What's the Truth about … Coinciding Birthdays?

By Ari Z. Zivotofsky

Misconception: A person's Hebrew and English birthdays coincide once every 19 years.

Fact: There is a 19-year cycle within the Jewish calendar, but it only determines which years are "regular" years and which are leap years. The calendar does not precisely repeat every 19 years, and birthdays do not necessarily coincide (mine did not).

Background: The subject of the Jewish calendar is daunting to some people, but it need not be. This article provides a brief overview of only those points related to the misconception, but even an in-depth analysis of the Jewish calendar should not intimidate. Rambam (*Kiddush Hachodesh* 11:4) says that a schoolchild can master the details of this subject in three or four days. One should take pride in studying this material, as the Talmud (*Shabbat* 75a) states that it is praiseworthy to calculate the *tekufot* (solar seasons), and that when the Torah says "for this is your wisdom and understanding in the eyes of the nations," it is referring to knowledge of the Jewish calendar (Devarim 4:6).

In order to examine the alignment of the Jewish and the secular calendar systems, it is first necessary to understand something about the nature and the workings of each of them. A calendrical system is an innovation to help track time and temporally relate events. In theory, it is possible to simply count days. Thus, if one had started counting from Creation (assumed to be September 7, 3761 BCE), January 1, 2000 was the date 2,103,548, and my birth date would be the easy-to-remember date 2,090,299.

Most calendrical systems, however, have some sort of cyclical nature, usually one that relates to a natural phenomenon. The Torah states that the sun and moon were created to provide a means to differentiate day from night and to determine holidays, days and years (Bereishit 1:14), and in the re-established covenant with Man after the Flood, God vowed to never again disrupt the flow of the seasons or of day and night (Bereishit 8:22). There are three primary natural cycles: a day, which corresponds to the earth's rotation on its axis; a month, which corresponds to the moon's revolution around the earth, and a year, which corresponds to the revolution of the earth around the sun. God, in His infinite wisdom (and with His sense of humor), arranged that none of these is a simple multiple of any other.

The Jewish calendar is linked to both the solar and lunar phenomena. The intrinsically unrelated lunar and solar cycles must be aligned so that the months follow the waxing and waning of the moon, with each month commencing with the appearance of the new moon (unlike the secular calendar in which months begin at random times within the lunar cycle), while the yearly holidays and individual months occur in a specific solar season (unlike the Muslim calendar in which months and holidays drift through the seasons).

Although we are mandated by the Torah (Rambam, *Sefer Hamitzvot, aseh* 153) to synchronize the two different cycles, the calendar did not always exist in its current, familiar form. In the Second Temple and Tana'itic periods, the *beit din* in Yerushalayim had almost complete control over the calendar and modified it, using certain guidelines, as needed. Thus, the first day of each month was determined by witnesses who testified to the appearance of the new moon and who were then cross-examined by the *beit din,* which had already calculated when, where and how the new moon would appear.[1] After cross-examining the witnesses, the *beit din* could choose to accept or reject their testimony, but every month was either 29 or 30 days long, with, in general, no pre-set rules. In order to maintain the calendar fixed within the solar cycle, the *beit din* would periodically insert an additional month (intercalate) between Adar and Nisan. Here, too, there was no predetermined cycle. The *beit din* would consider several factors in order to maintain the calendar fixed

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within the solar cycle (see Rambam, *Kiddush Hachodesh* 4:1-5, for the three main and several ancillary factors) and make a year-by-year determination as to whether to add the extra month.

No matter how small the Jewish population in Eretz Yisrael might be, it is always the center of the Jewish universe and remains responsible for the calendar. Thus, when the Jewish population in Eretz Yisrael began to dwindle in the fifth century, it was decided to establish the calendar as we know it. This process began in the fifth century and was not completed until the tenth century.[2]

The fixed calendar involved impressive computations. Because a lunar month is approximately 29 1/2 days, the basic, non-leap year has 12 months that alternate between 29 and 30 days. The solar year is approximately 365 1/4 days, and thus, cannot be made of an integral number of lunar months. To compensate for the disparity of approximately 11 days[3] and keep the lunar months aligned with the solar seasons, a leap month is added (an extra Adar) to 7 of every 19 years.[4]

The determination of when to add a leap month is no longer based on agricultural or meteorological indicators, but depends solely on the year within the 19-year cycle; a leap year occurs in years 3, 6, 8, 11, 14, 17 and 19.[5] This cycle is known as a *machzor katan,*[6] or the Metonic cycle,[7] and was also used by the ancient Babylonians, and by the Chinese for their civil calendar.

In addition to leap years, other refinements are made to the calendar so that it complies with additional rules, such as the well-known rule that the first day of Rosh Hashanah cannot fall on Sunday, Wednesday or Friday. These are made with the aid of two months with variable lengths, Marcheshvan[8] and Kislev, both of which can have either 29 or 30 days.

In order to create the calendar, one also needs to know when Rosh Hashanah occurs. The basic rule is that Rosh Hashanah is on the *molad* of Tishrei (calculated average new moon),[9]

unless one of four specific *dechiyot* (conditions that push it off)[10] occurs, in which case Rosh Hashanah is postponed.[11] Once the days of Rosh Hashanah for the current year and for the following year are determined, and the leap status is known based on the year in the Metonic cycle, the status of the two variable months is automatically determined, and the calendar is set.

Note that this calendar has no internal cycles, or periodicity. The 19-year Metonic cycle does not determine the length of the two variable months, and hence the lengths of the various years within the cycle are not fixed. The only cyclical characteristic relating to the 19-year period is the sequence of regular and leap years (such that all 19-year cycles have 235 months). Because of the variations in Marcheshvan and Kislev, a 19-year cycle can be either 6,939, 6,940, 6,941 or 6,942 days long. Thus, the Jewish calendar does not repeat every 19 years.

A longer cycle is possible. After thirteen 19-year cycles, i.e., 247 years, a period known as *Iggul de Rav Nachshon Gaon,*[12] the *molad* returns very close to its initial value, nearly yielding a "period." But the 247-year cycle, too, is inexact.[13] It is short by 905 *chalakim* (about 3016.67 seconds or about 50.278 minutes). Mistaking this near-cycle for an exact cycle can lead to very serious errors according to the Pri Chadash (*OC* 428, immediately before the detailed table).[14]

The secular calendar used in the Western World today is known as the Gregorian calendar, which is an updated version of the Julian calendar instituted by Julius Caesar in 45 BCE. A regular Julian year had 365 days, and every fourth year was a leap year with 366 days. This would have been perfect if the solar year was exactly 365.25 days long. But God did not make things so easy. The solar year is closer to 365.242 days. Because of this slight discrepancy of 11 minutes and 14 seconds (0.0078 days) each year, the Julian calendar accumulates an error of about one day every 128 years or 7.8 days every 1,000

years. Although not obvious at first, this inaccuracy started to be noticeable with the drift of the equinoxes. By the sixteenth century, the slip in the calendar had reached 10 days, and Pope Gregory XIII decided that something had to be done. On February 24, 1582, the pope issued a papal bull inaugurating the current calendar. In order to correct the 10 days the calendar had slipped, he simply dropped 10 days from that year. October 4, 1582 became October 15, 1582, and the calendar was back in sync. To prevent future calendrical slips, the pope knocked out 3 leap years every 400 years by removing leap years at century boundaries, except when they are divisible by 400. Thus, 1800 and 1900 were not leap years, although they are divisible by four, but 2000 was a leap year. With this correction, the average year is 365.2425 days long; the calendar will lose only one day every 3,000 or so years. Not everyone immediately embraced this Gregorian sleight of hand. Great Britain and its American colonies kept the Julian calendar until

1752, when they dropped 11 days from September 3 to September 14, 1752. The Russians did not adopt the Gregorian calendar until after the Russian Revolution of 1917.

With this background, it is obvious that the Jewish and Gregorian calendars do not have to synchronize every 19 years. As noted above, a 19-year Jewish cycle can be 6,939, 6,940, 6,941 or 6,942 days long. The number of days in 19 Gregorian years depends upon where in the Gregorian leap-year cycle the 19 years begins, and the 19 years can have either 6,939 days (if there are 4 leap years) or 6,940 days (if there are 5 leap years). Nor does a larger cycle guarantee "birthday coincidence," because it too does not always have the same number of days, although it is more consistent than the 19-year cycle. Over 98 percent of 247-year cycles have 90,216 days, but there are cycles with 90,214 as well as with 90,215 days.[15] And here too, not all periods of 247 Gregorian years have the same number of days. In addition, the Gregorian calendar is moving past the Hebrew calendar at a rate of about one day every 231 years. So for those who live long enough, there is still no guaranteed relationship between one's 247th Hebrew and English birthdays. For example, people born September 23, 1901, 1902, 1903 or 1905 will find that in 2148, 2149, 2150 or 2152, respectively, their 247th birthdays do indeed coincide. However, those born in 1904, 1908, 1963 or 1965 will find that their birthdays in 2151, 2155, 2210 and 2212, respectively, miss coincidence by one day, and those born in 1964 will find their 247th birthdays in 2211 to be misaligned by two days. There are just no guarantees even after 247 years!

One more important reason why it might appear that Jewish and secular birthdays do not necessarily coincide every 19 years is the different conventions in transitioning from one day to the next. In the Jewish calendar, a new day begins at sunset, while in the secular calendar, a new day starts at midnight.

Jewish and secular birthdays can also coincide in fewer than 19 years. The 19-year cycle incorporates two less accurate sub-cycles: an 8-year cycle and an 11-year cycle. The 8-year sub-cycle, an octaeteris, contains 99 synodic lunar months, and produces an error of one day every 5 years. The 11-year sub-cycle is 136 lunations, and produces an error of one day every 7.3 years. Because of these mini-cycles within the calendar, there is the possibility of synchrony in years that are multiples of 19 plus or minus 8 or 11 years, such as 27 or 30 years. This is because in 8 lunar years in which there are 3 leap years (there could also be 2), there are 99 months and between 2,922 and 2,925 days. The solar years during that period will always have 2,922 days. In 11 lunar years in which there are 4 leap years (there could also be 5), there will be between 4,015 and 4,017 days, while the 11 solar years can have either 4,017 or 4,018 days, again allowing for the possibility of coinciding birthdays.

Take, for example, someone born on Monday, Sivan 9, 5749/June 12, 1989. Eleven years later his birthday was Monday, Sivan 9, 5760/June 12, 2000. Again, only 8 years later June 12 and Sivan 9 coincide in 5768/2008, and again 11 years after that in 5779/2019. Thus, his thirtieth birthday will be his third with coinciding birthdays!

By far the most common interval of coincidence occurs every 19 years, and this explains why people are under the misconception that the coincidence *must* occur every 19 years. Most people are not aware of the fact that it can occur in shorter intervals and that it does not always occur after 19 years. In a 120-year lifetime the median number of coinciding Hebrew and English birthdays on a multiple of 19 years will be 3, with another 1 or 2 occurring on a multiple of 19 plus or minus 8 or 11 years. (I thank Phil Chernofsky for the statistics.)

The discussion of the topic also highlights the fact that as practicing Jews in the twenty-first century, we are attempting, and in a large way succeeding, to simultaneously live in two worlds.[16] To talk of having two birthdays that do or do not coincide indicates an awareness of, and a dwelling in, two disparate worlds: a Torah-oriented Jewish world and a secular Western one. While we are engaged in this delicate balancing act, it should always be clear that they are indeed two different cultures and worldviews, which, like their respective calendars, do not often coincide. Just as at all times one needs to be aware of the "date" in both systems,[17] and is acutely aware that they differ, one must also maintain an awareness of the difference in values between the two systems. The twenty-first-century Jew, while balancing two complex, separate worlds, must recognize that, like their independent calendars, these worlds often do not coincide, and their synchrony is rare.

Those interested in additional details about the calendar should visit Remy Landau's web site: http://www.geocities.com/Athens/1584/, and those who want to look up their own (or others') birthdays can download the program Kaluach: http://www.kaluach.org/. **JA**

Notes

1. Rabbeinu Bachaya (Shemot 12:2) cites an opinion (in the name of Rabbeinu Chananel; it is also attributed to Rav Sa'adia Gaon) that the essence of the mitzvah of declaring the new month is via calculation and not by witnesses, and he notes that during the 40 years the Jews were in the desert, Rosh Chodesh was determined by calculation (as in the fixed calendar) and not by observation, because the heavens were blocked by the protective Clouds of Glory. However, see Rambam's negative reaction to this opinion in his commentary to *Mishnah Rosh Hashanah* 2:7.

2. See *Shu"t Rashba* 4:254. Throughout that period, from the fifth to the tenth century, the calendar for the coming year was publicly proclaimed by the head of the community in Eretz Yisrael on Hoshana Rabbah from Har Hazeitim. In the year 920,

Rabbi Aharon Ben Meir set off a major controversy when his announced dates differed from those of Rav Sa'adia Gaon. On this incident, which led to the final fixing of the calendric rules, see Yosef Gavriel Bechhofer with Ari Z. Zivotofsky, "The Rabbi Sa'adia Gaon—Rabbi Aharon ben Meir Controversy," *Jewish Observer* 33:4 (Nisan 5760/April 2000): 40-44.

3. Rambam (*Hilchot Kiddush Hachodesh* 10:1) quantifies it as 10 days, 21 hours, 121 *chalakim* (see note 9) and 48 *regaim* (1/76 of a *chelek*).

4. The 13-month year is known as "gravid" in English or a *"shanah meuberet"* in Hebrew.

5. This is remembered by the Hebrew mnemonic GUCHADZaT, standing for the Hebrew letters *gimmel-vav-chet-aleph-dalet-zayin-tet.*

6. As opposed to the *machzor gadol,* the 28-year solar cycle.

7. Named after the fifth-century BCE Greek astronomer Meton, who is said to have discovered that 235 lunation periods brought the solar year into very close synchronization with the lunar year.

8. On the name of this month, see Rabbi Ari Z. Zivotofsky, PhD, "What's the Truth about … Mar Cheshvan?" *Jewish Action* (fall 2000): 28-29, available at: www.ou.org/publications/ja/5761fall/LEGALEAS.PDF.

9. The *molad* is calculated by adding to the original *molad* the mean length of a month for each month that has elapsed since the first *molad*. The first *molad* is taken as *molad* Tishrei in year 1, at day 2, 5 hours and 204 *"chalakim"* (a *chelek* is a part equaling 1/1080 of an hour, which equals 1/18 of a minute, which equals 3 1/3 seconds). (See Tur, *OC* 427 for these facts and a primer in calculating the *molad*.) The average lunar month is taken to be 29 days, 12 hours and 793 *chalakim*. The number of months that have elapsed can be calculated by assuming 12 months a year, plus 7 additional months for each complete 19-year cycle, plus one more month for each leap year in the current cycle.

The average lunation period was determined very accurately. Rabban Gamliel quotes a family tradition (*Rosh Hashanah* 25a) that it is "not less" than 29 days, 2/3 of an hour and 73 *chalakim* (equaling 29 days, 12 hours and 793 *chalakim,* or 29 days, 12 hours, 44 minutes and 3 1/3 seconds). That is as accurate a mean (Rambam, *Kiddush Hachodesh* 6:3) as possible using the *chelek* as the smallest unit, and produces an error of about 0.11 days in 1,500 years.

One method of arriving at the average lunation period (i.e., synodic month) was used by Hipparchus of Rhodes (ca. 190 BCE–120 BCE), who observed a solar eclipse in the year 141 BCE and also had Babylonian records of another eclipse 345 years earlier. Putting the two together, he calculated that 4,267 lunations elapsed in the 126,007 days and 1 hour (3,024,169 hours) between those two eclipses. He did the arithmetic and showed that those 4,267 months average to the then accepted value of 29.5 days and 793 *chalakim.*

10. Without too much detail, the 4 *dechiyot* are: 1. if the *molad* is on Sunday, Wednesday or Friday; 2. if *molad* is after noon; 3. if the *molad* of a non-leap year is on Tuesday—on or after 9 hours and 204 *chalakim*; 4. if the *molad* following a leap year is on Monday—on or after 15 hours and 589 *chalakim* (this rare *dechiya,* used about once every 186 years, applied last year, 5766).

11. Note that the only *molad* that is of significance in determining the calendar is the *molad* of Tishrei, and that is the only one that is not announced in shul.

12. Rav Nachshon ben Rav Tzaddok's connection to this cycle is unclear. About Rav Nachson (d. 4640 [879]), see *Encyclopaedia Judaica* 12:793.

13. According to Leo Levi, the Hebrew calendar precisely repeats itself after the ridiculously long period of 36,288 cycles of 19 years, or 689,472 Hebrew years, a period with no practical application; see Yehudah (Leo) Levi, *Jewish Chrononomy* (New York, 1967), 7-8.

14. The *Encyclopaedia Judaica* (12:793) erroneously states that "the Jewish calendar repeats itself exactly every 247 years." According to R. Sar-Shalom, *She'harim La'luach Ha'ivry* [Tel Aviv, 5744], 51-52) the almost 1,000-year calendar printed in the Tur following *OC* 428 contains errors in 24 of the years, most recently in 5662 (1902) because of this erroneous assumption. See *Pe'er Hador* 1, p. 179, regarding how the Chazon Ish made the calculations to show that the Pri Chadash was correct regarding 1902, but also claimed that there really is no debate between the Pri Chadash and the Tur, rather a printing error had crept into the Tur's words. Thanks to Rabbi Matis Greenblatt, literary editor of *Jewish Action*, for providing this source.

15. To be precise, out of the larger 689,472-year cycle, 675,716 years of the 247-year cycles have 90,216 days, 10,317 have 90,214 days (1.5 percent), and only 3,429 (0.48 percent) have 90,215 days.

16. The kernel for the rest of this paragraph was planted after reading Michael J. Broyde, "Truth-Seeking as the Mission," *My Yeshiva College: 75 Years of Memories,* ed. Menachem Butler and Zev Nagel (New York, 2006), 325-327.

17. One needs to be aware of the Jewish system because, among other reasons, it is a Biblical commandment to count the months from Nisan (as well as to link the days of the week to Shabbat). Furthermore, some authorities think it is wrong to use the Christian counting. One needs to be aware of the secular system just because it is necessary in order to take care of one's daily activities. Note that in Israel this may not be the case because one may use the Jewish date for all business and financial activities, and pursuant to a law the Knesset passed in 5758, all government documents must include the Jewish date.