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The Worldwide Waldorf Curriculum – Proteins as an Example of its Adaptation to Present Teaching

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1. Summary

In the last 100 years, Waldorf pedagogy has spread (and still spreads) out around the world. There are many discussions about how to adapt the traditional Waldorf curriculum to the changed conditions of today's populations, the societies they live in, to scientific progress and the like. For some subjects, for example history, the changes required are so numerous that many colleagues suggest a complete reworking of the curriculum area. The task of renewing the chemistry curriculum is quite different compared to history. This article considers proteins as a central topic of the chemistry curriculum. Background information is given as well as suggestions for the teaching of proteins in contemporary Waldorf schools. As it turns out, Steiner's 100-year-old advice is still not only of high relevance for Waldorf pedagogy but can inspire teachers to go beyond his indications and to do their own research on them. This will deepen the understanding of healthy life processes, a valuable consideration when teaching any subject.

2. Preliminary remarks

The Waldorf curriculum consists first of all of advice given by Steiner to the teachers of the original school in Stuttgart/Germany between 1919 and 1924 for the first Waldorf students (most of whom were going to live their whole lives in the entire 20th century). But besides these concrete conditions, Steiner's statements include many inspirational ideas which offer wide perspectives on a higher meta-level. Therefore, all this advice has to be examined carefully to see in which ways it can still be useful today. We have to look carefully to see what advice is of a universal nature and what is related to local conditions at the time. In addition, we have to estimate to what extent Steiner's suggestions are mainly meant as specific learning content and to what extent they represent pedagogical advice. My purpose here is to take Steiner's suggestions on teaching proteins as an example. In the 1920s, he proposed that they be taught in chemistry in grade 8 and again in grade 12 (Rohde, 2013/2023). In addition, they can also be included when teaching anything related to nutrition, e.g., biology in grade 7.

3. The relevance of studying proteins

3.1 Is Steiner's suggestion for proteins a topic in state school curricula?

First, we need to check whether a topic from a 100-year-old curriculum still is relevant today. As it turns out, it is. Proteins have been and still are a central focus of global scientific research. In fact, they even have become more important in life sciences than they were at the beginning of the last century. Meanwhile, they are a topic in today's science curricula worldwide, in secondary school as well as in final high school exams and in a variety of fields in the universities. In this regard, Steiner's suggestion was ahead of his time. It has taken many decades to reach a clearer understanding of the relationship between inheritance through DNA and proteins – a process of investigation which has not yet come to an end. This is of outstanding importance for many fields in modern life.

3.2 Is studying proteins relevant to students' daily lives?

Again, certainly 'yes'. Proteins, carbohydrates and fats are widely known as the three main nutritional substances. Nutrition is a crucial aspect of everyone's daily life, everywhere they live and whatever their age. Nutrition touches upon many global topics such as ethics, health, agriculture, trade and transport, the cost of living – just to name a few. For students, it is interesting to learn more about this vast variety of closely related themes, thereby developing a deeper relationship to the world, to natural processes as well as to society. Moreover, it is crucial to learn how to keep one's own body healthy, and what to do if, for instance, signs of hereditary diseases occur which are related to protein metabolism.

3.3 What does Steiner suggest regarding proteins?

If proteins have to be taught in secondary schools, why is what Steiner suggested 100 years ago of interest? Especially, as we now know so much more about proteins? Steiner mentions characteristics of proteins which are rarely considered relevant in today's schools; however, these characteristics are both interesting and could be fundamentally important to students in their later life. For chemistry in grade 8, Steiner talks briefly about nutritional topics in general, in relationship to the human body and the industrial processes used to produce them. Without knowing how he speaks extensively about proteins at other occasions, these short comments do not sound surprising. However, in chemistry in grade 12, he emphasizes the difference between non-living and living chemical processes, and within the living processes the differences between plants, animals and humans; and to demonstrate this with differences in their particular proteins. He even goes into details, e.g., by naming specific enzymes like pepsin for teaching.[1] These remarks are striking.

Today, we know that plant proteins are mainly enzymes (which could be called 'protein tools', each one for a specific biochemical process). Plant bodies are first of all built up from carbohydrates, with some exceptions of storage proteins in seeds within a certain group of plants like beans, peas, lentils and their relatives. Animals, on the other hand, have bodies built up from proteins (skin, muscles, nerves, …). And animals also work within their biochemical processes with specific enzymes. Furthermore, with recent questions regarding transplantation medicine and vaccinations (which are also in part related to proteins), we can get a glimpse of what could be a chemistry which takes the pure individuality of the human being into account.

In this, Steiner's indications are not only meant to help with the selection of chemistry topics but also indicate the way they should be taught. By suggesting to the teacher (Eugen Kolisko) that the task for the 12th grade was to move from inorganic and organic chemistry towards a fourfold chemistry (inorganic/plant/animal/human), Steiner goes far beyond any task commonly given to teachers in any school today. These suggestions not only show an understanding and appreciation of scientific knowledge at the time, but indicate a new approach to chemistry overall. In school! This shows exactly why it is still important for Waldorf teachers to know the details of the first Waldorf curriculum. In the case of proteins, these indications are not outdated but, quite the contrary, contain statements which aim towards a goal far in the future.

1. See Steiner, R. (1998). ***Faculty meetings with Rudolf Steiner - Volume III,*** 1922-1924. Anthroposophic Press, meeting of 30. April 1924 (GA300c).

4. What might have been the background for Steiner's indications?

Steiner talks and writes about proteins in at least 206 different contexts in his lectures and books. As examples, the following are noteworthy from a pedagogical point of view.

As already mentioned in section 3.3, within the conferences with the teachers, through the example of proteins he relates chemistry to the fourfold human being; more precisely: inorganic chemistry relates to the physical body; plant chemistry to the etherical body; animal chemistry to the astral body; and specific humane chemistry to the inner self of the human being. Thereby, a remarkable relationship between teaching Waldorf chemistry and general Anthroposophy shows up clearly.

Not only for the chemistry curriculum, but also for general pedagogics Steiner refers to proteins. In his lecture of June 19th, 1921,[2] he explains the mistakes scientists make in setting up their hypotheses about life phenomena. They consider proteins as complicated structured compounds, whereas – according to Steiner – the opposite is true: proteins tend to become chaotic, especially in the germ cells, and thereby open up to "cosmic forces" from the surroundings of the organism. Steiner emphasises that it is necessary to understand this correlation because it enables us to comprehend how young children learn through imitation.

When teaching science in Waldorf schools, it is necessary to refer to Steiner's overall works and not only the pedagogical lectures, as references to relevant topics can be found throughout his lecture cycles. The field of medicine is closely related to science. In the book *Fundamentals of Therapy, An Extension of the Art of Healing Through Spiritual Knowledge*, written by Rudolf Steiner and Ita Wegman,[3] teachers will find remarkable lines about healthy and unhealthy processes of protein digestion, including suggestions for curing the latter (see chapter IX). Steiner gives significant answers to questions such as: Why can we eat meat from animals without taking on features of these animals? How do we build up our own body out of matter from other living beings, and yet persist in being completely human? When teaching nutrition, one should be aware of the line of argument mentioned here, how all specific living characteristics have to be stripped off from a nutriment before it can serve the upbuilding processes of another living being.

Similarly with the field of agriculture. When teaching proteins in 12th grade, it is helpful to read the third lecture of the agricultural course.[4] In this lecture, Steiner relates the four chemical elements which constitute proteins (carbon, oxygen, nitrogen and hydrogen) to the fourfold human being. He relates the fifth chemical element, sulphur, which is found in only two of the essential amino acids, to the spiritual world which steers the life processes. These remarks constitute valuable hints when choosing appropriate experiments to demonstrate in class the key characteristics of these five chemical elements as well as those of proteins.

5. How to teach proteins today

5.1 Teaching proteins in Waldorf schools in contrast to state schools

In general, there are some pedagogical approaches, characteristic of the Waldorf method, which have to be applied when teaching proteins, too, especially as chemistry is often taught in specific main lesson blocks which are characteristic of Waldorf schools. First of all, a theme is taught by carefully chosen examples which possess a wide variety of key features of this theme. Then, day by day, these features can be unfolded in class by proceeding step by step in a meaningful way, as in the growing processes of unfolding, flowering and bearing fruit. For this reason, this is called 'genetic teaching'. The teacher begins with a whole entity. From there, she goes into its different parts. And in the end, the teacher comes back to the whole entity once more - an analytical approach, followed by a synthetic approach. Along the way, the teacher emphasizes phenomenological observations before identifying rules, definitions and so on. Teaching in main lesson blocks enables three distinct steps: 1. observations at the end of a lesson -> 2. discussion of the underlying

2. Published in English as Steiner, R. (1921/1996). ***Education for adolescents*** (C. Hoffmann, Trans.) [GA302]. Anthroposophic Press. Lecture 8.
3. Steiner, R., & Wegman, I. (1925/1983). ***Fundamentals of therapy: An extension of the art of healing through spiritual knowledge*** (E. A. Frommer & J. Josephson, Trans.) [GA27]. Rudolf Steiner Press.
4. Steiner, R. (1924/1974). ***Agriculture*** (G. Adams, Trans.) [GA327]. Bio-dynamic Agricultural Association.

causalities at the beginning of the following lesson -> 3. defining terms needed to formulate (for example) natural laws. This method is known in Waldorf schools as the conclusion, judgement and concept model, allowing a night's sleep between the conclusion and judgement parts in order to 'sleep' on the observed context.

In the case of proteins in grade 8, a good example to start with is the chicken's egg. It is well known to the students (worldwide) and can combine aspects of several subjects – chemistry as well as biology, gardening/farming, trade/business, even literature and others. Like the chicken, many living beings start their life with a fertilised single egg cell. Eggs are a topic of interest from preschool onwards, and they can be examined in an increasing depth through different grades till the end of school. Therefore, class teachers need to know how far the chemistry teachers want to go in high school. And chemistry teachers need to know how the class teachers introduced the biology and chemistry of proteins in the grades 7 and 8. Only by taking each other's teaching into account, can it be ensured that the students' understanding will progress consistently.

In the final main lesson block of chemistry (usually in grade 12), one can start right away with a chicken's egg again and, at the same time, using all the knowledge which has been built up around this subject. This refers to the Waldorf method to try to gain an overview of each subject in this final class by looking back on the student's whole time at school. An appropriate first step is an experiment to find out which chemical elements build up proteins. From there, my experience is that Steiner's advice to go into enzymes is helpful. One can mimic the digestion of proteins within the human body by setting up a test tube experiment in the following order: digestion of chicken egg albumen with mouth enzymes (amylase); followed by the digestion of the 'mouth'-result with stomach enzymes (pepsin); and as a third step a continued digestion of the 'stomach'-result with small intestine-enzymes (trypsin). The different results can be distinguished by introducing chromatography. The discussion of the observations leads to the terms protein, polypeptide and amino acid.

Next steps could include experiments with enzymes like the effect of catalase on potato juice to deepen the understanding of the function of enzymes and of the differences between those and the (more or less) permanent body structures built up from proteins. Moreover, one has to introduce the meaning and use of structural formulas now. This should be done with a phenomenological approach by demonstrating characteristics of two different substances which nevertheless have the same elemental formula, like 1-butanol and diethyl ether. With structural formulas, one can go into the theory of the three-dimensional compositions of some different amino acids and illustrate the theory of a peptide bond.

Referring to the Waldorf method of synthesising ideas again at the end of a topic, the concluding experiments of this main lesson block should focus on some typical features of amino acids and on the upbuilding process of protein biosynthesis. Protein biosynthesis can be shown by the creation of a nylon thread as an analogy to what happens within living beings, since the direct study of this life process goes too far beyond of what is possible in a school lab. This also offers the chance for interesting discussions in class. Questions can come up like: What are decisive differences between natural and artificial products (e.g., degradable organic plastic versus non-degradable synthetic material)? How can we support and enhance sustainable life processes of living beings as well as on earth in general? What is needed for maintaining our own health? And maybe even that far as to the question: What is life all about?

These topics of grade 12 (but not those of lower high school) are quite different to the way proteins are taught in state high schools, at least in Germany, and possibly all over the world. Since proteins are considered to be complicated structures and teaching should start with simple contents, the typical starting point in organic chemistry is the chemistry of linear single bond alkanes. From there, step by step, further substance classes are constructed like building a house by putting brick onto brick. Alkanes, however, stem from crude oil, and this is a left-over deposit of a long-term degradation process below the surface, more or less deep in the earth, without contact to the air. One could call this a digestion process of former living beings which have died (thereby especially of proteins) by the earth itself, without oxygen (hence a sort of fermentation). Crude oil is a substance found by drilling, and alkanes are the products of a fractionized distillation of it. Therefore, to start with alkanes means beginning with the end product of a long process of decay. It means beginning with more or less dead matter instead of starting with the beginnings of life.

From the aspect of Waldorf pedagogy, it should be the other way round. Steiner encouraged teachers repeatedly to relate all topics to the living human being. Life processes are the primary ones, and dead left overs are secondary. This is not only supposed to be true for single living beings, but also for the earth as a whole. James Lovelock, for example, argued in a similar direction when he set up his Gaia hypothesis.[5] The life processes of the earth are declining now. In order to sustain life on earth (at best far into the future), humans have to take care of and strengthen its life processes. As a part of this task, students need to build up a relationship while still at school to the living realm. Waldorf teachers are well advised to start the teaching of proteins with whole living beings instead of alkanes (which, together with related substances, should be covered at the end). Living beings cannot be constructed like a house is or like plastic, instead, life has to be present from the very first moment on. Life does not emerge for unknown reasons all of a sudden from a certain mixture of dead components, having gotten into the right order by chance. Instead, life is a feature which has to be understood from its own characteristics. It is active on its own level of existence. This can lead to fruitful discussions in grade 12 when teaching proteins in the way suggested here.

5.2 How to adapt the teaching of proteins in Waldorf schools to different cultural conditions

First of all, it seems essential that each teacher in high school has to keep in mind that there will be exams required for graduating from school and/or for entering university. To pass these exams, usually specific knowledge of each subject is expected and often prescribed by state authorities. Like others, chemistry teachers have to take care that their students learn the necessary facts and competences in order to pass these exams. In the case of proteins, this should be no problem for Waldorf students. It is just a question of how deep and to what extent protein biochemistry is required. How to achieve this goal when one starts with a chicken egg? The answer to this has a decisive impact on all the teaching decisions made along the way. One has to calculate how much time is needed; which parts need to be taught in detail and in which parts short cuts can be used without losing the whole idea of the main lesson block. Maybe in addition, some ongoing lessons are needed to ensure that students remember enough of the necessary facts to be successful in exam situations. However, it is not a question that this content should be taught by applying Waldorf methods. Waldorf pedagogy mainly asks for certain methods and profound ideas, and much less for specific contents. In this way, there cannot be a general contradiction between Waldorf pedagogy and the requirements of final high school exams. One might have to make some compromises here and there, e.g., by selecting certain minor topics and neglecting others; and/or by selecting certain experiments and omitting others or substituting them with verbal input to save some time. But the general line of Waldorf teaching mentioned in the beginning of section 5.1 can always be followed, regardless of the individual situations imposed on a Waldorf school by local or national requirements.

After having set up a plan how to teach the proteins in a form which fits the graduating requirements, the next step is to adapt the suggestions of Waldorf pedagogy which were meant for specific German circumstances to the conditions of one's own local school. It can be helpful to align one's first sketch of the sequence of topics of the main lesson block with the threefold concept of willing, feeling and thinking. For the aspect of willing (of doing something), one can easily compare the food which is served in Germany (for example for breakfast) with the food one is used to at home. This is a physical reality one faces all the time everywhere. The same with emotional differences; it could be beneficial to compare the feelings one gets by listening to folk music from Germany in comparison to those evoked by the folk music typical for the home country. And for the realm of thinking, one can compare how the local currency is (or was) called in different countries. For example, in the Netherlands it was called *gulden* which refers to the material the coins were made of (gold). Britain, on the other hand, still has *pounds*, relating to the weight of the money (the same in Spain and other countries which use(d) the *peso* = weight). In Scandinavia, it was (and partly still is) named *kroner* (= crown), referring to the right of the emperors to coin money. And so on. In Germany, the currency was called *Mark* (= marrow, in the sense of bone marrow), which pointed towards the core essence of something. By researching the etymology of local currencies, one gets valuable insights into cultural differences between countries.

5. Lovelock, J. (1995). ***The ages of Gaia: A biography of our living earth.*** Commonwealth Fund Book Program.

Going further, it is both revealing and rewarding to look into local religions and philosophies in greater depth. In Europe, the New Testament of the Bible and philosophers from Plato to Kant (including some more recent ones) are held to be of high significance. It is therefore not surprising that aspects of the New Testament and European philosophy can be found in Waldorf pedagogy as well.

For example, there are many references to fourfoldness. Within the New Testament, this can be found in the equal importance of the four evangelists. Within Greek philosophy, one encounters the idea of four basic elements: earth, water, air and fire. Within Anthroposophy we meet the central concept of the fourfold human being. And within the Waldorf methods, fourfold approaches are used in many ways. In the case of proteins, it is not only the fact that there are four chemical elements which mainly build up these substances. One commonly teaches them in a fourfold way, by emphasizing physical aspects (like observations of a whole egg), gaseous aspects (discovering that three of the main four chemical elements are gases: oxygen, nitrogen and hydrogen), liquid aspects (e.g., how proteins get digested in enzyme solutions), and through performing experiments with heat to see how proteins thereby react.

How is it then in cultures where different traditional beliefs exist and have considerable influence? For instance, in cultures which value fivefoldness above fourfoldness? In this case, it would be obvious to bring all five protein chemical elements (the four main ones plus sulphur) more strongly into focus and treat them more equally than to distinguish between four abundant ones and one rare one. Also, it could be worthwhile to choose a fivefold experimental approach, oriented towards the idea of five basic elements (like in Daoism: wood, fire, earth, metal, and water; or in Buddhism: earth, water, air, fire, and emptiness/void).

Another example is the frequent practice of teaching out of polarities towards enhancement in Waldorf pedagogy. This relates partly to the trinity in Christianity and can also be discovered in Goethe's approach to gaining insight. There are many polarities which can be found in nature, like the ones between centre and periphery, day and night, male and female, assimilation and dissimilation, and so forth. In chemistry, bases and acids, for example, can be considered as polar substances. Their products of their reaction are salts and water. This implies that polarities do not extinguish each other when they meet; instead, a new entity results from their encounter which belongs to a different level. Since within life itself, offspring often derive from fertilization of polar germ cells (what causes the estimation as 'enhancement'), the Waldorf approach of 'lively' teaching can be pursued best by teaching out of polarities.

Within European cultures, however, polarities are often rather perceived as contradictions. This has a certain impact on Waldorf methods, too. So, what about cultures where polarities are not seen as contradictions but rather treated as two sides of the same coin, belonging closely together, forming balance? For instance, the concept of Yin and Yang seems to point strongly in this direction. In this case, it could be more appropriate to teach chemical substances along a gradient, with an emphasis on the middle, and going to the two extremes from there. Taking the example of salts, one might teach them more as the original sources of bases and acids instead of concentrating on salts as the results of the reactions of the latter. It should be easy to transfer this proposal to other topics and subjects as well. Since amino acids combine a base and an acid within one molecule (and thereby showing traits of a salt as well), they and the products of their reactions with each other can easily be taught either way.

This way, one can begin to adapt pedagogical suggestions made originally for German students so they become helpful advice for students in schools in different geographies and cultures. Teaching always needs to be modified to students by applying suitable facts and taking local circumstances into account. When preparing to teach about proteins, one might ask: To what extent are animal proteins used in our local culture, and to what extent plant proteins? Which animals and plants do we keep to produce proteins? How do we take care of them? How do we produce nutrients out of them? Which meals do we prepare out of them? And how do we eat them? How do we feel about our protein-producing animals, e.g., about the sounds chickens, pigs and cattle make to express themselves? How expensive are the protein products we buy for our daily use; can we easily afford them? And so on. As summary, one should ask: Why do we do all this the way we do it here at home at present?

The answers to these and many more similar questions will help to find the right tone and attitude in class which is able to touch and engage the students, not only their minds, but engage them as whole human beings, living in a particular place at a particular time. That is how Waldorf pedagogy puts students in contact with the world around them in order to prepare them to live their lives in a way that suits them best as well as being beneficial for society and nature.

6. Outlook

When we are considering revising the traditional Waldorf curriculum, we have to distinguish carefully between the different subjects and their themes. There is a wide range. On one side, some subjects or topics have been given up completely (stenography, classical language to a large extent), and, on the other, there are subjects which will show their full potential in the distant future and need to be examined further (like chemistry, physics, biology, technology). The vast majority of subjects and topics fall somewhere between these two extremes, although in every case the topic's location on this continuum has to be determined as precisely as possible. We need to ask to what extent a topic can be considered universal rather than local; more or less timeless rather than restricted to a specific social or historical period of development; and if it is of interest because of the content and/or of interest because of the pedagogical approach.[6]

This article has tried to identify criteria to demonstrate how to evaluate a topic within the Waldorf curriculum and adapt it so it is relevant and appropriate to teach within the worldwide Waldorf community, using the topic of proteins as an example. We should not lightly ignore Steiner's advice, on the contrary, it makes much sense to do intensive research on Steiner's indications in order to understand them more deeply before judging them from today's perspective.

It is important that a wider discussion of these criteria and suggestions for teaching takes place. This could help challenge current practices and lead to a more sensitive and appropriate adaptation of the Waldorf curriculum worldwide. All over the world, Waldorf teachers have to put immense work and effort into this task. This work must continue if we want to continue working with students in a way which can be called 'present' in the full sense of the word.

6. For further discussion, see Boland, N., & Rohde, D. (2022). The development of Steiner / Waldorf education: Looking through the lens of time. Research on Steiner Education, 13(1), 24-31. http://rosejourn.com/index.php/rose/article/view/665/607

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