of motion in the living human body. His name is *Guillaume Benjamin Duchenne* (1806-1875). Duchenne studied medicine in Paris, where it was said he exhibited no particular interests or abilities. In 1825 Duchenne became interested in the application of faradic current in the treatment of various diseases. Up to this time the electro-magnetic induction current, which was discovered by Michael Faraday (1792–1867), was applied by means of platinum needles inserted into the tissue. This was a painful procedure and often resulted in necrosis. Duchenne found that it was not necessary to puncture the skin in order to stimulate muscles; that application of electrodes to the skin was sufficient. Soon he realized the vast possibilities of this method in diagnosis and treatment.

Duchenne's classical work is the *Physiology of Movements* in which he describes the action of practically every important superficial muscle of the human body as determined by electrical stimulation and observation on hundreds of normal and abnormal individuals. Steiner writes: "Duchenne determined the action of muscles with great accuracy and clinical skill, and contributed innumerable clinical observations on pathological conditions involving muscle function. His works are a real treasure chest of information on muscle mechanics. Among the conditions which Duchenne identified and described were lassaetera stamin in tabes, and progressive muscular dystrophy. It was these latter patients who served as his most interesting "experimental" subjects."
Duchenne was the first to utilize abnormal muscle function for the study and analysis of normal muscular function. Duchenne states in his book "Physiology of Movements" (1866), "Clinical observation helped me to understand the mechanism of some of the obscure phenomena which were observed during the electro-physiological experiments - Clinical observation taught me that, taken as a guide in my electro-physiological investigations, muscle inevitably reveal the precise mechanism of muscular function which always requires a combined contraction of a large number of muscles." "It is known that the normal position of rest of the extremities depends almost exclusively on the tonic forces of the muscles which are responsible for motion of the extremities.

One can picture the muscle which surround a joint as so many springs - which act to maintain the extremity in its normal position during muscular rest. If one of these springs becomes weaker - the balance of the tonic forces is broken and the extremity is pulled continuously by the remaining springs in an abnormal direction. This results in deformities which gradually increase and cause articular and osseous changes." "Knowledge of the muscular mechanism leads to a rational treatment of paralysis, atrophies and deformities, by application of special local peripheral stimulation, physical exercise and physiologic prosthesis."

Selections from the clinical works of Duchenne were translated and published in 1883 by the Sydenham Society in England, but none of the selections were from the "Physiology of Movements". The translators stated that this was so great a work that it was hoped it may be translated in its entirety for the benefit of the English speaking world. The book was translated into German in 1885. The first translation into English was not made until 1949 by Dr. Emanuel B. Kaplan, Orthopedic Surgeon, Hospital for Joint Diseases at
Columbia University, New York. In his foreword Dr. Kaplan states:

"The surprising absence of translation was probably due to several factors, one of which was the state of medical thought of the period. It was not quite ready for Duchenne's abundant new findings and ideas. The notion of individual muscles and groups of muscles was of relatively little importance. The neurologists were interested in the all-embracing clinical entities; the surgeons did not develop effective operative treatment for the loss of muscles, tendon injury or peripheral nerve destruction. Surgery of the locomotor system was in its infancy. The anatomists of the period were preoccupied mostly with morphology and gave comparatively less thought to correlating physiology."

However, Dr. Kaplan continues, "this book may be placed among the greatest books of all times - not an account of its historical significance - but because it contains an excellent record of the kinesthetics of the entire muscular system, with very few exceptions, investigated by one observer whose genius, perseverance and originality permitted him a deeper insight into the action of muscles than given to any of his predecessors and, perhaps, more modern investigators in this field."

Since we are dealing here with history, and since it has been customary for historians to bestow great men with the title of father of . . . this reporting historian would like to suggest that Duchenne be given the honorary title of "Father of modern physical therapy." 20th Century

We are now ready to approach our present century and thus, are stepping out of history. One of the leading personalities in the scientific study of human motion is Dr. Arthur Steinke. His well known text on "Mechanics of Normal and Pathological Locomotion in Man" embraces far more material than the title indicates. The text was first published in 1935 and is a revised presentation of lectures given to students in orthopedic surgery and
physical education. Steiniger states in his foreword: "There are excellent treatises which deal abstractly with some phases of locomotion from the physical and mathematical point of view. Their very abstractness makes a rather difficult study to the non-mathematical mind. And more than that - the reader often fails to find the link between theory and practical application for his own clinical or educational needs. The reader wants to be shown in unequivocal manner to what theory leads and what it signifies for the practical side of the professional situation."

With a historian's point of view in mind, we can recognize in this statement a significant attitude, characteristic of our present time. Progress in all scientific areas is more rapid than it ever has been before. Even though basic research is always steps ahead of practical application, these steps tend to become fewer, or, the practitioners tend to become increasingly impatient, a trend which has created the need for more rapid and complete interpretation of highly abstract findings into the language of the professional worker.

This has been quite evident in the study of human motion. Excellent examples are two almost classical studies published by Isaac, Robert, Saunders, and Herbert. The first major study was "Observations on the function of the shoulder joint", published in 1866; the more recent one is an "Major Determinants in Normal and Pathological Gait", published in 1953.

This has been an attempt to trace the origin and the development of the scientific study of human motion. One cannot help but recognize that "Kinesiology" is a very broad, almost unlimited field. One can see that the contributions to this scientific area have come, and are coming from the biological as well as the physical sciences. The principal contributors are anatomy, bio-mechanics, physiology, basic and applied clinical science.
To present a logical and balanced correlation of these constituents within the scope of a college course is not an easy task. It may help, however, if one is reminded that "correlation" is a mental process and not a technique. A teacher can present, show and explain, but the student must correlate in his own mind. Correlation is based on reasoning, a highly individualized process, which can be stimulated but not taught.

Our own specific field of interest - Physical Therapy - deals with phenomena which can be perceived in the living human body, and these phenomena are not all abstract in nature. We have an unusual opportunity for assisting the student in his search for meaningful integration and correlation. We can avail ourselves of all channels through which a specific motor event can be perceived, interpreted and understood. Essentially these are: the mechanical aspects of the motor event, the afferent aspects - mainly proprioceptive, the afferent, or motor aspect proper, the intellectual aspect, and the psychological aspect.

These are merely the familiar avenues which we as physical therapists utilize in our daily work during the process of "motor teaching" and "motor learning". The teacher in physical therapy can assist the student in finding and understanding these avenues to a degree that eventually the correlation of kinesiology with the basic and applied sciences need not remain entirely an act of abstract thinking, but may become an intellectual as well as a very personal kinaesthetic experience.

To the extent that this goal can be approached, we may well be on the road toward giving deeper meaning to our specialty and toward training therapists who may offer increasingly valuable service.
BIBLIOGRAPHY


