When there was a Sanhedrin, months and years were calculated solely on the testimony of witnesses. How did we make the change to the fixed calendar, and how can we calculate our own calendar? Why does 577 1 have 385 days, the most possible in any year?

Answers to these questions, and some classified information, in this fascinating look at the Jewish calendar

The Longest Year:
the secrets of the jewish calendar

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"Thirty days hath September / April, June, and November."

If we were to adapt this poem to — *l'havdil* — our current, standardized Jewish calendar, we would say that thirty days hath Tishrei, Shvat, Nissan, Sivan, Av, and sometimes Cheshvan[1] and Kislev.

But the idea of having a standardized Jewish calendar seems to run counter to a *mishnah* in *Rosh HaShanah*. That *mishnah* states that whether a specific month has 29 days or 30 days depends on whether witnesses saw the new moon and testified in *beis din* early enough to declare the 30th day Rosh Chodesh [i.e., the first day of the next month]. In addition, the Gemara[2] states that when necessary, Elul could be made 30 days long — which cannot happen in our calendar.

How did our empirical calendar become so rigid and predictable in advance?

The Torah (*Shemos* 12:2) commands the main *beis din* of the Jewish people (also known as the Sanhedrin), or a *beis din* specially appointed by them, to declare Rosh Chodesh upon accepting the testimony of witnesses who observed the new moon.[3] The

purpose of having eyewitnesses was not to notify the *beis din* that the moon had appeared; the *beis din* had extensive knowledge of astronomy and could predict exactly when and where the new moon would appear and what size and shape it would be.[4]

The Torah obligated the *beis din* to wait for witnesses, however, and they could only rule on whether the 30th day would be the last day of the old month or would become the first day of a new month, based on testimony. If no witnesses to the new moon arrived on the 30th day, then the 31st day became Rosh Chodesh, regardless of the astronomic calculations (*Mishnah Rosh HaShanah* 24a). At that point in Jewish history, then, any month could be either 29 or 30 days.

The Torah also commands us that Pesach must always fall during the spring (*Devarim* 16:1). This seemingly innocuous mitzvah actually requires considerable manipulation of the calendar, since *months*, derived from the word *moon*, are determined by the length of time from one new moon to the next, which is a bit more than 29½ days. A lunar year is, therefore, almost exactly 354 days.

The seasons of the year, on the other hand, are calculated according to the solar

year, because seasons change based on the relative distance between the Earth and the sun. A solar year is a bit less than 365¼ days. Since Pesach must always take place during the spring, the calendar cannot be twelve lunar months every year, because over time the eleven-day discrepancy between the lunar and solar years would cause Pesach to wander its way through the solar year and occur in all seasons.[5]

The Two "Other" Calendars

There are three calendars commonly in use in the world today, two of which make no attempt to resolve the discrepancy between solar and lunar years.

The most common secular calendar (the Gregorian calendar) is based solely on the sun. Although the year is nominally broken into twelve months, the use of the word "months" here is a significant departure from its original meaning; according to this calendar, months have no relationship to the cycles of the moon. Most secular months have 31 days, while the lunar cycle is only about 29½ days, and even secular months that have 30 days do not relate to any phase or change in the moon. Similarly, the length of February as a month of either 28 or 29 days has

nothing to do with the moon. Thus, although the word month *should* correspond to the moon, the Western calendar is purely a solar one, with a borrowed term, "month," given a meaning detached from its origin.

Another calendar that is seeing increased use today is the Muslim one, which is purely a lunar calendar of twelve lunar months, some 29 days and some 30. In truth, a pure lunar calendar has no real "year," since a year is based on the relative locations of the sun and the Earth and the resultant seasons, and a lunar year completely ignores seasons. The word "year" is used in the Muslim sense only as a basis for counting longer periods of time, but has no relationship to the sun.

Thus the Muslim "year" is only 354 or 355 days long — almost eleven days shorter than a solar year. Therefore, a Muslim who tells you that he is 65 years old is really closer to 63 according to a solar year count. He has counted 65 years, each of which is at least ten days shorter than a real year. (I trust that Guinness takes these factors into account when computing world records for longevity and the like.)

It is noteworthy that although the Muslim "year" does not correspond at all to a solar or Western year, it corresponds closely

to our Jewish year in an "ordinary" year (a twelve-month year, as opposed to a leap year that has thirteen months). And the Muslim month usually coincides with a Jewish calendar month. Thus, for the last three years, the Muslim holy month of Ramadan has corresponded to our month of Elul, but this year, which is a leap year, Ramadan will fall in Av.

The Muslim year "wanders" its way through the seasons, taking 33 years until a specific month returns to the exact same point in the solar year in the previous cycle. In the interim, that month has visited each of the other seasons for several consecutive years. Therefore, Ramadan will not coincide with Elul again during this generation. Rather, it will correspond to Av for the next three years, and then to Tammuz for two years, and then to Sivan, etc.

The Jewish Calendar

As we have seen, we are commanded to create a calendar that uses the lunar cycle to define the months, but also to keep our months in sync with the seasons, which are dependent on the sun, in order to determine the dates of the Yamim Tovim. The only way to do so is to occasion-

ally add a month, thereby creating a thirteen-month year, to offset the almost eleven-day difference between twelve lunar months and a solar year. The result of this calendar is that although each date does not fall exactly on the same "solar date" every year, it falls within a close range relative to the solar year.

Who determined which years have thirteen months?

Under the original system, the main *beis din* appointed a smaller special *beis din* to determine whether the year should have an extra month added. This special *beis din* took into consideration:

1) Astronomical data, such as when Pesach will fall out relative to the vernal equinox (the spring day on which day and night are closest to being equal in length).

2) Agricultural data, such as: How ripe is the barley? How large are the newborn lambs and pigeons?

3) Weather: Is the rainy season drawing to a close? Is there a famine?

4) Convenience, or more specifically, the halachic *in*convenience of creating a leap year. The *shmittah* year was never made into a leap year, and the year before *shmittah* usually was.

5) Infrastructure. For example, what condition were the highways and bridges in?

All of these points influenced whether the thirteenth month, the extra Adar, would be added.[6] When this system was in place — during a period without interruption from the time of Moshe and Yehoshua until hundreds of years after the destruction of the Beis HaMikdash — the main *beis din* sent written messages notifying outlying communities of the decision to create a leap year, and the reasons for their decision.[7]

The Creation of the "Permanent" Calendar

During the later era of the Talmud, Roman persecution made it impossible to continue declaring Rosh Chodesh based on eyewitness testimony. Thus, Hillel HaNasi (not to be confused with his more illustrious ancestor, the Tanna Hillel, who lived several hundred years earlier) instituted a calendar based purely on calculation, without human observation of the new moon. Rambam explains that the mitzvah of the Torah is that if it becomes impossible to declare Rosh Chodesh and leap years on the basis of observation, then the *beis din* should create a permanent calendar.[8] Hillel HaNasi's calendar kept the same basic structure of 29- and 30-day months and twelve- and thirteen-month years, but it was based purely on calculation and not on the variables mentioned above.

When Hillel HaNasi created the new calendar, he incorporated in its calculations several innovations. The two major changes in this new calendar are:

1) A Leap of Fate

The leap years now follow a regular pattern of seven leap years, called *me'ubaros*; and twelve non-leap years, called *peshutos* (ordinary), in a nineteen-year cycle. The third, sixth, eighth, eleventh, fourteenth, seventeenth, and nineteenth years of the cycle are always leap years, and the rest are common years. This year, 5771, is the fourteenth year of the cycle and thus is a leap year.

2) The Haves versus the Have-nots

The length of most months is now fixed. Tishrei, Shvat, Adar Rishon (which exists only in a leap year), Nissan, Sivan, and Av will always have 30 days; whereas Teves, regular Adar (in a common, non-leap year), Adar Sheini (in a leap year), Iyar, Tammuz, and Elul are always 29 days long. The months of Cheshvan and Kislev are the only months that can vary — sometimes they are 29 days and sometimes they are 30 days.[9] A year in which both Cheshvan and Kislev have only 29 days is called *chaseirah*, lacking. If Cheshvan has 29 days and Kislev has 30, the year is considered *k'sidrah*, expected or regular. If both Cheshvan and Kislev have 30 days, the year is called *sheleimah*, full or excessive.[10]

Both ordinary and leap years can be either *chaseiros*, *k'sidrah*, or *sheleimos*. Thus, in the new calendar, all ordinary years are either 353 days (if both Cheshvan and Kislev have 29 days); 354 days (if Cheshvan has 29 days and Kislev has 30); or 355 days (if both Cheshvan and Kislev have 30 days). All leap years are either 383 days (if both Cheshvan and Kislev have 29 days); 384 days (if Cheshvan has 29 days and Kislev has 30); or 385 days (if both Cheshvan and Kislev have 30 days). Since Adar Rishon always has 30 days, the addition of an extra month in a leap year always adds exactly thirty days.

(Because the nineteen-year cycle synchronizes the lunar calendar with the solar year, the Hebrew and English dates of births, anniversaries, and other occasions *usually* coincide on the nineteenth anniversary of the event. If yours is off by a day or two, do not fret. Your record-keeping is accurate, but the cycle of nineteen years only relates to whether it is a leap year, not to whether the years are of the exact same length. The lengths of Cheshvan and Kislev are determined by other factors, and this will affect whether your 19th, 38th, or 57th birthday or anniversary exactly coincides with its Hebrew and secular counterpart, or whether it is slightly off.)

Revealing Top Secret Information

In order for the new calendar to be established properly, a very carefully guarded secret had to be revealed. Chazal had always kept secret how one can predict when the new moon is destined to appear, a calculation called the *sod ha'ibur*. This information had always been kept secret in order to prevent false witnesses from coming forth and testifying that they saw the moon at a time when they knew it could be seen. With the new calendar coming into use, this was no longer a concern. Moreover, people had to know the secret in order to formulate a calendar correctly.

The *sod ha'ibur* is that each new moon appears 29 days, 12 hours, and 793 *chalakim* (singular: *chelek*) or 793/1080[11] of an hour after the previous new moon. Once one knows when the new moon, called the *molad,* occurred on one Rosh HaShanah, he could add either twelve or thirteen times the *sod ha'ibur* figure and determine the time of the *molad* in the next year, which is the most important factor in determining the date of the next Rosh HaShanah.

Another factor had also been guarded as a secret: that Rosh HaShanah sometimes takes place not on the day of the *molad*, but the next day. In the old system, this happened when the *molad* fell on the afternoon of Rosh HaShanah and the moon would not be visible in Eretz Yisrael until the next day. When Rosh HaShanah was determined by the observation of witnesses, this information was important not only in determining when Rosh HaShanah falls, but also when interrogating potential witnesses testifying to the appearance of the new moon. Although the new calendar is no longer dependent on witnesses seeing the moon, and so we could conceivably set Rosh HaShanah even in a year when the *molad* falls during the afternoon, we nevertheless postpone Rosh HaShanah to the following day.

Thus, creating the calendar in a way that it could be used required revealing these two secrets, so that a person could determine which day should be Rosh HaShanah in the coming year.

Additional Innovations

Did you ever notice that Yom Kippur never falls on Friday or Sunday? If it did, we would have to observe two consecutive days that both have the stringency of Shabbos. When the calendar was based on observation, this could and did happen.[12]

However, Hillel HaNasi's new calendar included some innovations that were not part of the earlier calendar. Hillel HaNasi's calendar does not allow Yom Kippur to fall on either a Sunday or a Friday, thus avoiding the difficulty of having two Shabbos-like days fall consecutively. It also does not allow Hoshana Rabbah to fall on Shabbos, which would cause the cancellation of the Hoshanos ceremony.

As long as the calendar was determined on the basis of eyewitness testimony, the halachah favored having Rosh Chodesh fall on its most correct day, over the concerns of having two Shabbos-like days fall consecutively, or canceling the Hoshanas ceremony on Hoshana Rabbah.[13] But after eyewitness testimony could no longer be used, and we were going to implement a permanent calendar that fulfilled the mitzvah in a less-preferred way anyway, the halachah then went the other way: it favored keeping Yom Kippur from falling on Friday or Sunday, and keeping Hoshana Rabbah from falling on Shabbos.

In order to accommodate these innovations, Rosh HaShanah could now fall only on Monday, Tuesday, Thursday, or Shabbos, since if it falls on Sunday, Hoshana Rabbah falls on Shabbos; if Rosh HaShanah falls on Wednesday, Yom Kippur falls on Friday; and if Rosh HaShanah falls on Friday, Yom Kippur falls on Sunday. This would mean that when Rosh HaShanah in the coming year would naturally fall on Sunday, Wednesday, or Friday, an extra day is added to the calendar to make sure that Rosh HaShanah falls on Monday, Thursday, or Shabbos instead.[14]

This concept of ensuring that Rosh HaShanah not fall on Sunday, Wednesday, or Friday is called לא אד"ו ראש, *lo adu Rosh,* meaning that the beginning of the year, Rosh HaShanah, does not fall on א, the first day of the week, Sunday; ד, Wednesday; or ו, Friday. It is predominantly for this reason that there was a need to have Cheshvan and Kislev sometimes be 29 days and sometimes 30, in order to make the exact length of the years flexible.

Although the innovation of adding one day to the year so that Rosh HaShanah will not fall on a Sunday, Wednesday, or Friday seems relatively simple, it can have more complex applications. Sometimes adjusting Rosh HaShanah to avoid these days will create a problem in the year before or the year after. Since Hillel HaNasi's calendar did not allow a common year to be longer than 355 days and a leap year to be shorter than 383 days, the only way to avoid this happening is by planning in advance what will happen in the future years, and adjusting the calendar appropriately. In order to accommodate all these various calendar requirements, Hillel HaNasi established four rules, called *dechiyos*, which together with the *sod ha'ibur* calculation and the nineteen-year leap-year rotation, form the basis for determining our calendar.[15]

We'll use this year's and next year's calculation of the *molad* for Rosh HaShanah to explain a *dechiyah*. This year's *mo-*

lad calculation for Rosh HaShanah fell on Wednesday evening, and Rosh HaShanah therefore falls on Thursday, which is what we would expect. But next year's *molad* falls on Tuesday, less than two hours before the end of the day. Although the *molad* falls on Tuesday, it is too late in the day for this *molad* to be visible in Eretz Yisrael, and therefore Rosh HaShanah cannot occur before Wednesday. However, since Rosh HaShanah cannot fall on a Wednesday because of the rule of *lo adu Rosh*, it must be pushed off to Thursday, or **two** days after the *molad*. For this reason, this year must have an extra day, making it not only a leap year (because it is the fourteenth year of the nineteen-year cycle), but also a *sheleimah*, when both Cheshvan and Kislev have thirty days. This makes it a year of 385 days, the longest a year can be.[16]

As mentioned above, although the leap years follow an fixed nineteen-year cycle, whether the year is *chaseirah*, *k'sidrah*, or *sheleimah* is determined by the other factors we have noted, and therefore does not follow the nineteen-year pattern. Rather, one first calculates when Rosh HaShanah should fall out based on the *sod ha'ibur*, then checks the rules of the *dechiyos* to see what adjustments need to be made, and then determines on which day Rosh HaShanah should fall. As a result, whether the year in question needs to be *chaseirah*, *k'sidrah*, or *sheleimah* requires calculating not only this year's schedule, but also the coming year's calendar requirements.

A result of all these calculations is that although there are many potential variables used in calculating the years (the day of the week of Rosh HaShanah, whether it is a leap year or ordinary year, and whether the year is *chaseirah*, *k'sidrah*, or *sheleimah*), which should result in dozens of different calendar schedules, the calendar rules actually only require seven prototype years for an ordinary year, and seven for a leap year.

Each of these fourteen prototype "years" is identified by a three-letter acronym, in which the first letter identifies the day of the week of the first day of Rosh HaShanah; the second letter denotes whether the year is *chaseirah*, *k'sidrah*, or *sheleimah*; and the third letter identifies the day of the week of the first day of Pesach. No letter is used to denote whether the year is an ordinary year or a leap year, because this can be calculated by knowing how many days of the week there are between Pesach and Rosh HaShanah. In a common ordinary year that is *k'sidrah*, Pesach falls two days later in the week than Rosh HaShanah. In a leap year, it falls four days later, the two additional days being the extra two days that Adar Rishon, which is thirty days long, adds to the count of the days of the week. Of course, these calculations must be adjusted one day in either direction if the year is *chaseirah* or *sheleimah*.

According to these rules, this year, 5771, is known as השג, because Rosh HaShanah fell on Thursday (ה); it is a *sheleimah* (ש) year in which both Cheshvan and Kislev contain 30 days; and because it is a leap year, the first day of Pesach falls on Tuesday (ג). Next year — when Rosh HaShanah again falls on Thursday, Cheshvan has 29 days and Kislev has 30, making it a *k'sidrah* (כ), and the first day of Pesach falls on Shabbos — is therefore called הכז.

And now you know all the secrets! ∎

(Endnotes)

1 Although the correct name of the month is Marcheshvan, we will use the colloquial name, Cheshvan.
2 *Rosh HaShanah* 19b, 20a.
3 *Rambam, Hilchos Kiddush HaChodesh* 1:1, 7; 5:1.
4 Ibid. 2:4; *Ritva* on the Mishnah *Rosh HaShanah* 18a.
5 Rambam, ibid. 4:1.
6 *Sanhedrin* 11a–12a.
7 *Sanhedrin* 11b; Rambam, *Hilchos Kiddush HaChodesh* 4:17.
8 Ibid. 5:2.
9 Ibid. 8:5.
10 Since Kislev is sometimes 29 days and sometimes 30, the last day of Chanukah can either be on the second or the third day of Teves.
11 The term *chelek*, used when announcing the *molad* on Shabbos Mevarchim, equals 1/1080 of an hour, or 3 and 1/3 seconds.
12 *Sheilos of Rav Acha'ei Geon,* 67; Rambam, *Hilchos Shabbos* 5:21; *Ha'Emek She'eilah*, ad loc., note 22.
13 *Ha'Emek She'eilah,* ibid.; *Gri"z, Hilchos Kiddush HaChodesh.*
14 Rambam, *Hilchos Kiddush HaChodesh* 7:1.
15 Because these *dechiyos* are extremely technical, we suffice with explaining one of them.
16 Technically, it is only *one* of the possible combinations that will result in the year being this length. Of the fourteen different year prototypes, three are *sheleimah* leap years of 385 days.

Asarah B'Teves on Friday?

One of my students came to me with rather incredulous expression on his face.

"I heard that the Tenth of Teves falls on a Friday this year, but I thought that we can't have fast days on a Friday! I don't remember ever fasting on a Friday!"

Although his assumption was incorrect, it is easy to comprehend why he made this mistake. In our current fixed calendar, the only fast day that ever falls on a Friday is Asarah B'Teves. And the last time that happened was exactly ten years ago, before he was old enough to fast.

Adding a level of sophistication to his question, we could also note that in a regular (*k'sidrah*) year, when Cheshvan contains 29 days and Kislev 30, Asarah B'Teves falls on the same day of the week as Rosh HaShanah. And since Rosh HaShanah cannot fall on a Friday, one might think that Asarah B'Teves should not fall on Friday either.

In actuality, four of the fourteen possible combinations in our fixed calendar system result in Asarah B'Teves falling on Friday, two of them in a leap year and two in an ordinary year. This happens because if Rosh HaShanah falls on Thursday and the year must have a day added (*sheleimah*), the day we add is the 30th of Cheshvan, which postpones Asarah B'Teves to Friday. Similarly, if Rosh HaShanah falls on Shabbos and the year must be a day shorter (*chaseirah*), the day we subtract is the 30th of Kislev, which moves Asarah B'Teves forward one day in the week — again to Friday. Since both of these scenarios can happen in either an ordinary year or in a leap year, there are four different combinations that result in Asarah B'Teves falling on Friday.

Let's look at this year as an example. Rosh HaShanah fell on Thursday and the year is *sheleimah*, meaning that both Cheshvan and Kislev have 30 days, to prevent Rosh HaShanah from falling on Wednesday next year. (This would lead to Yom Kippur falling on Friday; as we said, we avoid having two consecutive days with the stringencies of Shabbos.) But adding the 30th day to Cheshvan causes Asarah B'Teves to fall on Friday.

If we plan a bit ahead, we will discover that all four types of years when Asarah B'Teves falls on Friday will occur within the next few years. The year 5781 (the end of the secular year 2020), is an ordinary year in which Rosh HaShanah falls on Shabbos. Both Cheshvan and Kislev are 29 days that year, which means that the last day of Chanukah that year is a Friday, the 3rd of Teves — and the fast of Asarah B'Teves falls on the following Friday.

If we look ahead to the Hebrew calendar years 5784 and 5785, corresponding roughly to the secular years 2024 and 2025, we discover the fairly unusual situation of having back-to-back years with Asarah B'Teves falling on Friday: both in 5784 (December 22, 2023), and in 5785 (January 10, 2025), each for a different reason. In 5784, which is a leap year, Rosh HaShanah falls on Shabbos and it is a *chaseirah*, since both Cheshvan and Kislev have 29 days. The next year, 5785, is an ordinary year when Rosh HaShanah falls on Thursday, and it is a *sheleimah*, when both Cheshvan and Kislev have 30 days.

A rocket scientist once attempted to explain to me why Asarah B'Teves occasionally falls on Friday two years consecutively. I am going to attempt to explain what he told me. When Rosh HaShanah in a leap year falls on Shabbos, that year cannot be a regular leap year of 384 days, because that would cause the next Rosh HaShanah to fall on Friday, violating the rule of *lo adu Rosh*. To avoid this, we must either shorten that year by a day (*chaseirah*), moving the next Rosh HaShanah forward to Thursday; or we can add a day (*sheleimah*), pushing the next Rosh Hashanah to Shabbos. What determines which of these happens is the day on which the *molad* of the new moon for the next Rosh HaShanah falls. But if the year is indeed *chaseirah,* the loss of the day moves Asarah B'Teves to Friday, a day earlier in the week than was Rosh HaShanah.

Now, then: when the year is made *chaseirah* (and Rosh HaShanah of the second year falls on Thursday as a result), it sometimes results that the second year requires an extra day to avoid the following year's *molad* from falling too early. What has basically transpired is that because one year was shortened by a day, the next year requires a compensation of an additional day. When this happens, both Cheshvan and Kislev in the second year now have 30 days. This results in Asarah B'Teves in the second year being postponed from Thursday to Friday.

If I understood the rocket scientist correctly, the only way we can have back-to-back occurrences of Asarah B'Teves falling on a Friday is when the first year is *chaseirah* and a leap year that begins on Shabbos, and the second year is a common *sheleimah* year that begins on Thursday.

The last time Asarah B'Teves fell on Friday in two consecutive years was in 5733 (December 15, 1972) and 5734 (January 4, 1974). Few of those reading this article were fasting the previous time that Asarah B'Teves occurred on Friday in back-to-back years: this was in 5662 (December 20, 1901) and 5663 (January 9, 1903).

The wait for back-to-back Friday Asarah B'Teves observances after 2023 and 2024 is not quite as long. Someone planning on good health and longevity can look forward to fasting on two consecutive Friday observances of Asarah B'Teves in the years 5831 (December 12, 2070) and 5832 (January 1, 2072).

By Chance or By Choice?

Although it would appear that the reason no other fast occurs on a Friday is simply a coincidence of the fixed calendar, one early authority contends that observing Asarah B'Teves on Friday has a basis in Tanach and deep halachic significance.

The Avudraham explains that since the verse in *Yechezkel* (24:2) identifies the Tenth of Teves as "*etzem hayom hazeh*" (this very day), we must observe Asarah B'Teves on that exact date, no matter which day of the week it falls on. The Avudraham therefore concludes that if Asarah B'Teves were to fall on Shabbos, we would be required to fast on Shabbos just as we are required to fast when it falls on a Friday.

This means that prior to Hillel HaNasi, whenever Asarah B'Teves fell on Shabbos (during the period after the Churban), Klal Yisrael fasted on Shabbos, similar to the fasting we do when Yom Kippur falls on Shabbos! This ruling of the Avudraham seems unusual, particularly because there is no record in the Gemara of such a halachah.

The *Beis Yosef* (*Orach Chayim* 550) takes strong issue with Avudraham's approach, and questions why we should treat Asarah B'Teves more strictly than any other rabbinically ordained fast. In addition, Avudraham's position conflicts with Rashi *(Megillah* 5a, s.v. *aval)* and the Rambam (*Hilchos Taanis* 5:5), both of whom mention that when Asarah B'Teves occurs on Shabbos, the fast is postponed to Sunday.

Nevertheless, we must understand *why* the Avudraham considers Asarah B'Teves to be stricter than the other fasts. It would seem that because it heralded the beginning of the Churban and the loss of our holy Beis HaMikdash, it is considered more stringent than all other fasts.