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MAIMONIDES AS PHYSICIAN AND SCIENTIST

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Introduction

An appreciation of Maimonides' status in the medical and scientific world will involve a short sketch of the social background of his medical and scientific work. For, his magnificent achievements in his many different spheres of activity, in spite of numerous adversities and obstacles—each of which might have sufficed to crush the spirit and arrest the progress of anyone less plentifully endowed with natural gifts—single him out as one of the greatest and most remarkable intellectual giants of his own or perhaps of any other age. "Per Aspera ad Astra" very accurately describes his life history.

Passing over the well-known story of the many wanderings and tribulations which he experienced from his 13th year onwards,[1] we find him after 1165 settled in Fostat (near Cairo) where he arrived at the age of 30, busily occupying himself with Jewish spiritual and communal affairs.

Refusing in accordance with the rabbinic ideal[2] to accept a salary as Rabbi, he utilized the medical knowledge, which he acquired during years of pilgrimage and extraordinary hardships, to earn a living as a medical practitioner. By virtue of his great professional skill and learning, his dynamic energy and indefatigability, his sympathy with human nature, his tact, idealism, enthusiasm in his work and abhorrence of quackery, his logical and systematic mind, his courage, independence of character, and great personal charm, his fame both as a physician and communal leader spread far beyond the borders of Egypt. In 1174, at the age of 39, he was appointed Court physician to Vizir Alfadhel (who was regent of Egypt during Saladin's prolonged absence, in connection with

[1] See W. M. Feldman, *The Life and Work of Maimonides, Proc. Roy. Soc. Med.* (Section History of Med.), 1st May, 1935, p. 1161.

[2] *Aboth*, iv, 7.

his campaign against the Crusaders in Palestine and elsewhere), a post which he retained under Saladin when the latter returned to Cairo. It is also related that Richard Coeur de Lion, who in the Third Crusade was fighting against Saladin for the capture of Jerusalem, invited Maimonides to become his personal physician and that he declined the offer.

After a while his medical practice became overwhelmingly arduous. His duties at Court (1½ miles from his residence, which at that time was a very considerable distance) occupied him from early morning till the afternoon every day. On his return, tired and hungry, he invariably found his waiting room crowded with patients of all creeds and classes of society, friends as well as foes, whom—after a hasty meal (the only one he took in 24 hours)—he attended until the early hours of the following morning. Saturdays were the only days in which he could spiritually commune with his fellow Jews and deliver rabbinical discourses.

Maimonides' Medical, Scientific, and other Writings

In addition to his busy work as a practising physician, Rabbi, as well as spiritual and communal leader and adviser to whom scholars and Jewish communal leaders in different parts of the world referred their various difficulties, Maimonides was a prolific and most versatile writer on a variety of subjects. The works which more than any other have immortalized Maimonides' name are his great Trilogy comprising: (1) The *Commentary on the Mishnah*, (2) The *Mishneh Torah*, and (3) The *Guide of the Perplexed*. The first two, though mainly of rabbinical and Jewish juridical interest, contain sufficient material coming within the scope of this paper to justify more than a passing reference here, while *The Guide* is a work which aims at reconciling Aristotelian philosophy with Jewish religion and Mosaic teaching, and has frequent references to the various branches of the Natural Sciences.

(1) The *Commentary on the Mishnah*, *Kitab al-Siraj* (Book of the Lamp), was written in Arabic—so as to appeal to the Jewish masses—but in Hebrew characters (as

it was not meant for non-Jews). It was begun at the age of 23 (in 1158), while on his wandering in Spain, and finished ten years later. In this monumental work Maimonides not only displays a detailed knowledge of mathematics,[1] biology, and other sciences, but he includes a special treatise of " Eight Chapters "—hence called in Hebrew *Shemoneh Perakim*, which forms an introduction to the Mishnah tractate, *Aboth* or " Ethics of the Fathers ". It is, in fact, a very lucid, systematic, and comprehensive treatise on Psychology and Psychotherapy (see p. 13). If we bear in mind the difficulties under which the Commentary was planned and partly written, with no reference books available, we shall gain some idea of the gigantic intellectual capacity and extraordinarily retentive memory of its remarkable author. It was translated into Hebrew by Samuel Ibn Tibbon in 1202.

(2) *The Mishneh Torah*, or *Yad ha-Hazakah*,[2] written in Hebrew, is really a systematic religious Code (in 14 volumes) based upon the Talmud, each volume consisting of several separate monographs (86 in all), at least two of which, viz. *Hilchoth Deoth* (Dispositions or Temperaments) and *Hilchoth Kiddush ha-Hodesh* (Sanctification of the New Moon), definitely come within the purview of this paper. The first deals with mental and physical hygiene [3] and supplements the " Eight Chapters ", while the second is a most recondite and elaborate, though very difficult, work on Mathematical Astronomy.[4] There is still a third monograph (the first of the first book), called *Yesode ha-Torah* (Fundamentals of Knowledge), which deals with Cosmology and the Aristotelian elements: earth, air, fire, and water (Chapters iii and iv).

(3) *The Guide of the Perplexed*, written in Arabic (*Dalalat al-Ha-irin*) and known in Hebrew as *Moreh Nebuchim*, is a philosophical and metaphysical work freely interspersed with discussions of astronomical, cosmographical, cosmogonal, and other scientific topics.

[1] See p. 25.
[2] Hereinafter referred to as *Yad*.
[3] See p. 13 et seq.
[4] See p. 19 et seq.

Apart from these three monumental works, Maimonides also wrote a large number of treatises on medical subjects, one book in fourteen chapters on Logic (said by Eppenstein[1] to have been written at the age of 16), and another on the Jewish Calendar, written at the age of about 23. All the medical books were written in Arabic, with the exception of one small and relatively unimportant volume called *Book of Remedies* (*Sefer Refuoth*) which was written for his son in Hebrew. The title is a misnomer because the booklet does not deal with therapeutics at all, but is really a short synopsis of Hygiene consisting of an introduction and fifty small paragraphs. All his Arabic books have at different times been translated into Hebrew, Latin, and different modern languages, but most of these translations were not scientifically accurate. During the present century, however, the late Rabbi Dr. H. Kroner, of Oberdorf-Bopfingen, in Würtemberg, published—in various volumes of the medico-historical journal *Janus*—annotated translations of several of our hero's medical works. Unfortunately, his premature death in 1930 has deprived us of a translation of the book on Asthma on which he was engaged at the time.

I shall divide Maimonides' works, other than his Rabbinical, Philosophical, and Responsa, into two groups : (I) Medical ; (II) Scientific.

I. Medical Writings

Although Wüstenfeld[2] enumerates sixteen medical works as having come from Maimonides' pen, it is practically certain that some of those are spurious. I shall only deal with those about the authenticity of which there is no doubt. They may be divided into :

(*a*) Works on General Medicine or Hygiene.

(*b*) Works on some particular medical topics.

(*a*) (1) *Aphorisms* (Arabic, *Futzul Musa* ; Hebrew, *Pirke Mosheh*). It consists of some 1,500 aphorisms selected from Galen and is divided into twenty-five chapters dealing with anatomy, physiology, pathology,

[1] See *Moses ben Maimon*, edited by J. Guttmann, Band ii, Leipzig, 1914.

[2] *Geschichte der arabischen Ärzte und Naturforscher*, Göttingen, 1840.

symptomatology, diagnosis, with special reference to the pulse (its rhythm, rate, and force), as well as the urine (its colour and the nature of its deposits), general and special therapeutics (including venesection, purgation, emesis, massage and gymnastics, baths, diet, and drugs), surgery, gynæcology, fevers, etc. The twenty-fifth chapter, which calls attention to more than forty inconsistencies and contradictions of Galen, is unique in the medical literature of the time because no previous author had either detected these discrepancies or had had the courage to commit such "sacrilege" as to criticize Galen. The following may be cited as examples :—

(i) In one place Galen gives only three causes of alteration of the pulse, and in another he mentions four.

(ii) In one place he says that body temperature is unaltered by age, but in another he says it decreases as the person gets older.

(iii) In one place he states camel's milk to be the best of all milks, while in another he assigns the first place to ass's milk.

(iv) In one place he says that the most abundant of the constituents of milk is fat, whereas elsewhere he says that it is the cheesy material which is present in largest amount.

He also points out that Galen contradicts himself regarding the properties of whey, the digestibility of pork, the causes of epilepsy and migraine, the treatment of hæmoptysis, etc., and that his failure to classify all the causes of syncope deprives the student of the ability to recognize and treat the disease.

Although, as Maimonides modestly states, the work follows Galen, he also states that it is not a mere compilation but a critical edition of his work, together with references to Arabian authorities.

Of very great interest is his reference to Diabetes, which he points out is much commoner in the East than in the West. For whereas Galen had seen only two cases of that disease, he (Maimonides) met with as many as twenty-three (twenty in men and three in women). It is probable that the differential incidence is due to racial rather than to geographical causes, as Galen had probably not seen many Jewish patients.

(2) *Regimen Sanitatis*,[1] written in Arabic about 1198 for the special use of the Sultan al Malik al Afdhal, who was a man of loose habits suffering from melancholia. It was translated into Hebrew in 1244 under the title *Hanhaggath ha-Beriuth*. It displays Maimonides' moral courage in warning his august but very irascible master, upon whose goodwill his own very life depended, of the danger of living a life of dissipation, and in offering him advice which was not very agreeable. The book consists of four parts dealing with a discussion of the Sultan's case, the reciprocity between mind and body, general hygiene and dietetics, psychotherapy, and first-aid remedies when no competent doctor is available. As an example of the influence of the mind upon the body he describes the changes in appearance and in the pulse, resulting from strong emotions. Thus a robust person of healthy complexion, on suddenly hearing some bad news, becomes pale, and trembles ; his pulse quickens, his eyes sink into his orbits, his appetite vanishes and his body becomes cold, because his blood and natural heat are withdrawn from the surface into the interior of the body. The reverse is seen when a person of weak physique hears some pleasant news. Similarly every sick person feels depressed, whereas a normally healthy person feels happy and cheerful. Hence in treating psychotic and psycho-neurotic cases it is necessary not only to remove all sources of worry and anxiety, but also to strengthen the body.

(3) Treatise on the explanation of accidents,[2] written about 1200, for the same Sultan, who was the son of Saladin. It consists of twenty-two chapters and in a sense complements his *Regimen Sanitatis*.

(4) *Book of Remedies*,[3] written in Hebrew for his son.[4] It is a short synopsis of Hygiene (not of therapeutics as its name would imply) consisting of an introduction and fifty short paragraphs.

[1] See H. Kroner's German translation from the Arabic text in *Janus*, xxvii–xxix, 1923–5.

[2] *Janus*, xxxii, 1928, 12–116, and *Isis*, xiii, 423.

[3] Edited from a MS. in the British Museum by Menasseh Grossberg, London, 1900. Its authenticity is somewhat in doubt, although Maimonides refers to a book of his of that name *Sefer Refuoth* in another of his works (*Deoth*).

[4] See p. 6.

(*b*) (1) *Book on Poisons*, written in 1199 at the request of the Kadi al-Fadil, to avert the great danger of snake bites so prevalent in Egypt at the time. It was translated into Hebrew by Moses ibn Tibbon (מאמר הנכבד). In its Latin translation it was much used as a textbook by the fourteenth century physicians.[1] The book consists of two parts. Part I deals in six chapters with bites of snakes, insects, and other animals—including rabid dogs. After explaining that the effects of a poison are produced by its absorption into the blood, he describes the proper treatment of those bitten by a known animal and those bitten by an unknown animal. The directions are so complete and scientifically accurate that they would serve even at the present day. The treatment consists of :—

(i) Tight tourniquet above the wound to prevent the poison being carried round the body by the blood.

(ii) Enlargement of the wound by incision, to allow free drainage and escape of the poison.

(iii) Suction of the wound, either by the mouth—if a healthy person is available who has no ulceration of the mouth organs—or by means of dry cups. If mouth suction is resorted to, the person must rinse his mouth out with oil, or with a mixture of wine and oil, and take a mild emetic followed by a strong antidote.

(iv) Cauterization of the wound to kill the poison.

(v) Closure and dressing of the wound—unless it had been inflicted by a rabid dog, in which case it must be left open to drain for forty days. He thus recognizes the long incubation period of rabies.[2] He relates the case of a boy so bitten in whom the wound had been allowed to heal too soon. After feeling well for a month, the patient suddenly sickened and died. All that is to be done in cases of dog bites must, he says, be done before the hydrophobia symptoms occur, since—in his experience —no patient has ever recovered after the onset of the symptoms.

(vi) General treatment, including that of shock.

[1] French translation by I. N. Rabbinowitz, Paris, 1865. German translation by M. Steinschneider, Virchow's Arch. lii, 1873.

[2] We know that the incubation period of rabies is on the average 6 weeks.

In cases of poisons swallowed by the mouth he prescribes emetics, purgatives, and antidotes, describing the exact pharmaceutical methods of their preparation, as well as their doses for various ages, climates, and different degrees of severity of the symptoms.

Part II deals with other poisons taken by the mouth, such as minerals (copper, lead, arsenic), vegetables (the solanaceous plants, e.g. conium, hyoscyamus, etc., and toadstools). He also describes the symptoms of poisoning by cantharides (viz. pain and hæmaturia) and of belladonna. He further devotes considerable space to the prevention of all kinds of poisoning. Thus all localities in which snakes abound should be fumigated with various substances which drive the snakes away. Indeed, the whole book is, as I have said, a thoroughly comprehensive and systematic textbook on Toxicology, and it is no wonder that it was extensively used throughout the world for several centuries after the author's death. Indeed, with a little editing it could be employed as a textbook even at the present day.

(2) A Treatise on *Coitus* dedicated to a nephew of Saladin. It was translated into Hebrew as *Maamar ha-Tashmish* as well as *Maamar ha-Mishgal*. It consists of nineteen chapters which deal with the Physiology of Coitus, differences in sexual temperaments, the benefit of moderate sexual satisfaction, the danger of excessive indulgence, and with aphrodisiacs, etc. He deals with the matter also in *Sefer Refuoth, Deoth*, as well as in *Issure Biah* (a monograph in *Mishneh Torah*).

(3) A work on *Asthma*, written about 1190, contains thirteen chapters dealing with the diet and climate suitable for asthmatics. He points out the benefit of country air as against the vitiated town air. Dr. Kroner was translating it from the original Arabic at the time of his death, in 1930.

(4) Treatise on *Hæmorrhoids*.[1] Translated into Hebrew as *Maamar bi-refuoth ha-Tehorim*. It consists of seven chapters, and is based on the seventeenth chapter of the third book of Avicenna's Canon which, in turn, is based on Galen. Maimonides also refers to Al-Razi and Ibn Wafid, but the book is largely a record of his own experience

[1] H. Kroner, *Janus*, xvi, 1911, 441–456 and 645–718.

and he prescribes original remedies. He attributes the condition to bad digestion due to faults in the quality and quantity of food as well as the order in which different foods are taken. He prescribes a vegetarian diet, which had not been done by his predecessors. He deprecates operation as a routine measure *because it does not remove the cause* of the condition, which is therefore liable to recur. Operation, says he, should only be resorted to in extreme cases. The average case should be treated by diet and the local application of various oils and fats such as Indian nut oil, castor oil, etc., or mixtures of lead and various oils. He gives minute pharmaceutical details about the methods of preparation, the quantities of the ingredients, etc. In cases of thrombosed veins, he recommends incision, or, if the patient is too old, the application of dry cups to the lumbar region. It will be seen, therefore, that the treatment does not differ in principle from that used at the present day (with the exception of the recently introduced injection treatment).

(5) *Explanation of Drug Names.*—Dr. Meyerhof, of Cairo, recently discovered this work in Constantinople and claims it as an authentic work of Maimonides.[1]

There are several other medical books, such as *The Causes and Symptoms of Disease,* attributed to him—but their authenticity is disputed. All these works display a most extensive knowledge of the subject under consideration, and of its literature, as well as a keen faculty of original clinical observation, and prove him to have been an independent thinker who had the courage of his convictions.

Summary of the Contents of Maimonides' Various Books on Physical and Mental Hygiene

(1) *General Physical Hygiene.* (*a*) *Heredity versus Environment.*—To ensure healthy offspring, one should marry a wife who is herself healthy and who comes from healthy stock. There should be no great disparity in the ages and there should be complete psychological harmony between husband and wife during sexual union.[2] It is

[1] See H. Friedenwald, *Bulletin of the Institute of History of Medicine,* July, 1935, iii, p. 575.

[2] *Issure Biah,* xxi.

impossible for a person to be born endowed by nature with either virtue or vice, just as it is impossible for him to be born skilled by nature in any particular art or craft. People are, however, endowed by nature with a special predisposition for good or evil which may be cultivated or suppressed by environment.[1] This relationship between nature and nurture is, I may add, in accordance with present-day views.

(*b*) *Diet.*—Food should be taken only when one is hungry, and drink when one is thirsty.[2] One should rise from the table before one feels quite full. One should take about three-quarters or two-thirds of the amount of food which gives repletion.[3] Not much fluid should be taken with, or soon after, meals, but one should wait until digestion is complete.[4] This again is in agreement with modern views, inasmuch as the fluid dilutes the gastric juice. Apart from quantity, attention must also be paid to the quality of the food, viz. freshness, digestibility, and composition (as regards sweetness and fat content), as well as its purgative properties. In addition, the various kinds of food must be taken in a definite order. Full details in accordance with contemporary, but now antiquated, views are given in *Deoth*, chapter iv, *Reg. San.*, and other of his writings, and it would serve no useful purpose to enumerate them here. Food should be properly chewed before swallowing.[5]

(*c*) *Exercise.*—Bodily activity promotes metabolism, and its neglect leads to ill-health.[6] On the other hand, excessive exercise, leading to fatigue, is harmful. The kind and amount of exercise should be such as to increase respiratory activity so as to make one breathe in more air. Games which stimulate one's interest are better than ordinary exercise because they keep the mind healthy.[7] But no exercise should be taken on a full stomach. The best time is in the morning, soon after waking.[8]

(*d*) *Sleep.*—Ordinary persons need eight hours' sleep,

[1] *Shem. Per.*, viii.
[2] *Deoth*, iv.
[3] Ibid., iv, 2. *Sefer Refuoth*, Introduction.
[4] Ibid.
[5] *Sef. Ref.*, vi.
[6] *Reg. San.*, i.
[7] *Aphorisms*, xviii.
[8] *Reg. San.*, i.

which should begin at such a time as to enable the person to rise at dawn.[1] One should not go to bed within three hours after a meal.

(*e*) *Cleanliness.*—Baths are necessary for health.[2] They should be taken once a week, and neither when one is too hungry nor soon after a meal.[3] Details regarding bathing, drying oneself, dressing, etc., are given both in *Deoth* and *Reg. San.* In addition to complete immersion, sponging of the different parts of the body every morning is very beneficial.[4]

(*f*) *Attention to the Bowels.*—Constipation leads to ill-health; therefore no call of nature should be postponed.[5] The kinds of food and drugs which have a purgative action are enumerated in *Deoth*, *Reg. San.*, and *Hæmorrhoids.*

(*g*) *Fresh Air and Sunshine.*—The house should be properly ventilated and should allow plenty of sunshine to enter it, for "the sun is the best disinfectant".[6]

(*h*) *Venesection and Cupping.*—Rules regarding these are given in *Aphorisms*, xii; *Hæmorrhoids*, vi; *Deoth*, iv, 18. These remedies should not be frequently used, and only at the advice of a doctor.[7]

(*i*) *Sexual Hygiene.*—This is dealt with fully and sensibly in his various treatises, in the special treatise on *Coitus* as well as in *Issure Biah.* Excesses should be avoided, but on the other hand total sexual abstinence is unhealthy for the mind.[8] One should not marry a woman who is either too good-looking (who would afford excessive temptation) nor too plain (who would not afford sufficient stimulus), but one of average good looks (*Sef. Ref.*, xvi).

(2) *Psychological Medicine and Hygiene.* These subjects are dealt with in detail in *Shemoneh Perakim* and in *Deoth*, and also, discursively, in *Regimen Sanitatis* and elsewhere.

The first two chapters of *Shemoneh Perakim* deal with the soul (*Nefesh*), which Maimonides defines as the vitality common to all sentient beings. Maimonides

[1] *Deoth*, iv, 4.
[2] *Reg. San.*, iv, 10.
[3] *Deoth*, iv, 16.
[4] *Asthma*, x.
[5] *Sef. Ref.*, xviii.
[6] *Reg. San.*, iv, 1.
[7] Ibid., ii.
[8] *Sef. Ref.*, x.

postulates only one soul (in opposition to the Hippocratic doctrine of three souls). The soul has five faculties (*Peuloth*), viz.:

(i) *Nutritive*, or vegetative (*ha-Zan*), consisting of ingestion, digestion and absorption of food, secretion, excretion, growth, and reproduction.

(ii) *Perceptive* (*ha-Margish*), consisting of the five senses.

(iii) *Imaginative* (*ha-Medammeh*), which constructs out of originally real impressions things that cannot exist. "For instance, one may imagine an iron ship floating in the air, or a person tall enough to reach the sky." On the other hand, in *Moreh Nebuchim* he stresses the possibility of the existence of things which the imagination would conceive as impossible, and he quotes as one example (among others) an illustration from Conic Sections, viz. asymptotes, which though seen to be constantly approaching the curve, yet never meet it—even if produced to infinity [1] (see p. 27). Indeed, as we know now, it is possible even for "an iron ship" to float in the air.

(iv) *Appetitive* (*ha-Mithorer*), which makes one yearn for a thing or abhor it, e.g. love and hate, compassion and cruelty, etc.

(v) *Rational* (*ha-Sichli*)—the only faculty peculiar to man—which enables him to understand, reflect, study, and discriminate between good and evil.

The third chapter in the same book deals with psychological abnormalities. The soul, like the body, can be healthy or sick; and just as those suffering from physical diseases must consult a physician who may prescribe bitter medicines to restore them to health, so must those suffering from psychological diseases consult mental specialists (*Rofei ha-Nefesh*), and follow his advice, however distasteful such advice may be.

The fourth chapter deals with the treatment of psychological diseases. As an Aristotelian, Maimonides declares that actions are good only when they follow a middle course between two extremes, each of which is bad and must be avoided (Law of the Mean). He gives different

[1] *Guide*, i, 73, Proposition 10.

types of antagonistic temperaments, which he also describes in the first chapter of *Deoth*, e.g. irritability and extreme placidity; extravagance and miserliness; haughtiness or arrogance and self-abasement; recklessness in the face of danger and cowardice, etc. The cure of a person suffering from either of these extremes is to make him practise the opposite extreme until the original fault has been remedied. A miser, for instance, must be made to practise extravagance, until his niggardliness has disappeared, when he is instructed to follow the medium course of generosity. The same is to be done with the other extremes.

The chapter also refers to the relation between heredity and environment in such anomalous behaviours—a theme which he develops more fully in the eighth chapter (see p. 12). He takes the opportunity to denounce the absurdities of astrology, which postulates the influence of the relative positions of the planets and the constellations, at the time of a person's birth, on his subsequent career and behaviour. Were this the case, says he, reward and punishment would be utterly unjust, since neither the virtuous nor the vicious person can help being what he is and doing what he does. It would, he continues, be, similarly, most illogical and useless to try and escape from any danger if the person is destined to his fate. Moreover, it would be absurd to punish a murderer, because not only is he irresponsible for his action, but his victim was, in any case, doomed from birth to meet such a fate.

Characteristic Features of Maimonides' Medical and Other Works

The characters which distinguish all his medical writings are :—

(i) *Rationalism.* He bases the diagnosis, prevention, and treatment of disease on scientific principles and common sense, rather than on guesswork, mysticism, and superstition. He deprecates all kinds of quackery, including amulets, incantations, and belief in astrological influences upon human destiny.[1] He only sanctions this kind of

[1] *Guide*, i, 61 and 62 ; *Shem. Per.*, viii, and elsewhere.

faith treatment in cases of very dangerous illness for the sake of the patient's peace of mind.[1] In this respect he was very much ahead of his time.

(ii) *Belief in Vis Medicatrix Naturae and in the great Influence of Diet.* He says that minor ailments must be left alone for nature to cure. If possible, treat by diet alone and administer drugs only in cases of severe illness, as recommended by Hippocrates, Galen, and Razi.[2] He also deprecates Galen's use of polypharmacy.

(iii) *Belief in the Superiority of Prevention over Cure.* In this respect, again, he is ultra-modern. He somewhat oversteps the limit when he assures his readers that faithful obedience to the rules of hygiene, which he advocates, will make them live to a ripe old age unless they succumb to some epidemic or unforeseen accident.[3]

(iv) *Realization of the Reciprocity between Mind and Body.* A healthy mind goes with a healthy body.[4]

(v) *Advocacy of Moderation in everything*—diet, exercise, sexual indulgence, etc. "No one would overfeed his animals, yet one does not control the amount of one's own food." Also, while people take care that their animals should get a proper amount of exercise to prevent their limbs becoming stiff, they nevertheless neglect to take exercise themselves to safeguard them against disease.[5]

(vi) *Directness, Lucidity, and Absence of any Ambiguity regarding the message which he intends to convey.* As most of his writings must, owing to his extremely busy life, have been done in the late hours of the night, it is most remarkable that, as Yellin and Abrahams put it, "the mid-day sun rather than the midnight lamp shines through all his work."[6]

(vii) *Extreme Frankness.* He is not ashamed to acknowledge his ignorance on any particular topic, and he urges his pupils to adhere to the rabbinical maxim "Teach your tongue to say, 'I do not know'", nor to be loath to learn from juniors. In these respects he contrasts with

[1] *Yad, Akkum*, xi, xii.
[2] *Introduction to Mishnah Commentary*, 11. See also *Reg. San.*, ii.
[3] *Deoth*, iv, 19.
[4] *Reg. San.*, iii. *Guide*, iii, 12 (iii).
[5] *Reg. San.*, i.
[6] *Maimonides*, London, 1903, p. 13.

Galen, who claimed omniscience, and had a ready answer for every problem—a failing which is only slowly dying out at the present day. Indeed, as recently as May this year (1935) a surgeon reviewing the progress of surgery during the 25 years of our own King's reign, wrote : " He (the surgeon) no longer feels that it is derogatory to admit that others know more on one subject than himself ; the advice of the most junior colleague is as eagerly sought as that of the senior." [1]

(viii) *Brevity and Absence of Circumlocution.* He uses no " padding ", and, as he says himself, he would never use two sentences where one would suffice.

In all these respects, therefore, Maimonides was many centuries ahead of his time.

The Place of Maimonides in Medical History

That Maimonides was a most experienced, skilful, and brilliantly successful physician, who treated disease, not by rule of thumb methods but rationally and scientifically, is proved by the following facts :—

(i) Notwithstanding his Jewish birth and creed he occupied the most exalted position of physician to several royal courts, and, in addition to a salary, had numerous honours, privileges and distinctions bestowed upon him.

(ii) His most extensive private practice among all creeds and classes of society—friends as well as foes.

(iii) Famous foreign physicians, e.g. Abd-el-Latif, of Bagdad, paid special visits to Cairo for the privilege of meeting " Musa ibn Maimon, the ' Eagle of Physicians ' ".

(iv) A foreign potentate, Richard Coeur de Lion, is said to have been eager to have him as his own physician (see p. 4).

(v) A famous Moslem poet, Alsaid ibn Sina Almulk, sang in ecstasy about his wonderful achievements as a healer of both physical and mental diseases—thus eclipsing Galen who excelled in the treatment of bodily diseases alone. The following is a translation of his poem by my cousin Mr. Reginald V. Feldman, M.A. :—

> Contrast Maimuni's with famed Galen's art :
> Health to the body Galen can impart,

[1] A. J. Walton, *Lancet*, 5th May, 1935.

But the wise Hebrew, with a two-fold skill,
Relieves both mind and body from all ill ;
Shows how base ignorance can hurt the soul,
While wisdom, counteracting, makes it whole.
Even the moon, obedient to his cure,
From periodic taint would be secure ;
No spots the brightness of her disc would stain,
Nor would rebirth entail her death again.

But, apart from all this, his prolific medical literary output marks him out as one of the most eminent and scholarly physicians not only of his own time, but of many preceding and succeeding generations. For his writings, which, as already stated, are characterized by lucidity of exposition, accuracy of observation, logical thinking, a fund of common sense, a keen critical faculty, rationality of treatment, emphasis laid on the inter-relationship between body and mind, and an ultra-modern realization of the superiority of prevention over the cure of disease, have secured for him a permanent and most honoured niche in the Hall of Fame as a scientific physician, as well as a great and inspiring teacher.

This pinnacle of greatness he reached along a path which, in his earlier years, was steep, and strewn, not with roses—as was the case, for instance, with Avicenna—but with thorns and thistles and other obstacles, each of which might have completely arrested the progress of a less gifted and less determined person. It is true that he can claim no original epoch-making discoveries, such for instance as Galen and Avicenna made in experimental physiology and pathology, and that he used the medical material provided by the ancient Greeks (Hippocrates and Galen) as well as the famous Arabian physicians such as Avicenna, Avenzoar, and others (who in turn copied it from the Greeks who, again, had borrowed a great deal from Egypt, Babylon, and Phoenicia). But this material he used with discrimination, merely as a foundation on which to base his own clinical observations ; and unlike Avicenna, for instance, who was completely subservient to Galen,[1] he did not hesitate to deviate from the paths

[1] See Cyril Elgood, *Medicine in Persia*, New York, 1934, p. 45.

trodden by these pioneers when the need arose. A painter does not forfeit his claim to fame as an artist because he used the same canvas, the same colours, or even the same theme as had been used by previous artists. Shakespeare achieved everlasting fame as a playwright in spite of the fact that the plots of most of his plays are admittedly not his own. It is the kind of " cement " that Maimonides used to put together the various " bricks " as well as the glorious architectural beauty of the structure which he raised and which served to instruct, stimulate, and inspire many generations of physicians throughout the world, that proclaims him as one of the most famous Master-Minds in the History of Medicine. He was, in fact, not only the Physician of Princes but, as Sir William Osler rightly called him, the " Prince of Physicians ! "

II. Scientific Writings

(*a*) *Astronomy*

(1) A most important contribution that Maimonides made to astronomical literature is his treatise on Mathematical Astronomy, *Hilchoth Kiddush ha-Hodesh*, published in 1178 as the eighth monograph of the third book of the *Yad*.[1] Written in Hebrew, it consists of nineteen chapters dealing mainly with the principles of the Jewish Calendar. It aims at fulfilling two purposes, viz. :—

(i) To explain the principles of the Fixed Calendar.

(ii) To give the astronomical data, and the rules necessary for making use of those data for the purpose of determining the exact time at which the crescent of the new moon would—under suitable climatic conditions —be visible at any given point on the earth's surface. Such calculations were necessary in the time of the Talmud when the beginning of every month was determined on the accredited evidence of witnesses who attested to having seen the crescent of the new moon. The Calendar Council in order to test the reliability of those witnesses had to ascertain, by astronomical calculation, whether at the time and place at which the witnesses claimed to have seen the

[1] See p. 5.

new moon, the crescent was, in fact, of such a size, and in such a position, as to be capable of being seen. If their mathematical calculations, which involved an expert knowledge of both mathematics and astronomy, confirmed the witnesses' statement, then that day was declared to be the first of the new month.

(i) The Fixed Calendar Method of determining the beginning of every Jewish month at the present day has been in use ever since about the fifth century of the present era. It is very simple and does not require any mathematical skill—other than a knowledge of rudimentary arithmetic. Indeed, as Maimonides puts it,[1] " elementary pupils can master the method in three or four days ". Notwithstanding its simplicity, however, Maimonides deserves the credit of having described the shortest and clearest method of converting the Jewish and the Julian Calendars into each other. The Fixed Calendar Method makes use of the Mean Conjunction, i.e. the moment at which the centres of the sun and moon would have exactly the same longitude if both moved with uniform angular velocities throughout their respective orbits. The intervals between two consecutive mean conjunctions (i.e. a lunation, or synodic month) being constant, viz. 29d. 12h. 44m. $3\frac{1}{3}$s., it is obvious that, if the time, T, of the Mean Conjunction (i.e. the Molad, or birth of the moon), of any given month in any given year (called the " Epoch ") is known, the time M, of the Mean Conjunction, or Molad, of any month in any year, which is n lunations after the epoch is given by :

$$M = T + n \text{ (29d. 12h. 44m. } 3\tfrac{1}{3}\text{s.)}$$

Having thus found the time of the Molad, and knowing also the exact time of a " Tekufah ", i.e. the moment at which one of the equinoxes, or solstices, occurs (marking the beginnings of the respective four seasons of the year) on the basis of a Gregorian year of $365\frac{1}{4}$ days—which can also be determined by simple arithmetic—the data are at hand for fixing the exact calendar for the year : the beginning of each Jewish month, the length of that month (whether 29 or 30 days), the number of days in that particular year, as well as the dates in the secular

[1] *Kid. ha-Hod.*, xi, 5.

Calendar on which the various Jewish feasts and fasts occur, etc.[1]

(ii) It is, however, the chapters dealing with the Method of Determining the True Conjunction of the Moon, i.e. the exact (as contrasted with the average) moment at which the centres of the sun and moon actually have the same longitude in any given month, that renders *Hilchoth Kiddush ha-Hodesh* unique in astronomical literature. For, although Albattani, some three hundred years before Maimonides, devoted a chapter in his astronomical work to this particular topic, he confined himself only to a description of the manner of using certain tables, specially constructed for the purpose, without giving the various steps of the method. Maimonides, however, is the first and, indeed, the only astronomical author to describe the method in detail, and to give the various steps and data, as well as the rules for using the latter. Indeed, he says himself [2] that the principles of the method are not to be found in any other book. With characteristic honesty, however, he acknowledges that the method is not original but was acquired by him orally from his teachers.

But, although he gives an abundance of numerical data, as well as a large number of practical rules (illustrated by numerical examples) by means of which the numerous calculations can be accomplished, he gives no explanation of the mathematical and astronomical principles on which these rules are based. It is for this reason that the chapters devoted to this subject form most difficult and, indeed, perplexing reading to any but the most expert astronomical reader. It is the late Rabbi Professor E. Baneth who deserves the highest credit for having, in his monumental classical monograph, *Maimuni's Neumondsberechnung*,[3] explained the principles by means of modern mathematical methods, thus rendering the otherwise unintelligible chapters of the *Hilchoth Kiddush ha-Hodesh* capable of being understood by the interested student. The chapters in the present writer's *Rabbinical Mathematics and Astronomy*

[1] For details see the present writer's *Rabbinical Mathematics and Astronomy*, ch. xvii.

[2] *Kid. ha-Hod.*, xi, 3.

[3] *Lehranstalt für die Wissenschaft des Judenthums, Jahresbericht*, Berlin, 1898, 1899, 1902, and 1903.

dealing with that subject, to which the reader is referred for an elucidation of the mathematico-astronomical principles underlying Maimonides' method, are based on Baneth's brilliant work. There are, however, a few interesting points which must be mentioned here. One is the astonishingly accurate value that Maimonides gives for the length of a tropical year, i.e. the time taken by the sun (or earth as we now know it) to make a complete revolution of the heavens from a vernal equinox (i.e. the point where the sun crosses the equator in the spring) to the same point again. The value as calculated from his data is 365d. 5h. 48m. 49·65,[1] which differs by no more than one-fifth of a second from the true value of the tropical year at that time. Inasmuch as Ptolemy's value was more than six minutes too high, that of Albattani more than 2½ minutes too low, and that even the great Copernicus—365 years after Maimonides—gave a value which was more that twenty seconds too high, one cannot help concluding that Maimonides, who disregarded the estimates given by his illustrious predecessors, was *a theoretical astronomer of the very first rank*! As to how he arrived at this astoundingly brilliant result, it is not easy to say. One possibility is that he obtained it from a very accurate personal astronomical determination of the time of an equinox. It is true that he nowhere refers to any astronomical observations of his own, but there is some evidence [2] that he may have been a practical as well as a theoretical astronomer. A more probable explanation is the following: A tropical year is, as I have mentioned, the period between two consecutive vernal equinoxes. As, however, it is not possible to ascertain with absolute accuracy the exact moment at which the sun crosses the equator, the interval measured between two consecutive equinoxes is bound to be considerably higher or lower than the true value of the tropical year. By measuring, however, the interval in days, hours, minutes, and seconds between two vernal equinoxes, say 100 years apart, and dividing that interval by 100, the errors of the observations are correspondingly diminished. Indeed, the greater

[1] *Kid. ha-Hod.*, xii, 1.
[2] See p. 23.

the number of years that separates the two observations, the more accurate must be the value of the length of the tropical year so found. Now, Albattani, who made a personal observation of a vernal equinox (by noting the moment at which the sun's declination, or height above the equator, is zero), took as the other vernal equinox figure the one found by Ptolemy 700 years before, but it is possible that Maimonides, while accepting Albattani's observation, may, for greater accuracy, have made use of Hipparchus' observation of a vernal equinox, some 285 years before that of Ptolemy. By thus increasing the interval between two equinox observations from 700 to 985, he correspondingly increased the accuracy of the figure he obtained for the length of a tropical year.

The second interesting point is that Maimonides gives the longitude of the sun's apogee (i.e. the size of the arc of the ecliptic between the vernal equinoctial point and the point where the sun is furthest away from the earth) on 22nd March, 1178, as 86° 45′ 8″, and he also states that this longitude increases at the rate of 1·5″ in 10 days.[1] Now, in view of the fact that on 1st March, 880, i.e. 108,865 days previously, Albattani found the longitude of sun's apogee to have been 82° 17′, its value on 22nd March, 1178, should have been 86° 49′ 10″ instead of 86° 45′ 8″ as given by Maimonides. It is, therefore, possible that Maimonides did not rely upon Albattani's figure and estimated the longitude of sun's apogee from actual personal observation.

(2) Another work of some astronomical interest is a " Primer " on the Jewish Calendar (*Maamar ha-Ibbur*) published in Arabic when he was 23 years old. It deals in an elementary manner with the Fixed Calendar, and explains how to compute the Molad or mean conjunction, and the Tekufoth (the equinoxes and solstices) which mark the beginning of the seasons (Spring, Summer, Autumn, and Winter).

(3) As regards Cosmography and astronomical theory with which he deals in *Yesode ha-Torah* and more critically in the Guide, he adhered, in the main, to the erroneous and now completely disregarded metaphysical doctrines

[1] *Kid. ha-Hod.*, xii, 3.

of his time; but in some respects, such as the orbits of Mercury and Venus as well as in connection with epicycles in relation to the sun's supposed motion round the earth, he expressed views contrary to those of Ptolemy.[1] Contrary to the opinion of the Talmudic Rabbis (*Yoma*, 20*b*), but in agreement with Aristotle, he rejects the belief held by the ancients, and prevalent until the time of Kepler (seventeenth century), that the motions of the heavenly spheres produced musical sounds which had the same proportions to each other as the musical notes (Music of the Spheres). This is of very great interest not only intrinsically but because of the very penetrating remark he makes in connection therewith. He says: "Our Sages (who believed in this alleged phenomenon) have in this astronomical matter abandoned their own theory in favour of the theory of others (i.e. Aristotle). Thus it is distinctly stated, 'The wise men of other nations have prevailed over the men of Israel.' *It is quite right that our Sages have abandoned their own theory; for in matters of a speculative nature every one acts according to the results of his own study and accepts that which appears to him to be established by proof.*"[2]

Another very striking fact is that although he indirectly refers to Precession, i.e. the movement of the equinoctial point (when speaking of the movement of sun's apogee), and gives its approximately correct rate of motion, viz. one degree in about seventy years,[3] he does not refer to "Trepidation"—a theory which held sway till the sixteenth century—according to which the equinoctial point was believed to oscillate to and fro along the ecliptic, moving for a fixed period of years with the sun and then for another period of years in the opposite direction. We now know that the movement of the equinoctial point is continually in a direction opposite to that of the sun. From his silence on the matter it would, therefore, appear that he did not believe in it, a point greatly to his credit. On the other hand, it would seem that he was not aware

[1] *Guide*, i, 72; ii, 9, 11, and 24.

[2] Ibid., ii, 8. I have italicized the last sentence because of its great importance from the point of view of assessing the place of Maimonides as a Scientist (see p. 28 et seq.).

[3] *Kid. ha-Hod.*, xii, 3.

that movement of apogee is something additional to precession and not identical with it.[1]

(*b*) *Mathematics*

Maimonides wrote no special book on mathematics from which it would be possible directly to assess his status as a Mathematician. His various mathematical notes in his Mishnah Commentary, however, show that he was a capable practical Mathematician who was able skilfully to apply the principles of mathematics to everyday problems. He was aware of the fact that some ratios are incommensurable—such as π (i.e. the relation between the circumference of a circle and its diameter), or that between the diagonal of a square and its side. He adds that " this is not due to our ignorance but to the peculiar character of the calculation ". In connection with " fenced-in " spaces within which it is permissible to carry on the Sabbath Day, in reference to which R. Josi [2] states that " within a rectangular space the area of which is 5,000 square cubits, and the diagonal of which is twice the length of the shorter side, it is permitted to carry on the Sabbath Day ", the problem is to find the exact dimensions of such a space. The calculation, which can easily be done by simple algebra,[3] involves the evolution of $\sqrt{3}$ as well as $\sqrt[4]{3}$, Maimonides, without giving the steps of his calculations, gives the requisite dimensions, which are compared with the correct values in the table below.

	Sides of Rectangle		Diagonal	Twice Short Side
	Long	Short		
Correct Values . .	93·0605	53·7285	107·457	107·457
Maimonides' Values .	93·0370	53·3333	107·500	106·667

It would appear, therefore, that there is some error in Maimonides' calculations, since not only does his value of the diagonal (107·500) exceed by 0·833, twice the length

[1] See W. M. Feldman, *Rabb. Math. and Astronomy*, p. 109.
[2] *Mishnah, Erubin*, ii, 5.
[3] See *Rabb. Math. and Astron.* p. 54.

of the short side (i.e. 106·667), but the diagonal of a rectangle 93·0370 × 53·3333 is 107·2 and not 107·5. Although famous mathematicians are proverbially bad arithmeticians, it is not likely that Maimonides would have allowed such errors to pass, and the probability is that the value $53\frac{1}{3}$ which he gives for the short side is an error on the part of the translator or transcriber for $53\frac{2}{3}$.[1]

For further problems in connection with "mixed seeds" (Kilayim), etc., see the present writer's *Rabbinical Mathematics and Astronomy*; but taking everything into consideration we must conclude that although Maimonides had extensive mathematical manipulative knowledge and skill he cannot be classed among the world's celebrated Mathematicians.

The work on Logic, translated into Hebrew as *Maamar ha-Higgayon* and used as a textbook up to the sixteenth century, has already been referred to. Moses Mendelssohn wrote an introduction and commentary to it in 1761.[2] Maimonides considers a study of Logic indispensable to all scholars, for, as he says, "Logic is to reason what grammar is to language; the one lends precision to thought, the other gives precision to speech."

(*c*) *Natural Science*

Although his writings in the domain of pure Science are not extensive, he possessed a large store of scientific knowledge and he urged upon his pupils the study of "such subjects as mathematics, conic sections, mechanics, geometry, hydraulics, and many others of a similar nature . . . for the purpose of sharpening the intellect and training the mental faculties by scientific investigations, so that they might acquire the capacity of discriminating between proof which is scientific and that which is not."[3]

[1] After writing this article, an examination of the British Museum MS. Or. 2220 revealed that the Arabic original gives the length of the short side as "53·75 approximately", which is practically identical with the correct value (53·7285).

[2] A Hebrew translation by R. Achituh, a Palermo physician of the thirteenth century, was recently edited by M. Chamizer in Hermann Cohen's *Festschrift*, Berlin, 1912, pp. 423–450.

[3] *Shem. Per.* v. See also *Guide*, i, 34, where for similar reasons he urges the study of Logic, Physics and Astronomy, and the various branches of Mathematics.

Indeed, he frequently regales us with illustrations of the use of scientific knowledge for the purposes of mental discipline. To show, for instance, that what appears to be impossible may actually exist, he gives the following examples : All persons not on our own horizon, as well as those in the Antipodes, should, as far as our imagination can perceive, fall away into space, nevertheless we know they do not.[1] Further on he says, " It is proved in books on Conic Sections that the asymptotes are lines which are not parallel to a curve but approach it as they are produced further and further and yet they never meet the curve even if produced to infinity, although the asymptotes and the curve are observed to be constantly converging."

He emphasizes the importance of research,[2] and, as already stated,[3] exhorts his pupils not to pretend to knowledge which they do not possess. He further warns people against accepting any statement unless (i) its truth can be established by the same kind of logical proof as is required in the various branches of mathematics, or (ii) it can be verified through perception by one or more of the five senses ; or (iii) in the absence of such proof, if the statement has been made by persons of unimpeachable veracity and authority. Anyone who accepts a statement not attested by one of these *criteria*, he stigmatizes—in the words of King Solomon (Prov. xiv, 15)—as a simpleton who believes everything.[4]

He speaks of the sphericity of the earth as a proved fact which none but the ignorant would deny.[5] He also, in accordance with the Ptolemaic views then prevailing, speaks of the eccentrically circular orbits of the planets as similarly established facts ; this, however, we now know to be wrong, since Kepler showed all planetary orbits to be ellipses.

He refers to tides as being due to the influence of the moon on water, as proved by the increase and decrease

[1] *Guide*, i, 73, Proposition 10.
[2] Ibid., i, 32.
[3] p. 16.
[4] Letter to the Rabbis of Marseilles in which he denounces Astrology. See also *Shem. Per.*, viii, and *Guide*, iii, 37.
[5] *Guide*, i, 21.

of water in the seas according to the increase and decrease of the moon,[1] facts which were known to Pliny and Aristotle. But, like them and his own contemporaries, he was not aware that this phenomenon was not peculiar to the moon, but that all heavenly bodies had a similar influence on tidal movements—except, that owing to their enormous distances (compared with that of the moon), their influence is either less well marked or altogether imperceptible. Indeed, this truth was not realized until Newton, in 1687, announced his Law of Gravitation, according to which the force of attraction between two bodies varies, not only directly as the product of their masses, but also inversely as the square of the distance between them. Therefore, in the case of the planets, which have heavier masses than the moon, their distances, being so much greater than that of the moon, which is nearest the earth, make their effect upon the tides negligible, while in the case of the sun, which is so much heavier than the moon as to make its gravitational influence upon the water felt in spite of its enormous distance, its effect upon the tides is not so perceptible because of its simultaneous pull upon the solid earth. Maimonides, however, in conformity with contemporary ideas, believed each particular class of heavenly bodies to have a specific influence upon one of the four Aristotelian elements—earth, air, fire, and water. Thus, the moon has this peculiar influence on water ; the sun has an influence on fire as seen " in the increase of heat or cold, according as the sun approaches the earth or recedes from it ". Air is influenced by the planets which " produce the various forms of the air with its frequent changes, contractions, and expansions ; the sphere of the fixed stars sets the earth in motion ".[2]

The Place of Maimonides in the History of Science

It will be seen that the border-line between the doctrine of specific planetary effects and that of astrology, which asserts that the destiny of a person is determined by the relative positions of the planets and various constellations

[1] *Guide*, ii, 10.
[2] Ibid., ii, 10.

at the time of his birth, is very thin. It is, therefore, a monument to Maimonides' rationalism, wisdom, scientific insight, and independence of thought that, contrary not only to prevailing ideas, but also to the conception of some of the Talmudic Rabbis, he resolutely refused to cross that line, and took every opportunity to denounce " the folly of astrology " and of other superstitions. Thus in his letter to the Rabbis of Marseilles he says : " All talk about the influence of stars upon human destiny is utter folly." [1]

If one bears in mind the fact that most of the highest intellects of his time as well as of subsequent generations subscribed to astrological beliefs,[2] it will be realized how advanced in his opinions Maimonides was in this as in many other respects. His third Criterion of Credibility [3] has been put forward as evidence of the limitations of his rationalism. Indeed, it has been stated that although he avowedly endeavoured to harmonize Scriptural teaching with Aristotelian rationalism, he abandoned the latter whenever he found such syncretism impossible. In other words, it is contended that he was always ready to subordinate reason to religion but never religion to reason. Whatever truth there may be in this contention, his treatment of the problem of the Eternity of the Universe is characteristic of his rationalism and entitles him to a place of honour in the galaxy of the Great Scientists of the world. " We do not reject," he writes, " the Eternity of the Universe because certain passages in Scripture confirm Creation . . . for we might have explained them in the same manner as we did the Incorporeality of God . . . But the Eternity of the Universe has not been proved ; a mere argument in favourof a certain theory is not sufficient for rejecting the literal meaning of a Biblical text . . . when the opposite theory can be supported by an equally good argument." [4]

It is this very scepticism and his refusal to grant finality

[1] See also *Shem. Per.* viii and *Guide.*

[2] Even as late as the middle of the eighteenth century, Mesmer's thesis on *The Influence of the Stars on Human Constitution* was accepted by the University of Vienna for the Doctorate of Medicine.

[3] See p. 27.

[4] *Guide,* ii, 25.

and infallibility to anything, in the realm of natural science, but proved facts; his claim to the right of having an open mind on matters of a controversial nature; as well as the encouragement which he gives to his pupils to foster the spirit of research and scientific method, to enable them to weigh evidence dispassionately and impartially, that stamps Maimonides as a Scientist in the best and most modern sense of the term.