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Seasonal and Zodiac Sign Properties of the Citric Acid Cycle and the Grouping of Biochemically Important Functional Groups

Jef Struyf*

A Retired Instructor of UCLL Campus Gasthuisberg, Chemistry Bachelors, Herestraat 49, Be-3000 Leuven, Belgium
*Corresponding author: jef.struyf@ucll.be

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Abstract Properties of the intermediates from the citric acid cycle (TCA cycle) match the zodiac signs and correspond to the seasons of the year. The grouping of the twelve most important biochemical functional groups exhibits the same ratios that are typical for the zodiac signs.

Keywords: *biochemistry functional groups, citric acid cycle, citric acid cycle zodiac, Krebs cycle, TCA cycle, tropical zodiac, zodiac signs*

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1. Introduction

This contribution investigates the accordance of biochemically important functional groups and the citric acid cycle, also known as the TCA cycle (tricarboxylic acid cycle) or Krebs cycle, to the zodiac signs of the ecliptic. The ecliptic is the celestial line of the sun path through the zodiac star constellations seen from the earth. The zodiac is a belt around the ecliptic. We use the tropical zodiac [1], which is based on the seasons and is independent of the factual continuous slow shift of equinoxes and solstices for the sidereal (pertaining to the stars) zodiac. For example: The March (or spring or vernal) equinox passed from Taurus into Aries in year -1865, passed into Pisces in year -67, and will pass into Aquarius in year 2597 [2]. Reference [3] describes more details about the tropical and sidereal zodiac and the shift of the equinoxes. The Almagest of Claudius Ptolemaeus overviews the knowledge of ancient astronomy [4,5].

1.1. Characteristic Ratios for the Zodiac Signs

Each zodiac sign represents 30° of the ecliptic. The zodiac signs in traditional order are: Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricorn, Aquarius and Pisces. Five of them are human related and seven are animal (related) names, which gives a ratio of five to seven. The human related signs are Aquarius, Gemini, Virgo, Libra and Sagittarius. Three of them indicate a human activity: Aquarius, Libra and Sagittarius and the two others are human beings: Gemini and Virgo. Consequently, we also have a ratio of three, two and seven signs. From the seven animal signs, four are mammals (Aries, Taurus, Leo and Capricornus), two are arthropods (Cancer and Scorpio) and Pisces, which results in a four-two-one to seven ratio. All the three ratios are encountered in the grouping of the twelve most important functional groups for biochemistry and for specific properties of the citric acid cycle.

1.2. A Seasonal Modification and Remark for the Tropical Zodiac

In accordance to our results for the citric acid cycle, we start the tropical zodiac with Capricorn on 23th of December; the begin of the winter. The connections of the tropical zodiac signs to the citric acid is valid for the northern hemisphere of the earth. The seasons at the southern hemisphere are the inverse of the seasons at the northern hemisphere. For example, when it is winter in the northern hemisphere, it is summer in the southern hemisphere. It should be noticed that the original researchers that are responsible for the naming of the zodiac signs and zodiac constellations are inhabitants of the northern hemisphere.

2. The Biochemically Important Functional Groups and the Zodiac Ratios

The zodiac ratios of five/seven, and three-two/seven, and four-two-one/seven are detectable for the twelve biochemically important functional groups; the functional

group zodiac. Three of them are hydrocarbon groups; alkyl, alkenyl and aryl. Two are groups on the carbon chain; hydroxyl (alcohol and phenol) and amine. Seven are carbonyls and derivatives; aldehyde-ketone, (hemi)acetals(ketals), imine, carboxyl, anhydride, amide and ester. The four-two-one/seven ratio for the carbonyls and derivatives is as follows: four (carboxyl, anhydride, amide and ester), two [aldehyde-ketone, (hemi)acetals(ketals)], one (imine) and seven for all the carbonyls and derivatives together. In the proposed grouping, the sulfur derivatives (thiols and thioesters), are regarded as included. In biochemistry, the (hemi)acetals (and sometimes also the esters) are often indicated as (glycoside) ethers. Ethers are not often present in biomolecules. The three hydrocarbon groups and the two functional groups on the carbon chain together form a group of five non carbonyl groups. The latter connection results in the five to seven ratio: Five non carbonyl and seven carbonyl groups including the derivative imine. Some examples of biochemically important functional groups for main biomolecules are: Long chain alkanoyl and alkenoyl groups of fats and oils, hemi-acetals for the monosaccharide ring structure, acetals for the glycoside bonds of polysaccharides, imines for the biosynthesis of nucleobases and the formation of amino acids from imino acids, esters for triglycerides and derivatives, phosphodiesters for nucleic acids, and amides for the protein peptide bonds [[6], second half of section 3.1].

3. The Citric Acid Cycle as a Biochemical Zodiac

The citric acid cycle as a biochemical zodiac is the main part of this article and searches accordance between the citric acid cycle and the year cycle as expressed by the twelve signs of the tropical zodiac.

3.1. Glucose, Magnesium, Chromium and the Twelve Steps from Glucose to Acetyl-CoA

The tropical zodiac is connected to the yearly cycle of the earth around the sun. From this viewpoint, a biochemical zodiac must be connected in some way to the photosynthesis. Photosynthesis is the primary process for all life processes.

3.1.1. Some Connections for Glucose

The photosynthesis end product is glucose, which is a molecular vehicle of solar energy. We look first at the remarkable chemical formula ($C_6H_{12}O_6$) of glucose. Hydrogen is an element that is already rather abundant in the cosmos. The twelve hydrogens in glucose indicate a possible connection to the zodiac. Furthermore, the element with atomic number twelve is magnesium, which is a component of the chlorophyll molecule, which plays an important role in photosynthesis. The 24 atoms in glucose show a connection to the daily (24 hours) cycle and the element chromium that has atomic number 24. Chromium is important in maintaining the normal glucose level in the blood [7]. The 24 atoms in glucose are in accord with the fact that photosynthesis is a process that shows a daily (24 hours) cycle, which is also called a circadian rhythm. Glucose is the main nutrient for the brain that gives us our consciousness.

3.1.2. A few Remarks on the Glycolysis

We situate the biochemical zodiac in the chemical degradation processes from which the glucose energy is transformed in common energy transferring ATP molecules. The first step is the glycolysis process that decomposes glucose (a C-6 molecule) first in two molecules of pyruvate (a C-3 molecule). Many intermediates have the suffix "-ate", which means that this product is negatively charged at physiologic pH. The glycolysis is located in the cytoplasm (cytosol) of a cell. The next stages of the glucose degradation are processes in the mitochondria. Pyruvate is converted in an acetic acid derivative (acetyl coenzyme A; $CH_3COSCoA$) of which the acetyl group is a C-2 group. The latter C-2 is incorporated in the citric acid cycle (Figure 1). The degradation of glucose into acetyl-CoA is a process in twelve stages if we include and count the hydroxyethyl-TPP (active acetaldehyde) and acetyl lipoamide intermediates. In this way, we connect in a nutshell the citric acid cycle to the photosynthesis.

3.2. The Selection of the Intermediates for the Citric Acid Cycle

A cyclic biochemical process in twelve stages should be striking for everyone who has biochemistry in his educational curriculum. Probably this is not the case because a cyclic biochemical process, including the citric acid cycle, in twelve stages, is not found in biochemistry textbooks. The citric acid cycle is a process in twelve stages if we take into account the following considerations. We select cis-aconitate as a necessary intermediate and, in line with most authors, we do not use oxalosuccinate as it is very unstable. The TPP and lipoamide connected intermediates are usually not depicted in citric acid cycles but nevertheless are real intermediates. Acetyl coenzyme A is usually not regarded a citric acid intermediate although it is a necessary component. We present the CoA and lipoamide derivatives including an "S" symbol to stress the thioester bond. The selection of the intermediates is based on logical grounds for the best match to the zodiac. The accordance of the selected intermediates to the zodiac further on supports the already logical choice of the intermediates. In Figure 1, the intermediates of the cycle are numbered and each of the twelve intermediates shows in its structure and/or properties a connection to its corresponding zodiac sign. In the text, the numbers of the intermediates for the corresponding zodiac signs are indicated in between parenthesis.

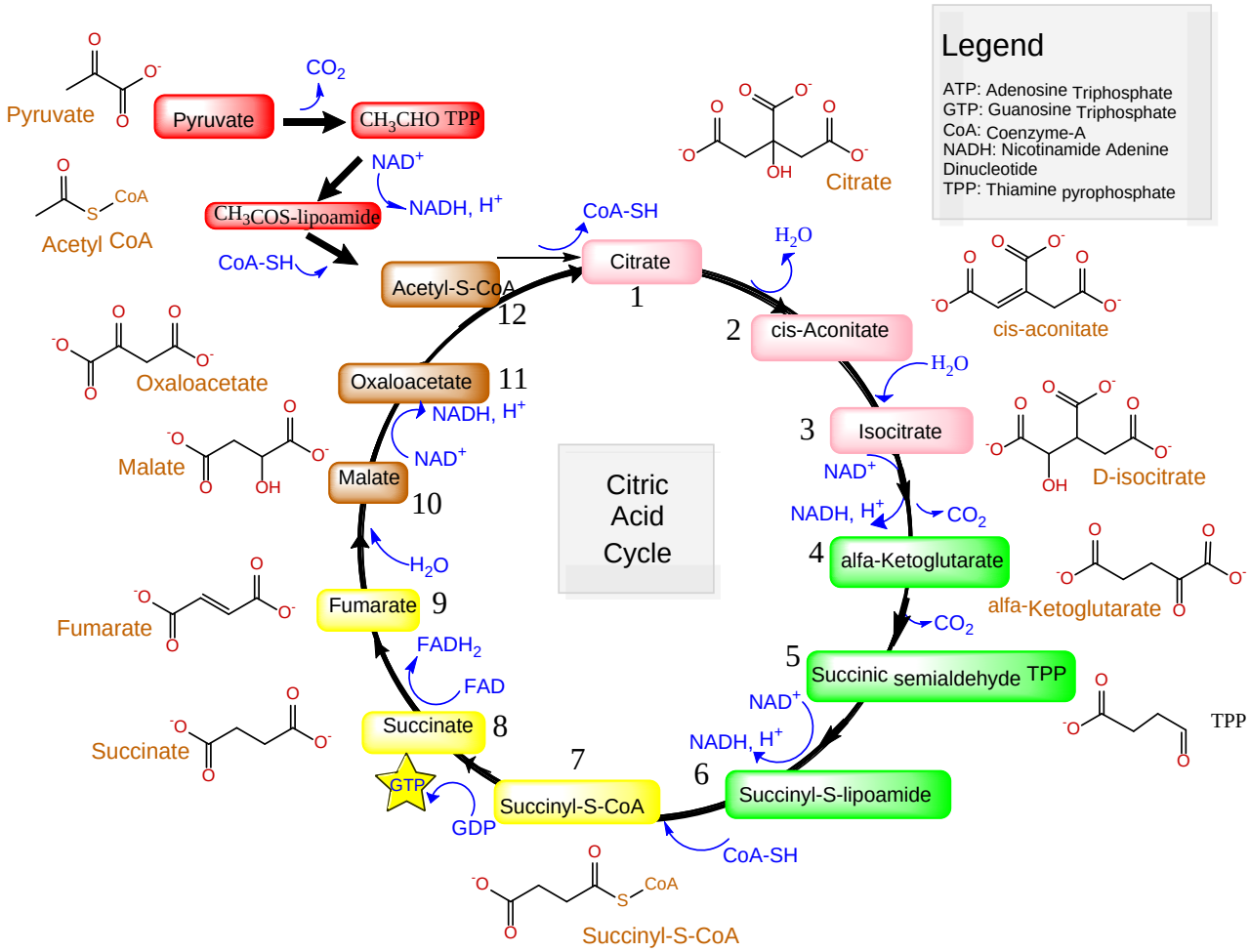

Figure 1. The citric acid cycle zodiac. The numbers of citric acid intermediates and matching zodiac signs are: 1-Capricorn, 2-Aquarius, 3-Pisces, 4-Aries, 5-Taurus, 6-Gemini, 7-Cancer, 8-Leo, 9-Virgo, 10-Libra, 11-Scorpio and 12-Sagittarius. Figure 1 is a modified Chemdraw template from "Chemdraw of PerkinElmer Informatics" [8]

3.3. The Energy Harvest of the Citric Acid Cycle

The steps that produce NADH, $FADH_2$ and GTP are important for the energy harvest. The ATP equivalent of NADH is 3 ATP, for $FADH_2$ it is 2 ATP and for GTP it is 1 ATP. One cycle produces 12 ATP molecules and 1 glucose molecule needs two cycles and produces therefore 24 ATP. A numerical accordance to the zodiac and the daily cycle is obvious.

3.4. The NAD Induced Ratios of Five/seven, Three-two/seven and Four-two-one/seven

The number of energy transfer steps in the citric acid cycle is five (3 NADH, 1 $FADH_2$ and 1 GTP). The five energy transfer steps can be grouped in three NADH and two non-NADH producing steps. These five steps match in number with the five human related zodiac signs. Consequently, there are still seven steps left that do not produce energy equivalents. These seven steps match in number with the seven animals of the zodiac. The four mammals match with the four steps that add or eliminate a small molecule (H_2O and CO_2). These four steps are between the following intermediates: 1-2, 2-3, 4-5 and 9-10. The two arthropods match with the two steps that add or eliminate CoA-SH respectively steps 6-7 and 12-1. The Pisces zodiac sign corresponds to step 11-12; the formation of citrate from acetyl-S-CoA and oxaloacetate. This section shows a projection of the zodiac signs on the citric acid cycle by a numerical accordance to the chemical conversions of the intermediates.

3.5. The Co-A Derivatives Induced Five to Seven Ratio

The Co-A derivatives of the citric acid cycle; acetyl-S-CoA (12) and succinyl-S-CoA (7) divide the cycle in a five to seven ratio. The number of intermediates in the series from intermediate 7 till 11 is five and from intermediate 12 till 6 is seven if one includes both ends of the series. The ratio of both intermediate series is 5/7. Furthermore, the sequence of the intermediates 12 till 4 (Acetyl-S-CoA (12) till alfa-ketoglutarate (4)) are similar in structure to the sequence of intermediates 7 till 11 (succinyl-S-CoA (7) till oxaloacetate (11)). The according intermediates of both sequences divide the cycle into ratios of five to seven (5/7) intermediates.

3.6. Citric Acid Cycle Accordance to a Solar Impulse, Day Length and Seasons

The names of the seasonal intermediates in Figure 1

are highlighted in rose, green, yellow and brown for respectively winter, spring, summer and autumn intermediates.

3.6.1. A Solar Impulse in the Year Cycle

The 21-22th of December, on the edge of Sagittarius (12) and Capricorn (1), the day length changes from decreasing into increasing. We refer to this change as a solar impulse from outside the year cycle of the earth that increases the day length. The term impulse is used because around the 23th of December the day length increase is scarcely visible. An outside cosmic force causes in nature this scarcely viewable event. But, during the zodiac signs Taurus (5) till Cancer (7) the day length reaches its maximum. What starts from a light increasing impulse at the 21-22th of December reaches its most clear expression from end of April till end of July (zodiac signs Taurus, Gemini and Cancer); the yearly period of the longest day length in the northern hemisphere. Although the day length at the beginning of May is comparable to that at the beginning of August, the decrease in day length for the latter period (Leo) is already obvious.

3.6.2. The Impact of the Solar Impulse on and the Spring in the Citric Acid Cycle

How is the accordance and connection of the solar impulse to the citric acid cycle? Because of photosynthesis, glucose is solar energy that, at the level of the mitochondrion, is already transformed into pyruvate. Pyruvate, TPP activated acetaldehyde and acetyl-S-lipoamide constitute the molecular solar impulse. The result of the solar impulse becomes most clearly developed and visible into the year cycle during the spring season. **The spring in the citric acid cycle** are the intermediates 4, 5 and 6; alfa-ketoglutarate (4), succinic semialdehyde TPP (5) and succinyl-S-lipoamide (6) that respectively correspond to pyruvate, TPP activated acetaldehyde (or hydroxyethyl-TPP) and acetyl-S-lipoamide at a longer chain length. The latter products match with an impulse from outside the cycle, which by the former intermediates (4 till 6) becomes visible inside the cycle. In the spring we observe a peak in plant grow. In the citric cycle, we observe the largest changes in the processing of the carbon chain during the cycle. But as we mentioned already (in 3.6.1), the zodiac sign Cancer (22/6-22/7) belongs also to the period of the longest day length. In the citric acid cycle Cancer accords to intermediate 7 (succinyl-S-CoA), which is the longer chain length derivative of intermediate 12 (acetyl-S-CoA). Intermediates (5) till (7) are three complex intermediates; they maximize the chemical structure of the corresponding intermediates like the corresponding period of the year maximizes day length. The chemical process from intermediate 4 till 7 is analogous and carries identical enzyme complexes as the production of acetyl-S-CoA from pyruvate. The forces that come from outside the citric cycle, the former process (acetyl-S-CoA from pyruvate), are for intermediate 4 till 7 (the latter process) completely inside the cycle. The solar impulse becomes visible in the citric acid cycle.

3.6.3. The Citric Acid Cycle Winter

During the first three zodiac signs we cannot see much progress in northern hemisphere nature. Just like in the citric acid cycle, there is not much energetical difference between citrate and D-isocitrate. It looks like nature makes an inner transformation that prepares for spring, just like the chemical conversion of citrate to isocitrate prepares for the next steps of the cycle. The first three zodiac signs correspond to the winter season in the year cycle.

3.6.4. Summer and Autumn in the Citric Acid Cycle

The acetyl-S-CoA (12) intermediate corresponds to the end of autumn and succinyl-S-CoA (7) corresponds to the **beginning of summer**; the day length begins to decrease. The CoA derivatives in the citric cycle mark the beginning (succinyl-S-CoA) and the end (acetyl-S-CoA) of the decrease of the day length (the summer and autumn seasons), accordingly the chain length of acetyl-S-CoA is shorter than in succinyl-S-CoA. The oxidation of L-Malate (10) nearly at the end of the cycle balances (a Libra 10 property) the oxidation of isocitrate (3) nearly at the begin of the cycle. Similarly, Libra (10) marks the beginning of the days that are shorter than the nights (**beginning of autumn**) and Pisces (3) marks the end of the shorter day lengths than the nights (end of winter).

3.7. The Biochemical Zodiac Signs of the Citric Acid Cycle

In this section, the seasons group the zodiac signs. The seasons between round brackets are southern hemisphere seasons.

3.7.1. The Winter (Summer) Zodiac Signs

The first three intermediates; **citrate (1), cis-aconitate (2) and isocitrate (3)**, have the highest energy level of all intermediates of the citric cycle. We compare them with the zodiac signs **Capricorn (1), Aquarius (2) and Pisces (3)**. These three zodiac signs also show high levels. The animal capricorn strives to reach the highest mountain tops. Aquarius, the water bearer, is a man who carries a water bag in regions where (at the time of the naming) normally only women carry water bags. A male human water bearer risks the mockery of his male companions and possibly also by the women of the community. Aquarius is a man who overcomes high psychological thresholds. Aquarius is a peak of psychological development. From the animals in the zodiac, the fish animals (Pisces) (3) have the highest reproductive forces. D-Isocitrate (3) just has incorporated water, which is of high need for fishes. Cis-aconitate (2) is in between two water processes and is therefore a perfect Aquarius candidate.

3.7.2. The Spring (Autumn) Zodiac Signs

The next two zodiac signs are **Aries (4) and Taurus (5)**, both animals like to push, especially the ram (Aries), and **alfa-ketoglutarate (4) (2-oxoglutarate)** is surrounded by

two decarboxylation processes that produce (push out) two CO_2. Both intermediates are among the most reactive in the cycle. The **succinic semialdehyde TPP (5)** complex is the only oxidation sensitive intermediate substrate of the cycle that is not directly oxidized by NAD^+ or FAD. Instead, the lipoamide disulfide oxidizes the succinic semialdehyde TPP (5) first and the reduced thiols of the lipoamide are afterward oxidized to the disulfide form by NAD^+. The complex oxidation process of intermediate 5 by the lipoamide moieties is in line with the more complex digestion of ruminants of which bovine animals (Taurus/bull) are good representatives. The next zodiac sign is **Gemini (6)**, which **corresponds to intermediate 6; succinyl-lipoamide**. Its enzyme complex has two identical lipoamide chains that successively bind the succinyl group to bring the succinyl group to the right position for further reaction with CoASH. A clearer Gemini activity is not thinkable. During the conversion of intermediate 5 into 6, the lipoamide sidechain oxidizes the succinic semialdehyde TPP (5) into the succinyl-S-lipoamide thioester (6). For more details in this process see the conversion of pyruvate into acetyl-S-CoA in the figure on p. 493 of reference [9]; the second edition of the book. In the first edition, it is Figure 14.9 on page 476. This figure shows the two lipoamide chains on E2 of the multienzyme complex. The mechanism of the alfa-keto (2-oxo)glutarate dehydrogenase enzyme is identical to that of pyruvate dehydrogenase. The Wikipedia reference and most other textbooks show the mechanism with one lipoamide chain possibly for educational reasons (easier but sufficient to explain) [10].

3.7.3. The Summer (Winter) Zodiac Signs

Succinyl-S-CoA (7) corresponds to zodiac sign Cancer (7). The lobster animals are afraid of light. Accordingly, the coenzyme A moiety, symbol of the day length maximization, is split off for the production of succinate. The lobster/crab animals regularly split off their protective shell so that they can grow. **Succinate (8)** is the only intermediate that shows energetic activity on both sides; respectively GTP and NADH. GTP is the only substrate level energy produced in the cycle. Around intermediate 8 is enough activity to resemble the lion animal **(Leo (8))**, in action. No other intermediate of the TCA cycle has energy producing reactions on both its sides. **Fumarate (9, Virgo)** is the most typical alkene addition substrate of the cycle. Water addition is a kind of chemical conception, which is the best possible chemical representation for Virgo (virgin). The second water addition reaction of the cycle is the water addition to cis-aconitate (2, Aquarius). The psychologically high standards of the water bearer (Aquarius) make him an ideal partner for a virgin. The distance between cis-aconitate (2) and fumarate (9) in the cycle [from (9) to (2) is five and from (2) to (9) is seven intermediates] accords to the five/seven ratio between human related and animal zodiac signs.

3.7.4. The Autumn (Spring) Zodiac Signs

The oxidation of **L-Malate (10)** nearly at the end of the cycle balances (a **Libra 10 property**) the oxidation of isocitrate (3) nearly at the beginning of the cycle. Both are NAD^+ conducted oxidations of a secondary alcohol to a ketone. Note that the NAD^+ oxidation of intermediate 5 into 6 has a completely different mechanism than the malate and isocitrate oxidations. The latter two oxidations are comparable and the best choice for a balance (Libra 10) comparison. **Oxaloacetate (11)** is the most oxidized intermediate of the citric cycle and has therefore the lowest energy level, just as the scorpion animals (**Scorpio (11)**), have the lowest reproductive capacity of the non-mammals from the cycle; fish and lobster/crab from respectively Pisces (3) and Cancer (7). During the day, the scorpion hides under stones. Instead of decarboxylation, oxaloacetate chooses for addition; hides its potential for decarboxylation and further on oxidation. **Acetyl-S-CoA (12)** is a degradation product of glucose, the by the sun produced molecule of cosmic solar energy in photosynthesis. Acetyl-S-CoA brings this cosmic energy in the cycle and gives the cycle its direction. The arrow of **Sagittarius (12)** corresponds to the acetyl group of acetyl-S-CoA (12) in the production of citrate (1). Sagittarius (12) gives the impulse for a next year cycle and points to its irreversible direction. Citrate synthase catalyzes the irreversible Claisen condensation reaction of oxaloacetate and acetyl-S-CoA to citrate.

4. Conclusion

The biochemically important functional groups and the citric acid cycle both significantly match the zodiac signs due to a numerical correspondence that follows characteristic zodiac sign ratios. The citric acid cycle additionally and significantly matches the zodiac signs by logically and structurally connected accordances. A seasonal matching of the citric acid cycle is pertinently demonstrated. Each cell, except for a few exceptions such as mature erythrocytes (red blood cells), harvests energy by means of the citric acid cycle. By this, nearly all cells show a connection with the zodiac thereby indicating a cosmic origin of life.

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