

# HALACHIC AND HASHKAFIC ISSUES IN CONTEMPORARY SOCIETY

## 76 - SCIENCE AND CHAZAL - PART 1

OU ISRAEL CENTER - WINTER 2017/2018

### A] KILLING LICE - THE HALACHA

1. דתניא ר"א אומר ההורג כינה בשבת כהורג גמל בשבת. מתקיף לה רב יוסף - עד כאן לא פליגי רבנן עליה דרבי אליעזר אלא בכינה דאינה פרה ורבה אבל שאר שקצים ורמשים דפרין ורבין לא פליגי ... א"ל אביי וכינה אין פרה ורבה!! והאמר מר יושב הקב"ה וזין מקרני ראמים ועד ביצי כינים! מינא הוא דמיקרי ביצי כינים

שבת קז.

*Killing animals on Shabbat is one of the 39 melachot. However, according to one view in the Gemara, killing lice was not included in this prohibition since they do not reproduce sexually like other creatures, but rather generate spontaneously.*

2. פרעוש ... אסור לצודו אא"כ הוא על בשרו ועוקצו, ואסור להרגו ... אבל כנה, מותר להרגה

שו"ע או"ח שט"ז

*This view is accepted as the halacha without any dissent and is ruled in the Shulchan Aruch.*

3. ואסור להרגו - הטעם דמחלקינן בין פרעוש לכנה הוא דכל מלאכות דשבת ממשכן ילפינן להן וילפינן מיתת כל בע"ח לחיוב משחיטת חילים מאדמים שהיו צמסין עורותיהן ולאו דוקא ע"י שחיטה דכ"י ע"י הכאה וחניקה או נחירה וכל כי האי גוונא כיון שזא עי"ז נטילת נשמה חייב. ואמרין מה חילים מאדמים שפרים ורצים אף כל שפרים ורצים לאפוקי כנה דאינה צאה מזכר ונקבה אלא צאה מן הזיבה לא חשיבא צריה אצל פרעוש אע"פ שגם היא אינה פרה ורצה מ"מ כיון שהייתה מן העפר יש צה חיות כאלו נצרה מזכר ונקבה וחייב עליה משום נטילת נשמה ואפילו אם הפרעוש עוקצו אסור להרגו:

משנה ברורה שט"ז:לח

*The Mishna Berura<sup>1</sup> explains that the prohibition of killing creatures on Shabbat is derived from the killing of animals in the Mishkan for the purpose of skins. Thus, any form of killing is a melacha, and not just shechita. The M.B. goes on to explain that lice are not considered 'creatures' for this purpose because they do not reproduce sexually. Fleas are also spontaneously generated, but killing them is prohibited for other reasons.*

### B] KILLING LICE - THE SCIENCE

The modern scientific understanding is that ALL biological life is generated only from other biological life and not spontaneously - see the article on the history of scientific thinking on this issue at the end of this source sheet.

### C] RESOLVING THE PROBLEM

#### C1] SOLUTION 1 - DIFFERENT LICE

A number of halachic authorities<sup>2</sup> have ruled that, although the lice at the time of Chazal no doubt did spontaneously generate, nevertheless we cannot be certain that our lice today are those that Chazal were talking about, so we must be stringent and not kill lice on Shabbat. The problem with this approach is that the lice to which the heter applied were not merely those of 4th Century Babylon, but also those of 16th Century Eretz Yisrael and 20th Century Russia! The Mishna Berura lived in living memory and ruled that the lice

1. Early 20th Century.

2. Shu't Shevet Kehati 3:126 quoted in Pitchei Teshuva 316:5

of his day did spontaneously generate!

## C2] SOLUTION 2 - נשתנה הטבע - NATURE HAS NOW CHANGED

'Nishtane Hateva'<sup>3</sup> - that nature has changed - is an idea which arises in many areas of halacha. It basically posits that there has been a fundamental change in the behavior or nature of certain physical observable phenomena. As such, Chazal were describing the facts as they existed then but the reality has clearly changed today. This in turn requires a consequent change in the halacha.

The following are examples:-

### a) Hargasha

The din of the Gemara, ruled by the Shulchan Aruch, is that a woman becomes niddah min haTorah only when she feels an internal discharge from the uterus through the cervix. It was absolutely standard until a few hundred years ago for women to feel this clearly. Today, women generally say that they do not feel this internal discharge. Thus the onset of halachic 'niddut' (deoraita) has to be established in other ways. Note that other poskim<sup>4</sup> take the approach that women today DO experience a hargasha. They are just insufficiently aware of their internal processes to recognize it as such. In many ways, this lack of awareness is itself a change in nature!

### b) 'Vest kavua'

A woman is required to separate from her husband on the day that she expects her monthly period. In the times of Chazal it was very common that women could predict the day and even time of day of her expected period with certainty. Today this is no longer the case and the halachot of the separation for the 'yom havest' have changed accordingly. The Shulchan Aruch (16C), like Chazal, rules that most women have a totally fixed *vest* - the time between menstruations. The Shach (17C) rules that most women then still had a *vest kavua*, but which was less precise. Contemporary poskim rule that today most women do not have a *vest kavua* at all.

### c) Premature babies

4. דתנו רבנן: בן שבעה מחללין עליו את השבת, ובן שמנה אין מחללין עליו את השבת. ספק בן שבעה ספק בן שמונה - אין מחללין עליו את השבת. בן שמונה הרי הוא כאבן, ואסור לטלטלו. אבל אמו שוחה ומניקתו מפני הסכנה

שבת קלה.

*Chazal understood (as was standard medical opinion of their time) that a baby born at 8 months gestation was unable to survive. However, one born at 7 months could! One could not therefore break Shabbat to save an '8th month' baby and, indeed, it was actually muktze on Shabbat. This din is ruled in the Shulchan Aruch.*

However, even in the time of Tosafot, there were poskim who tried to find halachic grounds to question this din - such as that we could not be certain whether the baby was indeed 7th or 8th month. The Chazon Ish rules that in our day the facts have clearly changed. Babies born at 36 weeks have a 95% survival rate and it is certainly obligatory to break Shabbat to save them. Rav Vosner writes that the invention of incubation for babies as also radically changed the circumstances, and thus the halacha. This is also the psak of the Shemirat Shabbat Kehilchata. The Minchat Yitzchak (4:123:19-20) rules that this is not actually a case of shinui hateva. Rather, even though eight-month babies are inherently less viable than others, modern medical care can help those babies survive. This is subtly but critically different.

### d) Brit mila

Chazal considered that washing a baby before and after brit mila in hot water was essential to the baby's well-being, to the extent that one was require to break Shabbat to prepare hot water.

5. בזמן חכמי הגמ' אם לא היו רוחצים את הולד לפני המילה ולאחר המילה וביום שלישי למילה במים חמין היה מסוכן. ... והאידינא לא נהגו ברחיצה כלל ודינו לרחוץ בשבת אם רצו כדין רחיצת כל אדם.

שולחן ערוך אורח חיים סימן שלא סעיף ט

*The Shulchan Aruch rules that, by his time, babies did need this so it is not permitted to break Shabbat to heat the water.*

### e) Chazal's medical advice

The Gemara contains many examples of medical cures or procedures. The mefarshim are unanimous that today it is forbidden to use

3. For a more detailed and sourced discussion on Nishtane Hateva see [www.rabbimanning.com](http://www.rabbimanning.com)

4. Aruch Hashulchan 183:61-62

these cures. One reason for this is 'nishtane hateva'. (For other possible reasons see Part 2).

6. ... ושמה נשתנו כמו הרפואות שבש"ס שאינן טובות בזמן הזה ...

תוספות מועד קטן יא.

*Tosefot clearly understood that the reason for not following Chazal's medical advise today is that nature has changed.*

#### **f] Onah in the first 3 months of pregnancy and for 24 months while nursing**

The experience of women at the time Chazal was that they DID menstruate in first 3 months of pregnancy, but then not for 24 months during nursing. Today, it is very standard that women do NOT menstruate during pregnancy (meaning that the change in nature would result in the traditional halacha being over-stringent) but they DO menstruate during nursing (and so the change in nature would result in the traditional halacha being over-lenient). How does that fit with the halachot of onah, vest and when to expect a period? Whilst R. Akiva Eiger stuck to the the traditional halacha as stated in Chazal and the Shulchan Aruch, Rav Moshe Feinstein was inclined to be stringent today with a nursing mother. Many poskim remain stringent with pregnant women even though they normally do not see blood.

#### **g] Eating rotting fish**

Chazal advised that the best time to eat certain fish was just as they are about to go off! Tosafot advise that this does NOT apply by their day and, in fact, such fish were dangerous to health. Tosafot compare this to the change in medical cures given by the Gemara.

#### **h] Cooking fish and meat together**

The Chatam Sofer draws attention to the fact that the Rambam omits certain dinim of cooking meat and fish together, which the Gemara took to be dangerous. He attributes this to fact that, according to the Rambam, nature had changed. Nevertheless, we still keep these dinim under the category of minhag, which may change the halachic framework for these laws.

#### **i] Mayim Emtzaim**

The Shulchan Aruch brings a halacha to wash during a meal between meat and fish. The Magen Avraham rules that we no longer do this due to the change in natural reality since fish and meat are no longer so dangerous. The Magen Avraham lived only 100 years after the Shulchan Aruch and it is therefore unlikely that he understood that nature had changed during that short time. Rather, it seems he is taking a different approach than the Shulchan Aruch to the change of halacha due to nishtane hateva.

#### **j] Salt and bad breath**

A similar case is the Shulchan Aruch's psak from Chazal that one must eat salt after a meal to avoid bad breath and illness. The Magen Avraham rules that this no longer applies due to nishtane hateva.

#### **k] Yibum**

One practical application of this debate is whether an '8th month' fetus will exempt the mother from Yibum. The Shulchan Aruch rules that, if such a baby was born and then died, it does NOT exempt the mother from Yibum. The Rema disagrees and DOES exempt the mother due to nishtane hateva and the fact that '8th month' babies now survive. The Rema is supported in this by a teshuva of the Rashbash (Rav Shimon ben Shlomo Duran - 15C). However, others take a stricter line and uphold the din of the Shulchan Aruch to render a woman obligated in chalitzah (which may be difficult, if not impossible).

#### **l] Pregnancy from first sexual relations**

Chazal state that a woman may not become pregnant from her first marital relations. The poskim debate to what extent Chazal were giving a general rule or do we say nishtane hateva. NB The commentators list women in Tanach who DID become pregnant from first relations - Hagar, Lot's daughters, Leah, Tamar.

#### **m] Sakanat Ever on Shabbat**

The medical implications of 'sakanat ever' - loss of a limb - appear to be different today to former times. The halacha was very clear that loss of a limb alone (other than an eye) did not constitute pikuach nefesh and thus did NOT justify breaking Shabbat deoraita

through a Jew. The Tzitz Eliezer here rules that today the circumstances have changed.

#### n] Shiurim today - eggs vs fingers

#### o] Metzitza during Milah

Metzitza is a part of the milah process, according to Chazal, and in the poskim, to avoid illness in the baby. The Maharam Shik rejects 19C medical advice that Metzitzta is no longer necessary on the grounds that (i) it is halacha leMoshe MiSinai; (b) Chazal were more 'machmir' than the doctors when it comes to danger; and (iii) Chazal's knowledge is deeper in the matter. See also Rav David Karliner<sup>5</sup> who distinguishes between halachot based on tradition or derived from Torah verses, which may not be changed, as opposed to halachot that Chazal derived from the nature they knew, which may be subject to change.

NOTE: other areas relating to potential danger where current physical nature seems to have changed but the halacha remains firmly as ruled by Chazal include - (i) brit mila for some babies who are yellow but on whom the doctors say it would be safe to perform mila; (ii) certain illnesses which Chazal felt warranted breaking Shabbat but which current doctors do not consider to be life-threatening.

#### p] Simanei Treifut

Rav Moshe Feinstein stresses that the the apparent change in reality - that a animal which is a treifa as defined by the halacha CAN now survive - will not result in a change in the halacha, since the details were given at Sinai.

#### q] Cows giving birth in the first two years

Chazal understood that a cow cannot give birth in its first two years. Tosafot states that this was no longer the case in their time.

#### r] Bovine anatomy

Similarly, the middle lobe of the cow's lung which the gemara records as a rarity and only in certain beasts, appears to be a standard anatomical feature by the time of Tosafot.

#### s] Animal Gestation

Chazal list gestation periods for various animals well in excess of those seen today eg 3 years for a monkey and 7 years for a snake. Some suggest Nishtane Hateva as a response.

#### t] Male Anatomy

Chazal understood that semen and urine are carried by separate vessels in the human body.

7.

14. [Urine is toxic to sperm and constant exposure may well result in ongoing infertility. However, it is not clear what phenomenon the Gemara is referring to physiologically.] The Gemara in *Yevamos* (75b, end, with *Rashi*) seems to say that there are two different vessels in the male member, one that carries urine and one that carries semen. The Gemara there relates that the semen tube of a certain man became clogged and he discharged his semen through the urine tube. *Chazon Ish* (*Even HaEzer* 12:7) notes that in contemporary times the anatomy of the male member is different than described in the Gemara. [Modern medicine has found that there is one tube – the urethra – that carries urine beginning from the bladder, and that carries semen from the middle of the prostate, and then extends from within the body into the male member until its tip.] *Chazon Ish* states that nature has changed since Talmudic times: Our anatomy is different than their anatomy. He mentions that a modern work on urological surgery notes a certain degree of possible anatomical variation between different times and places.

However, *Responsa Cheshev HaEphod* (2:8) expresses astonishment that this dramatic change in human anatomy would take place. He also cites a Mishnah in *Mikvaos* (8:4) that indicates there is only one tube for both semen and urine, at least at the tip of the member (see *Rambam Commentary* ad loc. and *Rashi* to *Chullin* 24ב לבישילב). *Cheshev HaEphod* therefore explains our Gemara in consonance with modern anatomy. For more on this topic, see comments of R' Shlomo Zalman Auerbach cited in *Nishmas Avraham, Even HaEzer* p. 40 and *Hishtanus HaTivi'im B'Halachah* pp. 64-65 with comments of R' Zalman Nechemiah Goldberg.

Schottenstein Gemara - Bechorot 44b n14

*Modern poskim are split as to whether it is reasonable to say Nishtane Hateva even in this extreme case.*

5. She'elat David, no. 1

N.B. The above are examples of where halachic conclusion were based on every-day clearly observable phenomena where Chazal's experience was different to ours. In all of the above cases no halachic principles have been changed. Rather, the halachic psak is based on a scientific reality of the times and has therefore altered simply due to a change in circumstances. In some of these cases, more than others, it seems difficult to argue that nature of reality has changed. In other cases it seems clear that the observed phenomena in those days were different from what we have today.<sup>6</sup>

### C3] SOLUTION 3 - SCIENCE IS WRONG!

8. ... אין לשנות הדינים המיוסדים על קבלת קדמונינו בשביל חקירת חכמי א"ה. .... אין צורך למאמין לבקש ממקום אחר ראיות וטענות אע"פ שישנן רבות ועצומות כי תספיק קבלת רבותינו. .... וא"כ אין לזוז ממה שנפסק עפ"י גמרתנו אפילו כל רוחות החקירות האנושיות שבעולם באות ונושבות בו כי רוח ה' דבר בנו. אכן חסר דעת החוקר ואין שכלו מגיע לעומק חכמת הטבע ומעשה בראשית כי רב הוא ... וחכמי א"ה לא יעדו ולא הבינו בטבע כי עם בשטחיות הדברים הנראה לעין ולא פנימותם כאשר השכילו מקבלי מעשה בראשית כמ"ש הר"ן בדרשותיו

תשובת רב יהודה בריל - מובא בפחד יצחק ערך, צידה האסורה'

*In a teshuva on the issue of lice, Rav Yehuda Brill (Italy 18C) takes the view that science cannot be trusted and when faced with a conflict between science and Chazal, Chazal must prevail.*

9. נמשך לזה אומר כי הנה היו מן הגדולים שעלה על דעתם לנטות קצת מדברי רז"ל בצד מה. והי' זה שהם היו חכמים בלימודיות וטבעיות ודעתם רחבה וסברו כי רז"ל היו חכמים לבד. וזה טעם שאמרו הלא גם בנו חכמה ודעת עם שהם חכמים יותר. אבל הי"ל לשום לבם כי רז"ל היה להם רוח הקודש ואליהו זכור לטוב שכיה גביהו ונשמתם ממקום עליון והיא נקיה ואין יחס ביניהם לבין רז"ל. וצריכים אנו לכופר ראשנו לקבל האמת מבעלי האמת.

חיד"א - שם הגדולים מערכת ספרים אות ה [פב] השגות הראב"ד על הר"ף

*The Chida upholds the supremacy of Chazal in all matters, including those of science, on the basis that they were gifted with Ruach Hakodesh and also visited by Eliyahu!*

10. א"ל מר זוטרא בריה דרב נחמן לרב נחמן - היכי דמי פדגרא? א"ל - כמחט בבשר החי. מנא ידע? איכא דאמרי מיחש הוה חש ביה. ואיכא דאמרי מרביה שמע ליה. וא"ד: (תהלים כה) סוד ה' ליראיו ובריתו להודיעם

סוטה י.

*Chazal understood that the Rabbis gained access to scientific (here medical) knowledge through Divine inspiration/revelation.<sup>7</sup>*

11. However, what we can't understand we rely on our faith. It is obvious that man's thoughts are not comparable to G-d's in the ability to understand Nature. Similarly, we acknowledge that we can't comprehend or adequately explain G-d's ways concerning good and evil in each generation. In these issues we simply rely on our faith in G-d's greatness. In contrast, they prefer to explain that man is the product of millions of years of development. As evidence they cite what appear to be ancient bone fragments that have been discovered in Madagascar and other places. Their evidence is total nonsense since prior to the Flood man lived for a thousand years. This difference in what was normal growth and development makes the bones appear as if they were a million years old. With this type of shaky evidence they want to refute the words of our Sages and undermine the faith that exists amongst the Jewish people. Their main concern is to shake the faith in G-d - which has been accepted by us generation after generation. They want to replace this faith with the acceptance that events are determined primarily by the laws of nature .... Scientists - even those who are described as religious - are ashamed that we don't agree with the views of leading scientists that man is descended from the apes. They rush to find isolated statements of our Sages, rabbis and commentaries that seem consistent with contemporary scientific view ... Therefore they use misleading and distorted citations from Torah literature to claim justification for such scientific beliefs in the words of the Sages.

Letter of Rav Moshe Sternbuch on the Relationship of Science to Torah - Jan 2005

6. For further reading on Nishtane HaTeva: 1) R. Neriah Gutal, Sefer Hishtanut Hateva'im. 2) R. Dr. Avraham Steinberg, Encyclopedia Hilkhait Refuit, s.v. Hishtanut Hateva'im. 3) <http://torahandscience.blogspot.com/> - comprehensive collection of primary source material. 4) D. Cohen, "Shinuy Hateva: An Analysis of the Halachic Process," Journal of Halacha and Contemporary Society 31(Spring 1996). 5) Or Yisrael (Monsey) 2:2 (Tevet 5757) - series of articles on fish parasites and the kashrus of fish. 6) Shlomo Sternberg book review and exchange of letters in BD'D Journal issues 4, 6, and 7. 7) <http://www.yeshiva.org.il/wiki> on השתנות הטבעיים

7. Ben Yohoyada explains that the reason the Gemara asks here 'how did he know?' is precisely because Rav Nachman was not a doctor. In other places in Shas where the Rabbis give medical advice, this is coming from doctors.

Rav Moshe Sternbuch puts forward a classical presentation of this argument, based on the following premises:

(i) The scientific evidence for the theory proposed is often shaky and thus it is not appropriate to try to fit the Torah into science which will almost certainly change in the future. (This argument will be stronger in some cases than in others - for example the statements 'man evolved from a single-celled organism'; 'the universe is older than 6000 years'; and 'the world is round and not flat' have quite different levels of scientific certainty.)

(ii) There is a scientific agenda (Rav Sternbuch doesn't say whether this is conscious or not) which is essentially anti-religious.

(iii) Attempts by other Rabbis to fit Torah in with science are essentially distortions of the true Torah view.

12. וכן בכאן אנו שואלין אותו שמעיד מאין אתה יודע ששהתה זו. שמא שכחת או שמא טעית או שמא נתחלף לך בזמן או שמא נתחלפה לך בהמה זו באחרת. שאי אפשר להעיד שתהא בהמה זו בין עיניו כל שנים עשר חודש. ואם יתחזק בטעותו ויאמר לא כי אהבתי דברים זרים והם אשר ראו עיניהם ואחריהם אלך. נאמר אליו להוציא לעז על דברי חכמים אי אפשר. ויבטל המעיד ואלף כיוצא בו ואל תבטל נקודה אחת ממה שהסכימו בו חכמי ישראל הקדושים הנביאים ובני נביאים ודברים שנאמרו למשה מסיני

שו"ת הרשב"א חלק א סימן צח

*The Rashba insists that a person who claims an animal with a siman treifut lived more than 12 months must be lying or mistaken! It is impossible to claim that Chazal were wrong on a matter like this which was given over at Sinai.*

13. שאין לנו, לדון בדיני תורתנו ומצותיה, על פי חכמי הטבע והרפואה. שאם נאמין לדבריהם, אין תורה מן השמים, חלילה! כי כן הניחו הם, במופתיהם הכוזבים. ואם תדין בדיני הטרפות, על פי חכמי הרפואה; שכן הרבה תטול מן הקצבים; כי באמת, יהפכו רובם: ממות לחיים, ומחיים למות; ויחליפו ח'י' במת. כי אין ספק בנטלה הכבד, ונשאר בה כזית; שאנחנו מכשירים; הם יאמרו: שימות לשעתו.

שו"ת הריב"ש סימן תמו

*The Rivash similarly dismisses the claims of science and medicine as contrary to truth and Torah and in danger of denying that Torah is from Heaven.*

14. אף לאחר שישתנו הטבעיים ויוכלו לחיות גם בלא רפואות כמו שרואין ויודעין כל העולם כולו, וליכא בזה שום כפירה בדברי המשנה והגמ' דאדרבה מתקיימין בזה דברי המשנה והגמ' שלא יקשה עליהו מהמציאות שבדורות האחרונים שאף הרשב"א אם היה חי וכן עתה שהוא בעולם האמת בגן עדן מודה שיש מקצתן מאלו שמנו במשנה וגמ' שהן טריפות שיכולין לחיות

שו"ת אגרות משה חושן משפט חלק ב סימן עג

*Rav Moshe Feinstein suggests that even the Rashba would agree that today medicine CAN save an animal with a siman treifut! But he still rules that the halacha will not change.*

In Part 2, we will see 5 more approaches, including the more controversial discussion on whether Chazal could indeed be wrong on certain scientific issues and the effect of such a position on Emunat Chachamim and the halachic system.

## **APPENDIX**

### **THE SLOW DEATH OF SPONTANEOUS GERNEATION (1668-1859)**

Russell Levine and Chris Evers

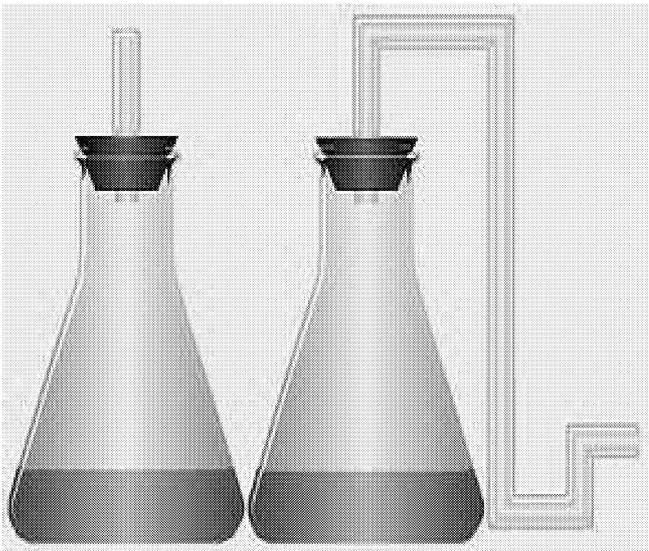
From the time of the ancient Romans, through the Middle Ages, and until the late nineteenth century, it was generally accepted that some life forms arose spontaneously from non-living matter. Such "spontaneous generation" appeared to occur primarily in decaying matter. For example, a seventeenth century recipe for the spontaneous production of mice required placing sweaty underwear and husks of wheat in an open-mouthed jar, then waiting for about 21 days, during which time it was alleged that the sweat from the underwear would penetrate the husks of wheat, changing them into mice. Although such a concept may seem laughable today, it is consistent with the other widely held cultural and religious beliefs of the time.

The first serious attack on the idea of spontaneous generation was made in 1668 by Francesco Redi, an Italian physician and poet. At that time, it was widely held that maggots arose spontaneously in rotting meat. Redi believed that maggots developed from eggs laid by flies. To test his hypothesis, he set out meat in a variety of flasks, some open to the air, some sealed completely, and others covered with gauze. As he had expected, maggots appeared only in the open flasks in which the flies could reach the meat and lay their eggs.

This was one of the first examples of an experiment in the modern sense, in which controls are used. In spite of his well-executed experiment, the belief in spontaneous generation remained strong, and even Redi continued to believe it occurred under some circumstances. The invention of the microscope only served to enhance this belief. Microscopy revealed a whole new world of organisms that appeared to arise spontaneously. It was quickly learned that to create "animalcules," as the organisms were called, you needed only to place hay in water and wait a few days before examining your new creations under the microscope.

The debate over spontaneous generation continued for centuries. In 1745, John Needham, an English clergyman, proposed what he considered the definitive experiment. Everyone knew that boiling killed microorganisms, so he proposed to test whether or not microorganisms appeared spontaneously after boiling. He boiled chicken broth, put it into a flask, sealed it, and waited - sure enough, microorganisms grew. Needham claimed victory for spontaneous generation.

An Italian priest, Lazzaro Spallanzani, was not convinced, and he suggested that perhaps the microorganisms had entered the broth from the air after the broth was boiled, but before it was sealed. To test his theory, he modified Needham's experiment - he placed the chicken broth in a flask, sealed the flask, drew off the air to create a partial vacuum, then boiled the broth. No microorganisms grew. Proponents of spontaneous generation argued that Spallanzani had only proven that spontaneous generation could not occur without air.



The theory of spontaneous generation was finally laid to rest in 1859 by the young French chemist, Louis Pasteur. The French Academy of Sciences sponsored a contest for the best experiment either proving or disproving spontaneous generation. Pasteur's winning experiment was a variation of the methods of Needham and Spallanzani. He boiled meat broth in a flask, heated the neck of the flask in a flame until it became pliable, and bent it into the shape of an S. Air could enter the flask, but airborne microorganisms could not - they would settle by gravity in the neck.

As Pasteur had expected, no microorganisms grew. When Pasteur tilted the flask so that the broth reached the lowest point in the neck, where any airborne particles would have settled, the broth rapidly became cloudy with life. Pasteur had both refuted the theory of spontaneous generation and convincingly demonstrated that microorganisms are everywhere - even in the air.

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