Rav Yehudah said in the name of Rav: In a town which bounds with ascents and descents, people and beasts die in the prime of their lives.

The *Gemora* explains: They age in the prime of life (due to the strains of the steep paths).

Rav Huna son of Rabbi Yehoshua remarked: The steep roads between Biri and Narash have made me old.

The *Gemora* cites a *braisa*: If a town is to be squared, the sides of the square must be made to correspond to the four directions of the world: Its northern side must correspond to the North, and its southern side to the South; and your guiding marks (for North and South) are the (constellation of the) Calf in the North and the Scorpion in the South.

Rabbi Yosi said: If one does not know how to square a town so as to make it correspond with the directions of the world, one may square it in accordance with the seasons. How? The direction in which on the longest day the sun rises and sets is the northern direction. The direction in which on the shortest day the sun rises and sets is the southern direction. At the spring and autumn equinoxes, the sun rises in the middle point of the East and sets in the middle point of the West, as it is written: *The sun goes toward the south and it circles toward the north*. "It goes toward the south" - by day, and "it circles toward the north" - by night.

The *Gemora* expounds the verse further: *It goes about continually in its course and in its travels it retraces the directions*. This refers to the eastern and western sides of the horizon, which the sun sometimes circles them (*during the winter nights*) and sometimes it traverses them (*during the summer days*).

Rav Mesharshiya said: This is not correct, for it was taught in a *braisa*: It never happened that the sun rose in the Northeast (of the horizon) or set in the Northwest, and it never happened that the sun rose in the Southeast or set in the Southwest.

Shmuel stated: The vernal equinox occurs only at the beginning of one of the four quarters of the day- that is either at the beginning of the day or at the beginning of the night or at midday or at midnight. [The year consists of three hundred and sixty-five days and six hours approx., representing fifty-two weeks and one and a quarter solar day's. The first vernal equinox which, according to tradition, occurred on the first of Nisan, which was then a Wednesday at the beginning of the first quarter of the solar day, i.e., at the 'beginning of the night' (solar days in the Jewish calendar beginning with nightfall) was consequently followed in the second year by a vernal equinox that began at the beginning of a second quarter of the solar day which was the 'midnight' of Thursday (the solar day again beginning as stated supra at nightfall). In the third year the equinox began at the beginning of a third quarter of the solar day, which was the 'beginning of the day' of Friday. In the fourth year it began at the beginning of the fourth quarter of the solar day which was 'midday' of Saturday. The vernal equinox thus begins at a different quarter of the solar day in the course of every four years.]

The summer solstice only occurs either at the end of one and a half, or at the end of seven and a half hours of the day or the night. [The period intervening between an equinox and the following solstice and between a solstice and the

following equinox is ninety-one days and seven and a half hours approx., representing thirteen weeks and seven and a half hours. When the first vernal equinox occurred at the beginning of a Wednesday, the following summer solstice must have occurred thirteen weeks later at the end of seven and a half hours after the beginning of the night belonging to that Wednesday. When the second vernal equinox occurred at the midnight of Thursday the summer solstice must have occurred thirteen weeks later at the end of one and a half hours after the beginning of the day also a Thursday. Since the third vernal equinox occurred on a Friday at the beginning of the day, the following solstice must have occurred thirteen weeks later at the end of seven and a half hours of the day also a Friday. Finally, when the fourth vernal equinox occurred at midday on Saturday, the following solstice must have occurred at the end of one and a half hours of the night of the Sunday thirteen weeks later.]

The autumnal equinox only occurs at the end of three, or nine hours of the day or the night (this is obtained by dropping the thirteen complete weeks which do not affect the weekday or the hour, and by adding the seven and a half hours to the respective summer solstices), and the winter solstice only occurs at the end of four and a half, or ten and a half hours of the day or the night.

The duration of a season of the year (the lapse of time between an equinox and a solstice that follows it, and between a solstice and an equinox that follows it) is no longer than ninety-one days and seven and a half hours; and the beginning of one season is removed from that of the other by no more than one half of a planetary hour.

Shmuel further stated: The vernal equinox never begins under Jupiter without it breaking the trees, nor does the winter solstice begin under Jupiter without it drying up the seed. This, however, is the case only when Rosh Chodesh occurred in the Moon-hour or in the Jupiter-hour. [Mercury, Moon, Saturn, Jupiter, Mars, Sun and Venus are planets that serve a different hour of the day in that order. It follows that the same heavenly body serves every eighth hour. Since, for instance, Mercury is in ascendancy in the first hour of the first day of the week, it is also in ascendancy in the eighth, the fifteenth and the twenty-second hour and so on ad infinitum. Similarly, Venus which is in ascendancy in the seventh hour of the first day of the week is also in ascendancy in the fourteenth and the twenty-first hour etc. Now, since the beginning of one season is removed from that of the next season by thirteen weeks and seven and a half hours, and since in every week (consisting of 7 X 24 hours) the same relative order and succession of the heavenly bodies is invariably repeated, the weeks may be entirely disregarded in the calculations that determine what heavenly body would exercise its influence at the beginning of a season. The seven and a half hours only having to be taken into consideration, and the number of heavenly bodies concerned being seven, it follows that the same heavenly body that was in ascendancy at the beginning of a season is again in ascendancy during the last half hour of that season and during the first half hour of the season that follows. Every season thus begins 'one half of a planetary hour' later than the preceding one.] (56a)

The *Gemora* cites a *braisa*: If a circular town is to be circumscribed by a square, the sides must be drawn in the shape of a square tablet. The techum also is then drawn in the shape of a square tablet. When the measurements are taken, one should not measure the two thousand amos from the middle point of the town corner, because, thereby, one loses the corners. One should rather imagine that a square tablet of the size of two thousand amos by two thousand amos is applied to each corner diagonally, so that the town gains thereby four hundred amos in each corner, the techum gain eight hundred amos in each corner, while the town and the techum together gain twelve hundred amos in each corner. The town spoken of here (as will be stated by Abaye) is one that is circular in shape, and the diameter of which is two thousand amos. By enclosing it in an imaginary square the diagonal of which (on the rule that the diagonal of a square exceeds its side by two fifths approx.), the town is extended in each of its four corners by (2000 X 2/5)/2) = 4000/10 = 400 amos. A line of two thousand amos is by two fifths, less than the diagonal of a two thousand amos square. 'A square tablet of the size of two thousand amos by two thousand amos applied to each corner diagonally' would

consequently add to each corner two thousand amos plus (2000 x 2)/5 = 800 amos.]

This is possible, Abaye explained, in a (circular) town of the size of two thousand by two thousand amos (in diameter).

The *Gemora* cites a *braisa*: Rabbi Eliezer son of Rabbi Yosi stated: The limit of the allotted land beyond the confines of the Levitical cities (which was also designated for the Leviim) was two thousand amos. [In addition to the cities themselves the Levites were allowed stretches of land around them for use as open spaces, fields and vineyards as will be specified below.] Subtract from these an open space of one thousand amos (to remain opened); such open space would represent a quarter of the entire area (which will be explained). The remainder of these two thousand amos consisted of fields and vineyards.

Rava cites the Scriptural source for this. [And the open land,..] from the wall of the city and outward a thousand cubits round about, the Torah has thus enjoined, 'Surround the city by an open space of one thousand cubits'. 'Such an open space [it was said] would represent a quarter of the entire area' — The *Gemora* asks: Is it but a quarter? Is it not in fact one half?

Rava replied: The surveyor Bar Adda explained this to me. Such a proportion is possible in the case of a town whose area is two thousand by two thousand amos. For what is the area of its techum? Sixteen million square amos. [2000 by 2000 amos on each of its four sides: 2000 X 2000 X 4 = 16,000,000 square amos.] What is the area of the corners? Also sixteen million square amos. Substract for the open spaces eight million square amos from the limits, and four million square amos from the corners, to what area would this space amount? To one of twelve million square amos.

The *Gemora* asks: Would then such an open space represent a quarter? Is it not in fact more than a third of the entire area?

The *Gemora* answers: Take the four million square amos of the town area itself and add to them.

The *Gemora* asks: Doesn't this, however, still amount to a third?

The *Gemora* answers: Do you imagine that a square town was spoken of? No, a circular town was meant. For by how much does the area of a square exceed that of a circle? It is by one quarter. Deduct a quarter from the measurements given and there would remain nine million square amos; and nine million represents one quarter of thirty six million. (56a – 56b)

INSIGHTS TO THE DAF

The Solar Calendar

In general, the Jewish year is based on a lunar calendar, by which we mark Rosh Hashana and all the Yomim Tovim. However, in regard to certain select issues, we also take into account the solar year. For example, in a leap year, an extra month of Adar is added in order to ensure that Nissan begins in the spring. Outside of *Eretz Yisrael*, we begin asking for rain in *Shemoneh Esrei* sixty days after the beginning of the solar season of Tishrei (this is not the lunar month of Tishrei, but the solar season that generally begins around Tishrei, and corresponds with fall). Also, the time for reciting *Birchas HaChama*, the blessing recited over the sun once every twenty-eight years, is determined based on the solar calendar. The Amora Shmuel said of himself that he was familiar with the paths of the Heavens, as he was with the streets in his hometown of Naharda. According to Shmuel, the solar year in which the Earth makes one complete cycle around the sun, takes exactly three hundred and sixty five days and six hours. Dividing this number into four, we find that each season of the solar years takes ninety-one days and seven and a half hours. Ninety-one days is exactly thirteen weeks. Thus, when we compare the cycle of seasons to the cycle of the week, we find that each season begins seven and a half hours later than the previous cycle. For example, if the solar season of Nissan begins on Sunday at 8:00 AM, the season of Tammuz will begin thirteen weeks later, on Sunday at 3:30 PM. Over the course of the four seasons of the year, the week will progress one day and six hours. Thus, if one
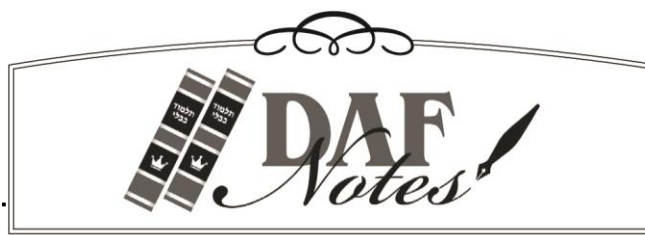
solar year begins on Sunday at 8:00 AM, the following year will begin on Monday at 2:00 PM.

Nowhere in Shas do we find any opinion that argues with Shmuel on this matter. However, the Rambam (Hilchos Kiddush HaChodesh 9:1) does cite a *machlokes*: "According to some of the Sages of Israel, the solar year is three hundred and sixty five days and one quarter day, which is six hours. Other Sages hold that the addition is slightly less than one quarter day. The scholars of Greece and Persia also disagree over this matter."

The commentaries explain that the second opinion cited in the Rambam measures the year as being only four minutes and 25.5 seconds shorter than Shmuel's estimation. The difference may seem negligible, but over the course of hundreds of years the discrepancy becomes more pronounced. For every hundred years, there is a seven hour discordance between the two opinions.

Although we do not find this second opinion cited in Shas, it is in fact based on a *beraysa,* a Tannaic source which Rebbe Yehuda HaNassi chose not to include in his Mishnayos. This *beraysa* became publicized about nine hundred years ago, by R' Avraham bar Chiya HaNassi, author of Sefer Ha'Ibur (3:4), who cites many proofs to this opinion. He attributes the opinion to the Amora R' Adda, and some commentaries attempt to find proofs from the sayings of R' Adda in Shas that support this view (see Rosh Hashana 21a; Commentary on Rambam 10:1).

One of the proofs for R' Adda's opinion is from the Gemara (Sanhedrin 13a) which states that the season of Nissan can never begin after the fifteenth of the month of Nissan. According to Shmuel's calculation, the season of Nissan begins after the fifteenth twice in a nineteen year cycle. Some Rishonim reject this proof, explaining that when Beis Din determined the new month based on the sighting of the moon, the season of Nissan never began after the fifteenth. Now that we use a predetermined calendar, the season of Nissan may begin after the fifteenth (Rabbeinu Chananel: Rosh Hashana 21b; Tosefos HaRosh, Sanhedrin 13b, s.v. Ravina).

The Ibn Ezra supports R' Adda's view, and cites no less than seven different proofs. The Rambam (ibid) also concluded, "This second calculation is more truthful than the first."

Shmuel was deliberately imprecise: Some Rishonim contend that the Gemara cited Shmuel's calculation with deliberate imprecision. They explain that certain supernatural powers can be drawn at the precise moment of the changing of seasons. Our Sages wished to hide these times to prevent unscrupulous people from misusing these powers (see Sefer Ha'Ibur by Raavach, ibid).

R' Yitzchak Yisraeli, a student of the Rosh and author of Yesod Olam (4:14), writes that before a set calendar was established, the Sanhedrin would determine the new month based on sightings of the moon. They would also decide to add an extra month of Adar to lengthen the year as they saw fit. If the exact length of the solar year would be revealed to all, free reign would be given to all gainsayers to dispute their rulings, and suggest their own calculations of the solar and lunar cycles. Therefore, the Chachomim revealed only Shmuel's approximation, and let it be known that this was not an exact figure. Without the precise numbers at their disposal, they would be unable to dispute the rulings of the Sages.