"The Development of our Knowledge regarding the Purpose and Mechanism of Respiration."

by

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Chapter I

Introduction

It is not very easy for us at the present day to realise the difficulties that physiologists have had to overcome in the past in their efforts to extend our knowledge of the human body to the point at which physiology do we find this more sign in that dealing with the system of our knowledge of respiration.

The simple chemical change that is the purpose of respiration seems to us so simple a matter that it is almost impossible for us to understand the difficulties of our predecessors in discovering it. When, however, we consider the complete ignorance, or rather the unaided and often amusing ideas on this subject that we now possess, we realise the truth of the apologium, that standard advances only to the
expert that its subconscious ideas became more numerous and definite.

Our knowledge of at least the principle function and mechanism of respiration is second nature in our experiential and clinical outlook and it is only this axiomatic foundation that we can build our other theories and their application in the realm of physiology and medicine and their kinds of subjects.

There was little or no definite or accurate knowledge of respiration until well after the beginning of the Renaissance. Probably the only thing known accurately was the necessity of respiration for maintaining life. This idea that the necessity of respiration must have been possessed by humanity since its first appearance on the earth, and the mention of it is all that is necessary for a survey which must deal rather with the mechanism by which
respiration has been supposed, at various times, to maintain life. It was the flood of knowledge and the awakening of investigation, and the seeking of false authority, that came with the Renaissance that opened our first exact knowledge of this subject. Since then our knowledge has increased; sometimes with periods of stagnation even of retrogression, but also with certain well-marked periods of advancement that we will study in detail. All knowledge, especially in Science, advances by jumps. After each new discovery, there comes a period in which facts are accumulating and are awaiting the arrival of some master-mind, who perhaps will make some key-discovery that will explain the present and perhaps misinterpreted work of others, and will give fresh en-couragement to investigators. Two such cycles stand out prominently in the history of this subject. First, there is the rise of
the science of Anatomy in Italy, which culminated in the works of Harvey and his pupils. An accurate knowledge of Anatomy has always preceded advances in Physiology, and we find that these peoples, such as the Chinese and Egyptians, who held the human body in the great respect to allow of its dissection, had little sound knowledge of Physiology. It was not, therefore, until the Renaissance and circulation systems had been carefully dissected and their relationships to each other observed, that their physiological functions were discovered. Thus, the history of respiration in this period indicates the close interdependence of the systems in the maintenance of life, an interdependence that is very obvious phenomena in many pathological and clinical conditions, and it will be constantly necessary to refer to the vascular anatomy that
have been held about the circulatory system. The second stage coincided with the rise of chemistry, and in particular, the investigation of the atmospheric gases and the application of this knowledge to the process of respiration was constantly being made. The principle discoveries of this period, which were made by chemists, physicists, and mathematicians, were due to the efforts of two men - Lavoisier and Cavendish - that the main problem of respiration was solved, although the work of these two men was separated by over a century, and the work of the latter was never appreciated till after the publication of the latter's investigations.

The third stage is a more indeterminate one in which the nervous control of respiration and the methods by which the respiratory gases are carried in the blood were investigated.
by means of improved experimental
methods, chemical and physical, that
the results of this period were
resolved.
Chapter II

Early Ideas

The oldest theories we possess about Physiology are obtained from the records of the Babylonians and Assyrians, who occupied the fertile lands around the Tigris and Euphrates, and who flourished about 34000 B.C. The information we have about their ideas gives us a very poor impression of their knowledge of Physiology. Gods, demons, and the stars seemed to have had important functions in the human economy. They recognized the heart as playing an important part - this theory calls the 'haematic' theory while breathing was regarded as a secondary function, and received scant attention. The heart was supposed to be the seat of understanding while the central organ of the body was the liver. But the blood was recognized as the vital principle, and this
were thought to be two kinds—day—flood and night—flood—
respective to red—arterial and dark—venous flood.

The Egyptians, who were at
their height around 2000 B.C.,
allowed no examination of the
dead body, which they identified
with 10 sins. They used helms in
adorneance the Hapschtes, who
occupied a menial rather than a
professional office, and whose duty
it was to make the incisions in
the body in the process of embalming.

We are told that when their job
was completed, they were assailed
with fears and only escaped with
their life.

The knowledge of Anatomy
possessed by the Egyptians, therefore,
was not very extensive, though
perhaps it is unfair for us to judge
as our sole sources of information
are purely medical texts. I lay
thought however, for instance, that
the things were size—listed.

They did, at any rate, lay
stress on the vital importance of

feeling as opposed to the haemal

theory of the Mesopotamians, and

thus they were the first to hold the

pneumatic theory. They thought

that the arteries contained air,

and we find this idea which

agree from the observation that

after death the arteries are emptied

of their blood, which collects in the

veins and tissues, recurring again

and again, even many centuries

after it was dispelled by the

Roman Galen. It has, indeed, been

encompassed in the word ‘artery’

itself - which is derived from

the Greek word for windpipe -

"pneuma".

The baboons of Ebers and Bungel

which date from the 16th and 12th

centuries B.C. respectively, though

dating back to 3000 B.C. are the

main source of our knowledge of

ancient Egyptian medicine. They

contain the oldest reference to

the ‘pneumatic theory’ and the

arteries, or ‘air vessels’ are described
there: The head contains twenty-two vessels, which draw the spirits into it and send them thence to all parts of the body. There are two vessels for the head, which communicate heat to the lower parts. There are two vessels for the thighs, two for the neck, two for the back of the head, two for the forehead, two for the eyes, two for the eyelids, two for the right ear, by which enter the "heath of life" and two for the left ear by which enter the "heath of death."

The "heath of life" they say are seen to enter by the right eye and consist of the "good and delicate" eye of the north, the sea-breeze which thunders the "hurricane of summer" and renews the strength of man continually weakened by the heat and threatened with exhaustion. These vital spirits enter the being by the ear of a rose and mingle with the blood which
carried them to all parts of the body. They sustained the body and were the cause of its movements. The heart, which was the "perpetual

innocent" collector of these "sacred spirits" and distributed them throughout the body; it was regarded as "the

beginning of all the members, and whatever part the physician touched, whether the heart, the limbs, the

neck, the hands, the breasts, the arm, the leg—his hand hit up on the heart, and he felt it beating

beneath his fingers."

This last extract suggests that the Egyptians had some knowledge of the circulation of the blood, even if they thought that the arteries contained blood. The physician exerted influence on the heart through the vessels above and below the evil. They became inflamed, were obstructed, gave way, and the physician had to remove the inflammation and re-establish their vigor and
elasticity. At the moment of death, the vital spirits were withdrawn with the soul, while the blood, deprived of air, became coagulated, the veins and arteries emptied themselves, and the creature perished for want of health.

There has been discovered a picture of a dead man receiving the "health of life," he holds in his hand a "nail inflated" by the wind, symbolizing the air, and holds it by his nostrils, that he may inhale the breath which will fill open his arteries and bring life to his limbs.

We see then, that the Egyptian laid great stress on the importance of breathing, and also suggest that the air contains blood, and interest us also that they distinguished between good and bad air; or the air of life and death, which are in all ages to the day and night-stars of the Babylon...
The physiological knowledge of the Indians of historical times was not on a par with their great hygienic knowledge and their amazing surgical skill. The writing of their greatest period—about 1500 B.C.—has shown that they were filled with the idea that certain 'elements' were the compelling forces in life— an idea that persisted recurring until long past Medieaval times. These were categorized to be three of these elements—air, phlogistic, fire which served to carry out the vital processes independently of the soul. Air served the purpose of movement and was greatly relied on, the wonder though how it got there does not seem to be explained. There was some confusion perhaps, with the gas produced in the alimentary canal by fermentation—a confusion incidentally that was to suppose many others, including an all investigator of the 18th century. owing to the religious interdiction...
of every occupation, involving contact with disease, Indian knowledge of Anatomy was not very extensive and this explains the paucity of their physiological ideas. Otherwise, a people which displayed such an excellent knowledge of Medicine and Surgery would surely have laid some founda-
tions of physiological activities in pre-Christian times.

The Chinese, like the Egyptian and Indians, approved the esca
mination of the bodies of their dead and they possessed little
knowledge of Anatomy. Their ideas of bodily functions, however,
seem to have been very near the truth. They appear to have known
of the circulation and they certainly knew of the pulsation
of the heart. From Ptolemaeus, this
was of the only accurate idea of
surviving ideas possessed on the
subject in early historical times,
and was similar to Galen's idea of,
respiration disposing of the
fugitive vapors.
The Chinese supposed that the
complete circulation of the blood
and vital spirits occurred fifty
times within twenty-four hours
and that at each respiration the
air travelled six inches. They
also recognized the importance of
the ratio of the numbers of pulse
beats and respiration, which they
considered normally to be four or
five to one, and they noted its
variability in disease, as we do
nowadays. The observation
of this ratio, which seems a
very simple matter, does not seem
to have been made by most of the
medical ages when we speak
history, even right up to the time
of Boyle in the 17th century.

The Jews of the time of the Old
Testament, were great masters of
the sciences of hygiene and
sanitation, and Moses was one of the
world’s greatest health officers. That
had little knowledge of Anatomy or
Physiology, however. Their knowledge of anatomy was derived from the natural inspection of the carcases of animals. They knew that the heart was essential to life, and thought that the soul was a vital principle identical with the soul's respiration. They considered breathing enough to be similar to conversation, that they supposed the lungs to take up all kinds of things to form an idea to be built by one of the Greeks of the past. Classical era.
Chapter III

The Theories of the Greeks

We have come to a period of which the records are more extensive and have been more studied, and which exercised a far more powerful influence on subsequent times in all branches of thought than any of the preceding eras — the classical Greek period and the times immediately preceding and following it. This age left us with little concrete information of any value on physiological subjects, but it possessed a more scientific outlook and one less obscured by religious speculation than the preceding periods, and the revival of Greek ideas and Greek literature at the time of the Renaissance was one of the main forces in that intellectual upheaval.

The medical practice of Homeric times i.e., before 1000 B.C. consisted of not very successful
war surgery. In pre-classical centuries, such practice was in
the hands of the followers of
Heseklaios, the son of Apollo. The
Achalupia, as the Temple of this
sect were called, were health
resorts in which a variety of
medical measures, such as
sunlight, bathing, gymnastics
and suggestion were successfully
employed. The Achelupia
was considered that inspiration was for
the generation of the and itself
life and health being thus
identified with them. The Egyptian
school, of the seventh or eighth
century B.C., thought that air was
the basis of all harmonies and the
medium of the special senses,
health being therefore considered the
vehicle of thought. It was to this
school that Ambrose (500-428 A.D)
belonged who propounded the
doctrine of the four elements — i.e.,
that earth, air, fire, and water
played dominant parts in creation, as
described similar to that which we
have seen possessed by the Indians.
belonged. This theory of the elements was further extended by the famous geometrical
philosopher, who added to the elements four humans and four qualities and tried to reduce
pathology to a matter of
mathematics.

The outstanding figure in Greek medicine is Hippocrates (460?–370 B.C.). This remarkable
man, who has rightly been
called the "Father of Medicine," was born at Kos, where there was
a temple of Asclepius, and he
is said to have been descended from
Asclepius. He inherited some
kind of official position in the
temple from his father, and studied
medical

He was the first person to
practice clinical medicine as we
know it now, and his descriptions
have lived up to the present day.
His knowledge of surgery was
remarkable, and very methodical in
many respects; but he was most
consider here his knowledge of Anatomy and Physiology. It is a disputed point whether he could have derived his knowledge of Anatomy from actual dissection. The Greeks held the human body in great reverence, and one of the five Professors was the result of constant observation of the nude body in the gymnasia, and not of dissection. Of the whole figure, however, it seems quite possible that Hippocrates did as a little dissection, though the manner of display a detail in anatomical knowledge.

Respiration, according to this doctrine, had the dual function of filling and maintaining the heat of the heart. The lungs, as they inhale air to enter the heart, while the warmth inherent in the heart was supposed to be constantly maintained by the air streaming out of the lungs and their vessels.
He noted physiologically, the phenomena of Rumphius's style of respiration, which he described as
"like that of a man recollecting himself," and observed other alterations in the respiration in
disease.

The title of one of his works is somewhat inadequately translated as "On Breathing," and is an
attempt to attribute diseases to these "breaths." It may be taken, however, as an example of his illustrating
one of his favorite themes—the importance of climate in health and disease.

Amongst the many eminent practitioners of Hippocrates, one
who lived in what was one of the most creative periods
in world history, was philosopher Plato. This
man, who was the pupil of Socrates and the teacher of Aristotle, in
his "Timaeus," expressed some remarkably original, medical
subjects, which nevertheless were to
have enormous influence for some
centuries. He considered that both respiration and inspiration were by some method brought about for the purpose of filling a vacuum.

The cause of respiration was to be explained. The expiration of air through the mouth and nostrils displaced the external air and at the same time leaves a vacuum into which through the pores the air which is displaced enters. Also the vacuum which is made when the air is exhales through the pores is filled up by the inflation of breath. The explanation of this daily phenomena is as follows:—— Elements move towards their natural places. Now as every animal has within him a fountain of fire, the air which is inhaled through the mouth and nostrils on coming into contact with this is heated, and when heated in accordance with the law of attraction, is escapes by
by the way it enters towards the place of fire, leaving the body still so cold and drives round the air which it displaces through the brecipits to the empty lungs. This again is from the internal fire and escapes, as it enters, through the pores.

He then goes on to describe many examples that obey the law, "Nature abhors a vacuum."

His pupil Aristotle (384-322 B.C.) grew as the man of birth was equally great, and his name was so large in medieval learning. He spent twenty years with Plato, and after being tutor to Alexander the Great, landlord of the Peripatetic gulf of philosophy at Athens. Among his pothiria, which had a profound
career in the manuscript condition, and which eventually reached Rome from Egypt in B.C. 68, include "The History of Plants" and "The Parts of Animals," which contain a vast mass of information on natural history subjects. The credit of his labors was obtained by the help of his illustrious pupil Alexander. His theories on physiological subjects are set down in detail. The brain was connected with the heart and was not the blood, but the brain's blood, as it were. The brain was treated as a single organ, subdivided into the-breathing and single outlet, the trachea. In his "History of Animals," he says the canal from the heart passes to the lung and divides in the same fashion as the windpipe does, the windpipe being a continuation of the lung. The lung, he says to a pair of bellows, first their expansion, then their contraction. He explains the
lungs is due to the heat of the heart. When the air rushes in, the heat is reduced, and the air is expelled again. The cooling process takes place between the bronchial tubes and the blood vessels running alongside. Some of the air, he also considered, entered the blood by means of transpiration, these being the tubes and the vessels; their air was supposed to penetrate throughout the vessels of the body and thus rapidly cool the blood. Yet we cannot establish this function, that rather a "subtilizing and condensing air" — a guess at the oxygen that was not to be discovered for centuries. Aristotle's ideas on respiration were refreshingly reasonable after those we have considered hitherto. He did not, moreover, make the mistake common among his contemporaries that the arteries contained nothing but air.

His theory of the air cooling the food was taken up by several...
philosophers who have earned the
title of the "Cortes." Amongst them
was Diocles of Carpius, who
lived not long after Hippocrates,
and to whom Pliny says he was
next in age and fame. He belonged
to the Dogmatic school, and is
said to have distinguished the
arteries and veins.

Philetas of Lichozi, who lived in
the 4th century B.C., advanced the
opinion—similar to that held by
the Physiocrates—that what is done by
the lungs. He was the founder
of the Empiric school, which placed
its faith in the clinical methods
of Hippocrates.

The Dogmatists, whom we have
mentioned, on the other hand, took
more interest in theory than in
practice. They included
eminent investigators of their craft, however,
including Diocles, Praxagoras, Co
(340-320 B.C.) who is said to have
been renowned for his knowledge
in Anatomy and Physiology, and who
explained the heart to be the seat
of the soul, and the pneuma of
perspiration and also distinguished between the air-conducting arteries and the fluid-conducting veins, and
prophet upon the body. What was acquired — Diogenes (circa 480) of Abollonia, who said that perspiration
maintained life, that the body contained air, and that the brain was distilled through the veins,
circulated through the heart with the blood, tempered the heat of the body, assisted sense impressions and movements and
stimulated the putrefactive processes and digestion, the heart being the central organ of the body. He is
also said to have described the anatomical structure of the vascular
system.

Embodolcal of Agrigentum (500-428 B.C.),
the great advocate of the element theory, was a physician who is
said to have been many years 27
a semi-magic character, and to have
ended his life by drowning himself
in the river of Mount Etna in
order that the mudf should consider
what happened. He taught that respiration
could take place through the skin as
well as through the lungs—of the trachea and forward pressure constituting the respiratory movements.

The last great school of any importance was that founded by Alexander—at Alexandria. Here for the first time in history it was seen, dissection was actually encouraged and was given official approval by the Ptolemies. It is even stated by Galen that dissection was practiced as an undergone criminal, but this is nowhere true. At Ptolemaic, who is our authority on this subject.

In the knowledge of the two chief investigators of this school, Herophilus and Erasistratus, is not obtained from their own writings, but from recent research.

Hippocrates (ca. 460 B.C.) a pupil of Praxagoras was a distinguished anatomist. He differentiated between air-conducting arteries and blood-conducting veins as his master Praxagoras had done.
Prashad 

Hers (e.g. 250 B.C.) thought that the bright mass was a fallacy that was not clearly recognized until recent years. He assigned the entry of the air into the pulmonary veins to a passive process. He said there were two kinds of "burema," the "niral," which was conveyed through the artes and the "sthep," which was distinct from the brain. The "niral" bureau was augmented by means of volition, whereby the air penetrated the left side of the heart through the pulmonary vein.
The air entered the lung so account of its greater density and weight and left the lungs when they were full, leaving behind its burst and most delicate part. The movement of the air was thus due to attraction, a broader comparable with that taking place in cupping or in the 

\[ \text{R.0. 0. D. - The water-clock.} \]
Chapter IV

The Thematics of the Roman

Greek medicine was first brought to Rome by the Seleucid king of Syria in 124 B.C., after the sack of Samos. When at the height of its power Rome had to turn to Greece for its inspiration and ideas, and Medicine was no exception to the rule. Before this time, according to the elder Pliny, the Romans had succeeded in getting along without medicine and had trusted to slaves and religious rites; the luxury and wealth that followed the conquests of Rome must we necessitate the existence of competent physicians and Greek medicine became firmly established. Seleucides himself was a true Seleucid, and fell back on natural methods of cure. He considered that respiration furnished the necessary material for human maintenance, and was born of mechanical and not organic. The influence of this art was brought about by the entrance of pneumonia. It is interesting to note that
This movement of the "pneuma," which is all-important in health and disease, was further assisted by the pulzatory activity of the arteries between the myocardial terminations of which the interchange took place through the skin, the pneuma being taken in in inspiration, while the foul air was eliminated in diastole.
Aeschylus is the first person to mention 'viviparity' or the provision of an artificial arrow in the neck. He was the founder of the so-called 'Methodist' school, which considers disease to be a derangement of the soul's particles of the body, fitting a derangement to the 'humoral' theory of Hippocrates, which considers the fluid particles to be more important.

The second school to appear on the scene, the 'Pneumatic' school, which varies in the derivation of all organic phenomena from the effects and condition of vital air. This school was founded by Timaeus of Athens. This 'vital air' or pneuma was supposed to be taken in by the lungs in order to form the fluid derived from the food, while it was carried while food itself the stomach. It was supposed to originate in the lungs, and the pneuma was replaced by respiration, and it was supposed that contraction of the thorax caused air to enter the lungs, while relaxation expelled it.
A physician, Galen, who wrote about A.D. 135. He distinguished between the arteries, which contained life-giving air, and the veins, which conveyed blood.

We now come to a man whose name has loomed larger in medicine in the past than anyone else—Filippo Bonus of Flandrim (132–201 A.D.). This man was a physician and voluminous writer, but his new Organon, which tried to combine the rigorous thought of Hippocrates with the older Galenist Semi, was an ideas that Gennaro developed into a philosophy and tradition that cost a shell more time be fall long after the Renaissance. For the long dark ages that followed the fall of the Roman empire there was to be no advance made in medical science beyond his ideas, and even after the Renaissance his ways were regarded with a bag time as being as antediluvian.
Nevertheless he possessed considerable knowledge of Anatomy, which was mainly however derived from dissection of animals such as the muley. It is said that on one occasion he had the opportunity of dissecting a human embryo that of an expert criminal and of a high rank washed up by the floods. Altogether it seems to be a result of Anatomy. He also seem to have practiced dissection, and there derived considerable knowledge of respiration. He found, by cutting the intercostal muscles and nerves that respiration was performed mainly by the diaphragm and in quiet respiration entirely by it. Dr. Jones' theory is that the intercostal muscles are only called into play although an advantage before his day were ignorant of their existence. The air moved into progressively into the distended cavity but he also assumes the pleural cavities to contain air to an adventitious produced on puncturing the chest wall. The function of the inspiratory air...
was to preserve the animal heat, and to remove from the body of the fluids and emfusions, the effects of the opinion that respiration and emfusions are analagous. He compares the lungs to a lamp, the heart to a rich effusion of oil, and the animal heat to flame. Fins were some quail in the air preparable to a spirit, he also said. He says, when deprived of air, we might say, the substance that imparted to the body through ignorant of the doctrine of atmospheric pressure, he knew its practical application. He knew that an open test were placed in water, and the air were lost of the tube, the water would rise and the eels would rise in that way, and it states that the spark of cancer and that place of certain bits and were were fatal to life, because they were lighter than air, and not, as Erasistratus had said,
because they were heavier—though
he seems to the wrong sense.

He thought that these were no

"These, then, are what the atmos

draw into themselves on every side;
these arteries which reach the skin

of the heart, one of the highest

of things."

He also seems to have had some
idea of at least a circulation of

and those arterioles which are

further from the heart and skin

of the heart, some of it passed through
the inter-ventricular septum into the left ventricle, while the rest reached the lungs with nutrient material via the 'arterial vein,' or Pulmonary Artery. The 'vena cava,' which was drawn into the lungs, types the blood, which it reaches by the Pulmonary Vein, and the 'alveolar particles' were expelled on expiration. The same process occurred in cutaneous respiration. The air was drawn into the dilated vessels, a diastole, and in systole the 'alveolar particles' were expelled—respiration and the pulse beat being considered strange to say "simultaneously." Galen also knew the difference between sensory and motor nerves and described the nervous control of the muscles of the larynx and of respiration. Of the sympathetic—long-geal nerves—which he called the spinal cranial vessels—cut speech was lost, while the section high up in the cervical cord made respiration cease because the origin of the phrenic nerve which supplies
the principal muscle of respiration - the diaphragm - was not affected because of its lower origin, while section of the upper part of the cord had no effect on respiration.

Perhaps not the least important part of Galen's work was his exposition of the oldest and firmly established fallacy that the arteries contained purging hot blood. By using the classic operation of the Surgeon Antyllus for amenorrhea - Ope of ligating the arteries on each side of the belly, and cutting into the abdomen - he definitely proved that the patient's blood was an observation which was to be of the greatest future value in physiology.

Wallace's work then was original and most of it exact. His fallacies, unfortunately, were for ever twelve centuries to be considered of equal value with his correct themes, and even Harvey's teacher
Fabricius was to be an ardent supporter of Galen's physiology. When at length his theories were fully investigated and many of them disproved, his position in the history of physiology is in no way shaken. His work has always been of the highest importance even if only for the eminently and fruitful investigation in which it resulted after the beginning of the Renaissance. The only other figure whose work is of any value in this subject is Nephi Marinos, whose discussions in his writings whether the arteries contained blood or fluid penetrate into the lungs. Unfortunately, only the table of contents of his work has survived, and it is therefore impossible to discuss them.
Chapter V
The Dark Ages

For more than twelve centuries after the death of Galen, medical science was at a standstill. The
Arabs whope way extended from Persia to Spain, made many
notable discoveries in such sciences as Mathematics and Astronomy, but
in Anatomy and Physiology they
strenuously followed the works of
Aristotle and Galen, although
they produced many notable
physicians.

Aristotle and Galen, indeed,
were the standard authorities on
these subjects during the Middle
Ages, and no advance was made, or
attempts, upon then. These works
were digested and interpreted by
famous teachers, such as Abbe
Magnus, that no
disagreement with their doctrines
was allowed. The Church, moreover,
was omniscient in the social and
political worlds, and restricted all
original investigation. The early
Italian anatomists therefore practiced dissection under the greatest of difficulties. Thus we find Mondinius, the Professor of Medicine in the University of Bologna (1315-1318) creating such scandal by his dissection of three bodies that he was compelled to give up his investigation of the "second human eyeball" and thing with Anatomia Magnana. It is merely an introduction to the orthodox Galenic teaching, although it forms the standard text-book for many years after his death. Recent research has shown, moreover, that the anatomical drawings that were produced between the times of Mondinius and Vesalius, the so-called "graphic invenzione" were merely record-hog's copies of previous works, and not the result of first-hand observation.

Great accuracy is shown in the anatomical drawings of the artist Leonardo da Vinci (1452-1519) but they were made for artistic and not scientific information.
We find, for instance, as an indication of the amount of anatomy
known by members of the medical
profession even after the work of the
great anatomists, that the
physician, Sir Thomas
Browne (1605-82), expressed in
his essay on 'Pneumium', the idea
that there is only a pellagra cavity
which occupies all sides of the
thorax.

Long before his time, however,
had reached that wonderful
knowledge of events known as the
Renaissance. The spirit of
printing, the eating of Constantinople
and by the Turks, and the
subsequent flight of its scholars and
their books through Europe, and
the new overseas discoveries all
combined to give a high impetus to
new thought and activity. The
study of the human body, shared in
the eyes of all, began to be
questioned, and we find that
Paracelsus (1493-1541) whose name will be
mentioned later in our study of
the atmosphere of ages, leading to
enraged against rebel
adherence to Galen’s doctrine,
and advocating the substitution of
individual judgment and
observation. He was the founder of
the modern science of materia medica,
but it rather with the rise of the
science of anatomy that we must now deal.
Chapter IV

The Rise of Anatomy in Italy and the Discovery of the Circulation of the Blood.

In 1514 there was born in Brussels an Andreas Vesalius, of a family famous for its medical attainments. He spent his boyhood in Louvain, where he developed his passion for dissection, and it related of him that on one occasion in his zeal to obtain bodies the even stole a skeleton from the gallows. He studied Anatomy at Padua under Sylvius, with whom he was later to quarrel on the subject of the infallibility of Galen's teaching. He also became court physician to Francis I, and served as an army surgeon. At the age of twenty he went to Italy and held the Chair of Anatomy at Padua for seven years. He simultaneously held a similar office at Bologna and Pisa. At this period he prosecuted his anatomical studies with unflagging enthusiasm, and it is related that followers displayed great eagerness in their
efforts to obtain bodies for dissection. At the age of twenty-five, he published his magnum opus, De Fabrica Humani Corporis. He then commenced this struggle with the Galenists. This work, which was well illustrated, contained the results of his own anatomical studies, and concludes with an account of his physiological theories. The anatomical part is largely a repetition of many Galenical superstitions, while the physiological part adheres in the main to Galen's ideas. It was an almost impossible task for Vesalius to disprove Galen's anatomical fallacies, and he does no more than show a reasonable skepticism of Galen's ideas of function.

All the physiological advances of this period were secondary. It was discovery in Anatomy and in studying this latter subject. Therefore, we are not considering isolated and unrelated science as a necessary part of the contemporary ideas of function. It was anatomical
observations, whether correct or incorrect, that were to suggest theories of function. I hope we find the demonstration of the valves in the veins suggesting the idea of the circulation, just as the accepted fact that the arteries contained air had been the cause of many fallacies about the circulatory system.

As a result of this examination and unorthodox speculations, Vesalius had now got into bad odors, and had to give up his appointments and take up the life of a court physician in 56 A.D. This meant giving up his beloved university, and it is said that he spent his hopes to apologize this divorce from science. In Spain he lived the quiet life of a professional man, but on one occasion, however, according to one of the legends that have come down, he happened to be doing a post-mortem examination on a young Spanish nobleman whose heart was seen to beat during the operation, and Vesalius was compelled to journey to the Holy Land as a penance.
He seized the opportunity on visiting
on the way his old friend in Italy.
He learnt that his pupil and
successor, Falloppius, whose
recent work had aroused his
lifelong enthusiasm and made
him long to investigate a piece new
"that Saxon Bible of the human
body and of the nature of man,"—
yielding edge it is vanish-
state that he was asked to occupy
his old chair of the vacant
professorship of Physic at Padua.
He also travelled to Tavola on his
way back from the Holy Land.
He also had authority, he said,
should only be accepted when it
was Galen's authority. His dispute
with Galen's anatomical knowledge
brought him into collision with
his old master, Sydenham, at Paris,
who strangely enough was a good
anatomist, and who defended an
utterable doctrine saying that "men had changed since Galen's
time, but not for the better."
His was not very extensive account
The septum of the ventricles, composed as it has been said of the thickest substance of the heart, abounds on both sides with little pits impressed in it. Of these pits were so far at least as can be discerned by the senses, penetrate through from the right into the left ventricle so that we are driven to wonder at the easy passage of the blood through the right passages which escape human vision.
He has nothing, therefore, to substitute for Galen’s ideas about
physiology, but at any rate, by means of dissection, he confirmed his
experiments that section of the
occipital language nerve caused
loss of the grip. He made reserves
an experiment that was to prove of
the greatest value in the subsequent
study of the mechanics of respiration,
proving that an animal may be
kept alive when its lungs have
been paralysed by means of artificial
respiration with a bellows.

The next discovery of the pulmonary
circulation was made by Michael
Venetus (1509-53) although he did
not describe it quite accurately.

Born in Spain, he fled from the
hand of the Inquisition and
studied under Sylvius, possibly
meeting Vesalius at that time. Of
this last man we say, one - Die
Injunctio Empyema in a purely
historical work while, this "Resistitio
Elisionis" contains his
reparable description of the
pulmonary circulation. He says -
"The vital spirit lies in the left ventricle of the heart. The lungs, especially the lung of the left, help towards the perfection of the power of heat and of a yellow color of a fiery potency. So that it is as if jetted a vapour shining out of the open pores containing the substance of water gain and of fire. It is generated through the communication which is effected in the lungs. After inspiring air with the elaborated blood, communicating from the right ventricle into the left. This communication goes to place through the partition of the heart, and is generally believed. It is another admirable substance, vigorously for the right ventricle. The right blood is agitated into the lung's course through the lungs, wherein heat and it becomes of a crimson color, and from the veena arterialis, pulmonary artery it transfers..."
into the aorta were given (pulmonary vein) together with the escaping air in the aereas venae, freed by respiration from the gradually\nbecoming a plentiful source of the vital spirit it is attracted at length into the left ventricle of the heart by the diastole of the organ.

This account, therefore, from a remarkably clear picture of our pulmonary circulation, the air\nminor mistakes being on suggestion that the mixing of the blood and\nair took place in the pulmonary veins.

Some of the ideas of the\nsystemic circulation, however, were identical with those of Lees. His physiological theories were unfortunately unsupported, and the\ntriumph at the stahle in 1833, at\nthe orders of Napoleon. He was not\n
unlucky, as is sometimes said,\n
picturesquely, for his description of\n
the pulmonary circulation is also described by Columbus (1516-1559)
who was at various times, Professor of Anatomy at Pisa, Padua and Rome. There is evidence that hedishonesty claimed the credit of
Santini's discovery. His principal
work, "De Le Anatomica" is an
imitation of design and matter of
Aristotle's work and he also seems
to have invented an imaginary figure of
first describing the shape of the ear. It is not
surprising therefore to find that
he copied 38 copies himself though
not published till after his death,
his "De Le Anatomica" was written
after the death of Santini, of whose
work he had probably seen a
manuscript copy. His account of the
pulmonary circulation at any past is
remarkably similar to that of
Benedict.

"Between these ventricles
there is placed the septum through
which almost all authors think
there is a way open from the right
to the left ventricle; and according
to them the blood is in the veins
rendered thinner by the generation of
the vital spirits in order that it
passage may take place more easily. But they make a great mistake.

In the blood is carried to the arteries, like veins to the lung and

heart. Those made thin is brought

back there together with air

in the vein-like arteries to the

left ventricle of the heart. The

first we are left little to observe

recorded in printing; yet it may

be not readily observed by any at

the time they began to attach the

idea of the Galenic and other

ideas about the function of the

pulmonary artery and vein.

"I for my part find quite a
different view, namely that this

pulmonary artery was made to carry

blood mixed with air from the left

ventricle of the heart."

It is quite to say

certain fluids both in the living and

death, and perhaps the divinest

expression of health is such a theory.
The actual mixing of blood and air
taking place in the pulmonary
vein—his theories on the systemic
circulation are like those of
Galenic.

The first person to suggest the
systemic circulation was the Greek
physician Andreas Vesalius (1514-1564),
who was Professor of Medicine at Pisa. He
refers to the value of the veins, and
suggests their function. Moreover, he
had a clear grasp of the pulmonary
circulation.

The passages of the heart
are so arranged by nature that
from the ventricle a flow
takes place into the right
ventricle, where the way is open
into the lung. From this lung
movement there is a constant
progress into the left ventricle of the
heart, from which the flow is
sent into the aorta. Arteries contain
membranes being so placed at the
mouths of these vessels that they
prevent return;thus there is a
sort of perpetual movement from the
perna eava through the heart, and
things into the aorta, artery as I
have explained in my previous
question.

A passing return was made to
the old Halybalical idea, was
made by Fabricius at Aquapendente
(1537-1619). Fabricius was one of the
most famous anatomical teachers
in Europe, and was the pupil of
Fallopian, who was the pupil of
Vesalius. His reverence for the work
of the school he followed, however,
was so great that he neglects the
spirit of that school. His physiology
is that followed, on the whole by Vesalius —
Fallopian's physiology. But he was
not the excuse of Vesalius for not
examining it. He had before him
the accumulated anatomical
deposits of Vesalius, Soranus,
Galen — Fallopian and many
others and much anatomical
work of his own. But in spite of
it all, the forces of reverence and
tradition were so strong, and he made
no advances in physiology.
Thus in his "De respirat. nat. vigintim太久 (he discusses the
mechanism of respiration, and
shows a complete ignorance of, or
perhaps disbelief in, the pulmonary
circulation. He says,
"Admitting then that the
lungs are endothelial of their own
broader tissue, of the artery-like
vein of the vein-like artery and
of the true artery (aorta), and
that they possess the artery-like
vein for the purpose of their
own maintenance, that they
possess their own proper tissue to
act like the bow for the purpose of
intersecting and guarding the
termination of the vessels, and
that they pass through
arterial in order that there
may be a fit receptacle for
receiving the air, admitting
this, it will be nevertheless seen
that the whole construction of
the lungs was gaining out
chiefly for the sake of the
remaining vessel, namely, the
vessels-like arteries, the use of which is that the air may conveniently reach the heart. For otherwise the air would be drawn into the cavity of the thorax, and would never reach the heart. The heart digests the heart; extending its vessels like arteries from its left sinus right up into the lungs."

This concludes that the heart enters the body to fill a vacuum, and is used for the purpose of generating the animal heat and maintaining the heat of the heart, and it leaves the body for the purpose of removing unnecessary all these theories might well have come from the pen of Galen.

His 'high' O. D. venenum phleboi — On the little dog of the vein — is an account of the valves of the vein, and their demonstration in the living subject. He considers that they are for the purpose of preventing the blood from being broken up,
and nowhere offers any suggestion as to the part they play in the circulation of the blood, of which, of course, he was entirely ignorant.

This observation of his fell like a seed into the mind of one of the many students who flocked to hear Fallopius at Padua—this time an Englishman, William Harvey (1578-1657). The affair of this man to the title of being the first beg to suppose the circulation of the blood is now clear and undisputed, and more even. And so much for the knowledge of the pulmonary circulation.

Flemings and Bolonia, as we have seen, realised the transit of the blood between the two sides of the heart. However, they merely surmised the difficulty that lay highest. She not the passage of blood through the heart. They did not realise that the whole of the blood

...
passed through the lungs. Harvey, however, by means of numerous
experiments conducted and calculation
of the volume of blood dealt in by
the arteries and veins, definitely
proved the existence of both the
pulmonary and systemic circulations
each and having continuos with the
other and forming, as it were, the
two looms of a figure of eight.

In his work De Motu
Cordis, he considers the theory
that only part of the blood passes
through the lungs and after
disposing the blood supply of
the lungs in both the Poets of
all-speed animals to the heart.

Finally, our position that
the blood is constantly passing
in the right to the left
ventricle from the vena cava
into the aorta; through the
large structure of the lungs
plainly appears from this that
since the blood is necessarily
sent from the right ventricle
in to the lungs by the pulmonary
artery, and in the change to


necessarily drawn from the lungs into the left ventricle, as appears from what precedes and the position of the valves, it cannot do otherwise than pass through continuously. And, as the blood is necessarily flowing into the right ventricle of the heart and is continually passed out from the left, as appears in figure 13, Wagner, and as is obvious from the passage and grasp, it is improbable that the blood can do otherwise than pass continuously from the heart into the aorta.

Harvey's only attempt at an explanation of the function of the pulmonary circulation was that it is for the purpose of cooling the blood, and he supports this with little evidence. He says, "If (i.e., the pulmonary circulation) must be either because the larger and more perfect animals are warmer and when adult their heat greater—equally, as I might
-ray and requiring to be dammed or mitigated in other, for it may be that the blood is sent through the lungs, that it may be tempered by the air that is inspired and prevented from rising up, and so becoming shop-in-liquids, or something else of that sort.

To summarize the advances may in our knowledge of respiration during this period. Then we find that it merely consists in the discovery that all the blood in the body passed through the lungs. Verulam's mere quill suggests as it how the heart's blood is sent from the right side of the heart to the other organs after passing through the lungs. From Harvey it is clear how this discovery was made. Galen had a highly clear idea of the passage of blood through the lungs, while Harvey defined what he knew that all the blood in the body circulate
through the lungs, although the misunderstanding on the former basis of minor circulation. On this firm basis we find that our knowledge of respiration proceeds at a great speed.
Chapter VII

The Mechanism of Respiration, and the
Work of the Lungs

Now that the circulation of the
blood of the body, through the lungs, was an established
fact, the next step to be taken
was the explanation of this
circulation, and of the respiratory
movement. None of the discoveries
of this period were made by Englishmen,
though the final proof of the idea
was given by a Frenchman.

The Honorable Robert Boyle
did much work in the
subjects of chemistry and physics,
and his name has become attached
to the well-known laws she states
about the pressure and volume of
gases. In his "Nova Experientia
Physica," published in 1662, he
describes how, by means of a
mechanical pump, he proved that animals
such as mice and sheep, could
not sustain life in a vacuum, and
that air was also necessary for the
epithelium of galls. Borely also noticed that the Chinese had
declared that the respiration and
debt were not simultaneous,
and did not occur in unison, as
Galen had thought, together with
all the physiologists who
preceded Borely.

His work and his pneumatic
machine were to be of value to the
Stations Borely (1608-1679) who
was a mathematician and who
belonged to the Scientific Mathematical
school—which began to explain
all physiology by the laws of
physics. Borely held that
expiration was far more important
than the heating of the heart of
a living creature after the removal of
its heart, in some cases, whereas the
stopping of inspiration meant the
end of life.

“Animals of all kinds shut up
in such a vacuum immediately
take deep breaths, but if the air be
properly renewed with care, may
be brought to life again.”
He realised that the air entered the chest extremely slowly, due to muscular action, in consequence of the great external pressure. He denied the assertion of Harvey that the pulmonary circulation is for the purpose of carrying the blood, or that of Hales who had the hard task of seeing, with the aid of the microscope, the capillaries of whose existence Harvey had been unaware. He thought that the blood was thoroughly mixed in the lungs. He commented: "It is clear that what has been said that the use of breathing is not the object of the exercise of the heart, nor the mixture of the fine aqueous blood of the blood, but is by the pressure of the inflated vesicles of the lungs, movement of the passage of blood from the right to the left ventricle of the heart, in order that the circulation may be..."
"carried on."

He then goes on to describe how the air finds its way into the floor not by means of minute pores, but by being dissolved in the fluid that is always present in the capillary channels. He does not suppose that any chemical combination formed by the pulmonary fluid and air that results from "equilibration" of a vibrating tone oscillator are produced for the purpose of controlling the bodily functions. B. Q. E., general opinion that the circulation are therefore seen to be very rapid except in the two details about the nature of communication between floor and air and the condition of the air in the floor. The function of the governor of the cephalo are well investigated by Robert Boyle (1627-1703). This idea was one of the first to use the microscope and the microscope to study the bubbling of experiments before the Royal Society. It was
his duty to perform many dissections and this brought him to hear of artificial respiration, which was used, as you have already noted, by Vesalius. He wrote that it was not the physicians of the time nor well-learned men that were necessary for this, but the changing of the air. He maintained that the life of animals was the thoracic air being sent through a current of air and then out with a bellows and allowing it to escape through holes bored in the lungs. He suggests that it was the expelling of the air of the venous blood that was the purpose of respiration, and that the movements of the thorax were only the mechanism for bringing this about.

It was two French investigators who were most to develop our knowledge of respiration to a higher level. Both of them were after experimenting and did most of their work at Oxford where C. G. come under Willis (1621-75) who was Professor of Natural Philosophy.
There, Willis was a physician who did much valuable and permanent work as a physician in clinical medicine. But it is as an anatomist that his name has achieved fame and has come down to us in the arterial anastomosis at the base of the brain, and the accessory nerve that are really other fibers. As a physiologist, however, this name is insignificant compared to that of his student illustrious pupils.

Richard Lower (1631-1691) was born at Tremecore in Cornwall and obtaining a studentship at Christ Church, Oxford, he both an art's degree, and studies chemistry and medicine. He also assisted William in his work. On going to London, he obtained a regular practice and became a fellow of the Royal Society. His name has long been to us in the subject of fever; and it is said that the practice blood-letting as a therapeutic measure will succeed, which must have been
which is contained in his ‘Tractatus de Conico’ published in 1669, before the publication of Spedili’s ‘De Notis Mathematicis’ which was issued in 1680-81, and which may have profited by lawyer’s ideas.
caused it to become lighter also on its exposure due age. Largely condensed,
therefore, this charge of the air due rise of the sun, to
air in the lungs of the blood.
It remained for lower's
contemporary—John Mayow (1663–78)
friend in this he won fame in London,
and became a student
Wadham College, and later a fellow
of All Souls, dying at the early
age of thirty-six. In addition
to this he published works which we
shall be discussing he practised
saw in Bally with some success it
is said, and he was elected a fellow
of the Royal Society, being imposed by

At the age of twenty-eight, he
published at Oxford his Latin

- De Respiration
- De Respiration

which were issued in a revised
edition together with three other

- De mal natura spinti
- nitro-acetic
- De respirative fodiens in utero et
  ora.
- De motu musculari et spiritus
  animatis.

at Oxford in 1674. He first
usually calls the 'animal respiration.'
They are well illustrated with
medicines on two of the
inorganic muscles and of his
observation and animal respiration
experiments.

In this 'De respirative' Lee
describes the mechanics of respiration
and admits function. He merely
suggests his ideas about the vitru-
vensial spirit that he was to
describe with such wonderful and
accurate detail in one of his works of
six years later.

He first explains that the air
enters the chest solely as a result of
the decreased pressure caused by the
dilation of the chest by the
diaphragm and it enters the
muscles.

With regard to the
gas exchange of the air, I think it is to be maintained
that it is caused in the following
manner of the pressure of the
atmospheric for as the air, on
account of the weight of the
superincumbent atmosphere, not only
presses into all the empty places,
but also presses with its full
whatever is near it (as Boyle's
experiment has put forth)
that if he should take the air
passed through the upper part
the tracked up to the higher or
gates of the lungs from within
and seeks an entrance by them
where it is that when the upper
sides of the thorax (which
expressing the lungs from
without, work resisting the pressure
of this air) are drawn upwards
by pulleys, cause together, it is to
collapse the chest, and the space in
the thorax is enlarged; the air
which is nearest the hippocr
inlet, now that every object is
removed, rises in depth to full
pressure of the atmosphere, fills
the cavity of the lungs and by
inflating them occupies and fills
"the above of the expanded chest."

He illustrates this by the following experiments that are still used - of a bladder being inflated in a vacuum and of a bladder being inflated with air the widening of a bellows - while it is attached. It is interesting to note the application of this idea to thoracic surgery.

"Thus by the body's purgative effects resulting from the process of the chest, it has been believed that the chest is exposed to the almost impenetrable air. Otherwise, if the opening made in the chest is closed when the chest is inflated, that is when the air has filled the lungs, it will be impossible for the patient to expand.

"in consequence distortion will necessarily follow."

The way the expanded chest may be expanded, or not..."
hanging that air in the pleural cavity is absorbed if the wound is closed.

He does express in detail, with the aid of a diagram, the exact function of the intercostal muscles—a point still debated—and concludes that both rotate and intercostal muscles dilate the chest, and that ordinary expiration, as we now know it, is a passive process, though forced expiration, such as occurs in laughing, sneezing or coughing is an active process. He accurately explains sneezing as being due to a contraction of the diaphragm, and not, as has been supposed before, to a contraction of the stomach.

He next discusses the function of respiration.

"The breath we inspire is destined for a still further use," for which arises such a necessity of changing breath that we cannot indeed live a moment without it. He dismisses the three theses, as
Savelli has demonstrated that respiration is for the purpose of cooling the blood and assisting its passage from one side of the heart to the other, and that during exercise and its consequent increase in perfusion, the blood is heated rather than cooled. He said that there is no pulmonary circulation in the dog, and that mere churning of the blood would not require a change of air.

"It was probably," he said, "that certain batches of a "nitrative nature, and these "were subtle, agile and in the "highest degree fermentative and "separated from the air by the "action of the lungs, and conveyed into the mass of the blood."

Death in the suberosis of suppuration is due to the failure of the supply of the aerial patches to the heart, and therefore the failure to supply the brain.
In his work "On the Origin and Nature of Objects," the
author describes in great detail the evidence for supporting the existence of
a "vital principle," and we must
each draw from this evidence that he
is speaking of the gap we now call
"oxygen," and that he was perfectly
aware of its importance in the
respiratory process. This principle
is mostly derived from the study of
the properties of nitric, which he
found to contain a substance
was not and itself this substance
being necessary for the combustion
of many substances. He refers to a concoction
that could only take place in the
presence of air. It is this substance
necessary that was contained in
antimony and increase its weight
when it is exposed to the sunlight,
and the ray has he made an
observation that is identical with
that that was to first make
flammable the existence of
oxygen, over a catalytic letter.
He says, "For should it be overlaid
that antimony, calcined by the
solar rays, is considerably
increased in weight, as has been
ascertained by experiment. Indeed, we
can scarcely imagine any other
source for this increase of the
antimony from the non-aerial
and igneous particles fixed in it
during calcination."

After further discussion of the
properties of this substance, he hopes
that it excites in the blood a vital
fermentation.

... It is our opinion, then, that
as in vegetables, so also in animal,
non-aerial particles of the blood
appear to excite its vital
fermentation. These latter are the principal
instruments of life and action.

We in the first place, non-aerial
object when mixed with the saline-
and phlegm particles of the blood appear
to excite in it vital fermentation. In
fact that is non-aerial particles
when they slowly enter the pores of the
...a salt encounter there salin-
mythman particles immnante
indeed in an osseus fermentating a
which as has been shown proceeds
the life of plants depends; so the
same nutritioanl particles when
introduced more profusely into the
mass of the body by the action of
the lungs and mixed in their
minutest parts with its saline-
mythman particles, brought to a
state of active vigor produces a
"marshy ferment" which as is
required for animal life.

He also quotes the confirming
observation of Laver in the contrast
the blood offering and leaving this
lungs. It is thus "these effervescence
that is the engine of muscular
contraction which he discusses in
detail and with great accuracy in
order of his breathes. The increase in
peristalsin on taking exercise is due
to an increased demand for nutriti-
genial particles and the increased
heat produced is due to greater
effervescence in the muscles.
We see, therefore, that Mayr's themes are almost exclusively at the history of the subject of theirignorance and accuracy. His conception of the mechanism and chemistry of respiration is identical with the age he lived at the present day although it is embellished in more cumbersome terminology.

Yet for some reason, Mayr's work was not appreciated by his contemporaries, and it remained for Lavoisier to rediscover over a century later the nature and physiological function of oxygen. It was only then that the point of Mayr's work was recognized, for we find that it was perfected by Le Blon in the early half of the eighteenth century. In *Vegetable Statics*, Lavoisier himself in his survey of the history of the respiratory gases, makes no mention of Mayr's, and we may presume that this ignorance was

It has lately been suggested that the non-recognition of Mayr's work was due to the mistaken made by...
In an English translation of his work that was done for the Royal Society. Perhaps we must charitably suppose that this is the case, and judge Maxon's galenophobia for what it is. Acknowledging one of the greatest geniuses in the history of physiology.
Chapter VII

The History of the Atmospheric Gas...

We have now considered the history of the atmospheric gases and their relation to respiration. Oxygen, as we have seen, had to be isolated, and its respiratory function rediscovered while Carl von Oppenheim, after a long history, was to become a definite chemical entity with an important role in respiration. Nitrogen and Hydrogen, though not present in the atmosphere, had also to be isolated before the nature of the gases and changes of respiration could be fully appreciated. Almost all the discoveries of this period and their publication to respiration were made by men who were not physicians, but some scientists.

The history of carbon dioxide, as has been said, is a longer one than that of the other gases, probably because this gas was studied earlier in account of its frequent occurrence in natural circumstances and its well-marked properties, such as its ability to sustain life.
Before the time of Paracelsus, there were no definite ideas about this gas thought to be produced during combustion and respiration. We well-known facts as you give the physiological properties of the famous "Grotta del Pane". Paracelsus himself, when we have described as leading the crusade against Galenist and founding the science of physiology, was little knowledge of physiology. He thought that this gas, whatever called "Spiritus Sulphuris" was the same as the air we breathe, but he disputed his statements, which was signed by his contemporaries with neither arguments nor experiments.

Paracelsus called it "gas" or "spirit air". "An incomprehensible vapor, which could neither be collected or be released under a visible form." Some writer, he
This substance—"not that it had been actually contained under that form in the hogs from which it was separated: otherwise nothing could have retained it, and its parts would have been dissipated. But it was contained under a concrete form, as if fixed or coagulated."

He shewed that it was produced in fermentation, and also issued from burning charcoal sixty-two parts of which they were contained in the tractate de phthis, he attributes the fatal effects of the stomach pelta, came to the gas, and also the melancholy of women in mines. He thought also that it was produced at the glands during digestion. He realized however that it was different from the air we breathe.

The discoveries in this direction of Boyle, whom we have already met with in cancer in with the accidents of vitreous matter, belong to Van Helmont. In his work Continutio
Experimentum physicum, euclidii aemum de gravitate et elatione reserat. Describit fermentationem, et probo quod gas producitur in poisons et quod fumus aeri est necessarium ad sustentationem vivendi. 

Mores praevaricae, a gas ex reserat. Compendiose, enim, de quibus dequitur. Haec reserat ad quod deicitur. 

Morbus aegrotorum, a gas ex reserat. 

Morbus aegrotorum, a gas ex reserat. 

Morbus aegrotorum, a gas ex reserat. 

Morbus aegrotorum, a gas ex reserat.
that absorbed by burning bodies and the respiration of animals. He says, "a lighted candle, ½ of an English night light diameter, absorbs 78 in of air." A rat engine in a "reservoir" absorbed 78 in of air and "78 in of air breathed by a man for one week was nearly suffocated, was reduced to 20 in."

He knew that the absorption of air when a burning candle was in contact to the volume of the vessel were the combustible body placed and that inhaled air could be made unusable by being heated through flammables evaporating salt of potash the flames becoming heavier in this progress. The dissipation of ethereal due to condensing he explains by the loss of the elasticity of the air. The absorption and dissipation of air, a point however, on which he
It is not very certain. He compares fixed air to a tiny proton, vapour freed from a soluble which shall be adapted among the chemical principles. 

And because a number which has been hitherto denied to it in reality, therefore they find themselves making careful experiments with water, dioxide and oxygen, and attributing their properties to air itself.

The Dutch chemist Boerhave (1668-1738) seems to have half-heartedly changed his opinion in reading Hales' work and to accept the theory which he advises his readers to consult.

His pupil Hales (1728-77) discusses the gases. The gas chemical and physical that had been advanced to explain the respiration, but concludes with the vague guess: 

"it is extremely probable that air plays the part of a cement holding together the earth's elements."
It was Black, who was Professor of Chemistry at different times in Edinburgh and Glasgow Universities, who was to blaze the question of fixed Air, or a gas in the words of Lavoisier, he may be fairly regarded as the person who first introduced fixed Air into Chemistry. In his first experiments published under the title "Experiments on Phlogiston, Air, and other Alkaline Substances," he observed that carbonated water lost half its weight or became lighter when treated with acids, and that if pure air was given off, it proved to be carbon dioxide. In response to the air of this discovery enabled him to use the lime-water test for fixed air and the confirmation of Helmholtz's discovery of Lachgas. He found that it was given off during fermentation and respiration and quoted the famous experiment of Lavoisier, which gases escaped from aqueous solutions.
Physician - P. Macleod - for the discovery of Ruber Dicicle, which seems to have been done independently, though some time after Black's work. He found that Ruber Dicicle was given off in putrefaction, and eventually that it was an elastic substance, very different from atmospheric air. It was dangerous in the lungs, he thought, but harmless in the alimentary canal, where he supposed it to have some effect on digestion. Absence of it, indeed, he said was the cause of scurvy, diseases and sea-sickness, which could be cured by the consumption of vegetable containing it, and he here seems to have it upon Vitamin C, without knowing it. He says: "It is also observed that the diet which is not varied in these diseases is that consist of animal food, which yields much less air by fermentation than vegetables. The method of cure on the contrary consists of the use of a vegetable diet, and of all those which are best.

..."
and thus made it respirable for a
longer time.
A black bread then for that
was present in air in an unstable
percentage of gas that was a
product of combustion and respiration,
which was fatal to animals if
breathed for any length of time.

Before discussing the
rediscovery of Oxygen and its
usefulness, it will be well to
consider the principle chemical
theory that was current during the
time of Priestley and Lavoisier—
that 'phlogiston' theory, which
was first enunciated by the
chemist Stahl (1660-1734) and was
to obstruct the progress of chemistry
for a hundred years. The principle
was that when combustion takes
place, 'phlogiston' departs from the
body that is burned. Lavoisier had
already shown that a body
 gaining at one's expense was losing weight during
combustion, and this was to be
formed again by Lavoisier. Nevertheless,
this theory was so well established
in the minds of scientists that when
"furnishing an abundance of fixed air."

He states, incorrectly, as we know now, that this 'fixed air' was contained in the red part of the blood, and not the serum.

It is interesting to note that Lavoisier refers to the "vivans" and "accurate experiments" of O. Macbeth.
Priestly described Volta as misunderstanding it entirely, and said that the subject abstruct plan as it were the sight that must be given him for his use. Like Joseph Priestly (1733-1804), it is like Gates was a clergyman at one time, and seems to hold that he is a clergyman's career. He first of all succeeded in making liquid air respirable by means of exposure to plant life in a vegetative condition. He then explained Gates with his recovery that some of the atmosphere was then producing the gas that contain with the rubber. He exposed the vapor external—there are all the parts of the sun's rays in the atmosphere of air. The gas produced by these rays was favorable to combustion and animal life. This gas which was produced in watts the self-digestion into air and carbon. Priestly was aware of the some position of this gas in the moon.
of respiration. The function of the lungs, he said, was to be a means of negotiation of a putrid humour which would corrupt the blood in the same way that it corrupts the dead. He explained, however, that lactic acid is not dangerous because for respiration purposes, as we know now, it is not harmful. In a sense, it is the fitting link in the air with the respiratory processes.

"Expiration and inspiration effect a common air in the same manner, and in the same manner in which all respiration processes diminish air and make it fresher, and all agree in holding this the case. It shall seem that the phreneticists will take it with and almost after having disregarded it, break their function in the respiring system as effect of the lungs into the"
great column nearer the atmosphere.

- Edward Bunsen, and his delphos. Our Oxygene, we see that his ideas on respiration were accurate and substantial. But that were upside down. He saw the respiratory processes as it were, in mirror image, but nevertheless we must know him for being the first person to realize the importance of oxygen, and its determinism. Though vague, its place in animal life was already promised for the great French chemist - Antoine Lavoisier (1743-94) to understand the broken place of oxygen. He proved the cause of death all this life, which was eventually led by his own death for some of his official duties. A car a keg sign in his paper. Being met with the reply "La Republique" in his first column, in which the serious
The history of this subject, and its originating and original, at the end of this essay, have Expressions, which express it in a manner amusing. De Cremers, in his Letter, published in 1775, and describing experiments to place in the air, 

He shews that the reduction of metallic particles with the aid of carbon dioxide produces a gas capable of smelling and breathing. The air itself, without alteration or without decomposition, to such a degree, that after having been engaged in this emulsion, it can be felt at the sense, and it is perhaps more 

pure than respirable. It may be permitted to use the expression, then, than the air of the atmosphere and is more proper a support than 

and is the condition of breathing, we conclude if well.
preventing Prout's chemical test for two years later in 1777. In his experiments at the Botanical Gardens, with the aid of his biologist, W. W. W. W., on. Animals, and the 600 Changers, with the air undergoing a test passage through the lungs, he found by accurate experiments the true respiratory function of oxygen and in 1785 in his "Change Under the Focus of Oxygen" and in 1781, to.

All his work up to this point had been on plants. Some theories were stretched to-day. Towards the end of his life, however, he was misled into subsuming the actual reduction took place in the red bloodfolds. But means of a hydros complex fluid that was several kilograms of water. A physiological colleague sequent, who collaborated in this.
Coagulation of the blood. The unit of the state of Larvaria in the prime of their life was present in the derivation of this idea. At any rate, it was disproved by Lagrange and Wussberg who showed that the "respiration" took place in the tissues, and not in the lungs.

The current of our knowledge of respiration was really in Larvaria the ground and his books were accepted by the world. It was when it was written, the full nature of Oxygen and its role in the respiratory process was disintegrated. The discovery in Physiological Respiration has played such an important part as this. It reflected the propagating and to us understanding idea with the prevailing respiration and all further discoveries were to the trend of respiration—merely leaves in the central stem erects by Larvaria.
Chapter IX

The Chemistry and the Control of Respiration

It now remains for us to discuss two things in detail: the carriage of the gases in the blood, and the control of respiration.

It had been known for some time that the blood contained respiratory gases. In 1837, through the work of Gustave Pflüger, it was shown that the blood contained the respiratory gases. So in 1837, Pflüger showed by means of an air-breath method that the gases were carried in the blood. The simple solution of nitrogen first discovered by Robert Boyle in 1667 was also recognized in 1857 by Virchow. It was also known that the blood gases were eventually determined by Winkelmann in 1857—also called Hagemann. Stilling, whose name has come down to us in the reagent and in...
Eugène-Stéphen Pflüger, physician, shows that oxygen is easily dissolved in the blood and is transported to the tissues. The nature of the method by which Carot-Dische is transferred in the blood, and still not agreed upon.

Pflüger (1829-1910) of Pflueger (1829-1910) of Physiology and which is communicated by his archives, proves in 1866 and the following year that the rest of respiration gas in the tissues, and not in the blood. In recent years, much work has been placed on the tissue of gases in the blood and on the respiratory exchange, particularly by Barcroft (1872-) and Walden (1860-1937) who have used for many years to determine the change of gases between the air and the blood. It is a matter of physical processes, a process of partial pressure. It has been shown by Barcroft that in all the exchanges of simple physiological processes at that under almost conditions of abnormal
premure, the alveolar epithelium may secrete pange into the lung. Fluid only in ALI subject to the close of inspiration at high altitudes, especially those of Pichincha Peak and of the Peruvian Expedition of the Royal Society a few years ago. In early stages of respiratory deceases together the last century and the dual process and allergy central was fairly established. The invention of the diaphragm by the Hellenic age we have seen dreamed by Pelle and Vesalius, and the control of muscles by nerves was observed to Chalde Bell (1874-1842) in 1811. The role in inspiration of the vesicular vagus nerve was investigated in 1864 by Farquhar, who made the classic experiment of causing pleurisy and paralyzing breathing by section of the vagi. This work was for example by Hering and Brum, who showed that the vagus contained the set of
fibres which limited inspiration
and expiration respectively by
giving a the breathing centre of
the medulla, overdistortion of the
lungs causing inspiratory efforts,
while a marked decrease in the
pressure in the lungs caused
inspiratory efforts.

Sir Henry Head, one famous
as a neurologist shown in 1889,
by means of electrical experimental
methods, such as preventing
conduction in a nerve by tying it
and thus avoiding a stimulus,
and also using the tip
distal of the diaphragm attaches
to the right extremum to move lungs,
found that the vagus nerve acts
as a control on the rhythmic
rhythmical of the respiratory
The existence of a respiratory
centre in the medulla was first
demonstrated by Legat (1770-1814)
who says that the region of a small
area of the bulbus seconds
had an inhibitory effect on respiration.
This centre was first fully described
by Head, who by means of
They have little or no function in the process of restoration.

The disequilibrium is a restoration that lags yet to be made of our matters of detail, and await the assistance of the sciences of physics, chemistry and even mathematics. Whatever the future of this great branch of physiology may be, it is doubtful if it can ever be of the same fascinating interest from the historical point of view as the wonderful pageant of human endeavor and achievement that has forced its past to been.