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PRE- SERVICE TEACHERS' ALTERNATIVE CONCEPTIONS CONCERNING THE tRNA CONCEPT

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Abstract
Biology, a branch of science studying living things in all aspects, has a large scope. Besides covering a large content, it also includes abstract concepts in some matters. Especially in the issues of abstract and microscopic biology, various alternative terms are determined at different levels of education. This study aims at determining pre-service teachers' alternative conceptions regarding the tRNA concepts on protein synthesis. 12 first year university students participated in the research. Semi-structured interviews were conducted so as to determine the pre-service teachers' alternative conceptions for the tRNA concept. On analyzing the data obtained through the interviews, it was found that the pre-service teachers had differing alternative conceptions for the concept of tRNA. Those conceptions were tabulated in categories.

Keywords: Alternative concepts, tRNA, Pre-Service Teachers.

INTRODUCTION

Considerable difficulties are encountered by students, teachers and individuals of differing age groups and statuses in learning and comprehending the topics of biology- which include a great number of abstract concepts- meaningfully. Researchers also found that several difficulties were available in teaching and learning the topics of biology, mainly those which were abstract (Wood-Robinson, Lewis & Leach, 2000; Bahar, Johnstone, & Hansell, 1999; Yip, 1998; Turney, 1995; Songer & Mintzes, 1994; Kindfield, 1994; Lazarowitz & Penso, 1992; Westbrook & Marek, 1991). It is pointed out that particularly the abstract issues such as cell division (Lewis, & Wood-Robinson, 2000; Smith, 1991), photosynthesis (Lonergan, 2000; Hazel & Prosser, 1994) and protein synthesis (Fisher, 1985; Johnstone & Mahmoud, 1980) are insufficiently and badly learnt by students of every age and every level. Ambiguity stemming from difficulties in learning the concepts is likely to lead students to form alternative conceptions in their mind (Öztaş, Özay, & Öztaş, 2003).

Several studies regarding biology education show that students of every level of education as well as teacher candidates, and even teachers have alternative conceptions for the terms forming the basis of biology knowledge (Soyibo, 1993). Furthermore, a group of research on students' understanding the concepts of science demonstrates that students hold many alternative conceptions different from the scientific knowledge even after formal education (Wandersee, Mintzes & Novak, 1994; Sanders, 1993).

In addition to that, some research on teacher candidates suggests that pre-service teachers do not possess sufficient knowledge to teach the topics of biology meaningfully and sufficiently, that they hold alternative conceptions for many issues of biology, and that they transfer those alternative conceptions into their students in their teaching career (Soyibo, 1993).

Students' thoughts that they hold as part of their prior knowledge, which are incorrect, have a negative effect on their understanding and mastering more advanced concepts in the forthcoming levels of education (Tsai, 1999). Therefore, Pashley (1994) holds the view that the primary and most

important duty in replacing students' alternative concepts with scientific facts and in raising the number of students achieving this replacement is to determine students' alternative conceptions.

This research aims to determine pre-service teachers' alternative conceptions for tRNA, a basic concept in learning the issue of protein synthesis and its role in protein synthesis.

METHODS AND DATA ANALYSIS

12 pre-service teachers attending the first year courses at university were selected for interviews, and they were given semi-structured interviews.

The data were obtained through interviews containing open-ended questions as well as True-False questions. In the analysis of the data, firstly the voice recordings of interviews were decoded and transcribed. Then, they were encoded through computer programmes by considering the pre-service teachers' responses to the interview questions and their alternative conceptions. All the codes constructed were revised and re-arranged, and thus final codes were formed. The alternative conceptions regarding tRNA possessed by the pre-service teachers were categorized on the basis of similarities, and the categories as well as the related codes were tabulated.

FINDINGS

When the data obtained from the study were analyzed, it was determined that the pre-service teachers had many alternative concepts related to the tRNA concept. The alternative concepts identified from pre-service teachers are presented in four themes. These themes and associated codes are presented in Tables below.

1. The function of tRNA. (What does tRNA carry?)

The most common alternative concepts about tRNA, relate to what the tRNA carries. Based on the name of tRNA, pre-service teachers predict that tRNA carries something, but they develop various alternative concepts about what they carry. Alternative concepts related to this theme are presented in Table 1.

Table 1: Alternative conceptions of pre- service teachers about the function of tRNA. (What does tRNA carry?)

Topics	Alternative Conceptions	
The function of tRNA (What does tRNA carry?)	**1.1.**	tRNA takes a strand of DNA to ribosome, and DNA complements itself with the help of remaining strand.
	1.2.	tRNA, carries mRNA into ribosome.
	1.3.	Since tRNA is a carrier, it carries the received code into ribosome.
	1.4.	tRNA carries nucleic acids into ribosome.
	1.5.	tRNA carries nucleotides into ribosome.
	1.6.	tRNA carries amino acids consisting of 3 nucleotides into ribosome.
	1.7.	tRNA brings amino acids to ribosome, and takes away the proteins formed through reshaping of amino acids in the ribosome.

One of the alternative concepts identified in the pre-service teachers for the function of tRNA is "tRNA takes a strand of DNA to ribosome, and DNA complements itself with the help of remaining strand." Pre-service teacher statements concerning this alternative conception are as follows:
R: What is the role of tRNA?
S: The tRNA carrier is here. He takes one of these strands (one of DNA strand) and takes ribosome. One of the strands was taken from ribosome.
R: The other DNA strand was remained alone. What's happening to that?
S: The remaining strand here completes itself.

R: The strand went to the ribosome. What is going on there?
S: The strand went to the ribosome, where the appropriate bases come in the way that uracil instead of the thymine.

Examining the answers obtained by the pre-service teachers, they are aware of the fact that protein syntheses occur through carrying the code in DNA to the ribosome. However, it is also observed that the pre-service teachers had such alternative conceptions as tRNA's carrying this code and one of DNA's strand's being carried to the ribosome as a code.

Another alternative conception the pre-service teachers had regarding the duty of tRNA was that "tRNA carries mRNA to the ribosome". For example, a pre-service teacher's views, which are similar to the abovementioned conceptions, are as follows.
R: What do you say about tRNA?
S: tRNA carries it to the ribosome.
R: What does tRNA carry?
S: It carries mRNA. It carries mRNA to the ribosome. Then it is paired with the convenient amino acids in the ribosome.
R: Are the convenient amino acids paired with mRNA?
S: Yes.

Differently from the previous alternative conception, in this context the pre-service teachers believe that mRNA is carried to the ribosome by tRNA and mRNA is paired with the convenient amino acids in the ribosome.

Another alternative conception the pre-service teachers had regarding the duty of tRNA is that "tRNA carries amino acids to the ribosome and it takes away the proteins, which emerge after the amino acids change shape in the ribosome". The expression of the pre-service teacher, who reflected this alternative conception, is as follows:
S: mRNA gives the code to the ribosome. There is an amino acid for the code in the ribosome in that environment. Amino acid is carried there via tRNA.
R: Does tRNA bring amino acids?
S: Yes, it brings the amino acids and takes away the proteins.
R: So it brings the amino acids, then what happens to the amino acids?
S: This code gives them a shape. It depends on the code.
R: Does the code change the amino acids?
S: For instance you enter everything about the iron program into the computer. The iron takes its shape according to that code. Something likes that.
R: So it turns raw amino acids into protein?
S: Yes.
R: Does tRNA also carry the proteins?
S: Yes, that is how protein is synthesized.

In the expression above, the pre-service teacher accurately described the duty of tRNA as carrying amino acids to the ribosome. However, the pre-service teacher believes that the amino acids change shape in the ribosome according to the code in mRNA and then are converted to protein and that these proteins are again carried by tRNA. The pre-service teacher has an alternative conception that tRNA brings raw amino acids to the ribosome and takes away the proteins.

Another alternative conception about the duty of tRNA is that "tRNA carries nucleic acids to the ribosome".

S: mRNA penetrates the organelle of the ribosome. There are mRNA, carrier, and then another RNA after the carrier. It penetrated the ribosome. rRNA penetrated the ribosome. Copying takes place there.

R: What is copied?
S: mRNA is copied. It transfers the information to the rRNA. When it penetrates the ribosome, nucleic acids are supposed to come along. So that everything there can be synthesized. tRNA carries those things. The ribosome starts synthesizing proteins after tRNA brings them.
R: What does tRNA bring?
S: It brings nucleic acids.

The pre-service teacher believes that mRNA is copied after penetrating the ribosome and transfers its information to rRNA. Moreover, the pre-service teacher asserts that nucleic acids are required in order to copy mRNA and nucleic acids are brought to the ribosome by tRNA. Another assumption of the pre-service teacher is that the duty of tRNA in protein synthesis is bringing nucleic acids to the ribosome.
Furthermore, some other alternative conceptions regarding the duty of tRNA were detected in the pre-service teachers, such as "tRNA carries nucleotides to the ribosome" and "as a result of being the carrier, tRNA carries the code to the ribosome".

Examining the expressions of the pre-service teachers within that framework, it can be uttered that they all assume tRNA carries something; however, they have developed various alternative conceptions about what tRNA exactly carries.

2. The role of tRNA in protein synthesis

Another alternative conception regarding tRNA, which were observed among the pre-service teachers, is related to "the Role of tRNA in Protein Synthesis". Table 2 presents the alternative conceptions related to this role, which were observed in this study.

Table 2: Alternative conceptions of pre- service teachers about the role of tRNA in protein synthesis

Topics	Alternative Conceptions	
The role of tRNA in protein synthesis	**2.1.**	tRNA combines with amino acids and is included in the protein structure in protein synthesis.
	2.2.	tRNA carrying the codes into ribosome combines with amino acids and protein is synthesized.
	2.3.	Triple nucleotides such as AUG on tRNA pass through ribosome and become amino acids.
	2.4.	tRNA arranges the triple codones that it carries into ribosome, and thus protein is synthesized.
	2.5	The 3 nucleotides brought by tRNA are an amino acid, and they are arranged opposite mRNA, and thus protein is synthesized.

The pre-service teachers, who somewhat associated tRNA with amino acids, yet still had alternative conceptions about this relationship, have reflected their false opinions by saying "in protein synthesis, tRNA is combined with amino acids and becomes a part of protein structure". The expression of the pre-service teacher, who reflected this alternative opinion, is as follows:
A. What type of a relationship exists between mRNA and tRNA?
S: mRNA is only a code for tRNA.
R: What type of a code is that?
S: It is for establishing a relationship between amino acids and peptides. In other words, a merged signal with amino acids.
R: Do tRNAs combine with amino acids?
S: Yes. They overlap them. Then amino acids emerge. Did they remain there after overlapping tRNAs? Well, I know they overlap tRNAs. Then, it moves away. Then this tRNA remains there, mRNA goes this way or tRNA goes out. Meaning, amino acid emerges over this. Afterwards, these amino acids are combined.

R: What happens to tRNAs?
S: tRNAs remains in the protein structure along with amino acids.

Even though the pre-service teacher knows that the duty of tRNA in protein synthesis is to bring amino acids, he/she still thinks that as a result of protein synthesis, tRNA and amino acids merge and become a part of the protein structure. In other words, the pre-service teachers believe that proteins are created by tRNAs, which are combined with amino acids.

Another alternative conception is that "three nucleotides brought by tRNA equal to an amino acid and protein are synthesized by lining these nucleotides across mRNA". The views of the pre-service teacher, who had the abovementioned conception, are as follows.
S: The ribosome reads mRNA. Then, the anticodons brought by tRNA read it once again. These are triple codes, which symbolize a protein. For instance, the "AUC" in mRNA is the code of a protein. 'When the ''TAG" in tRNA corresponds to it, a new protein is created, I don't remember the name of the protein. It must be melanin. You know, there are types of amino acids, I am talking about them. That's how they come together.
R: Is "TAG" trilogy an amino acid?
S: It is an amino acid. Yes.
R: What is the duty of tRNA here?
S: What was it called? It carries nucleotides.
R: To where does it carry nucleotides?
S: It carries them across mRNA.
R: So, does that mean when it brings three nucleotides, it also brings one amino acid?
S: Yes that is what it means.

The pre-service teacher believes that the structures, which consist of 3 nucleotides, are an amino acid. The expression of the pre-service teacher suggests that he believes protein is synthesized when tRNAs carry these structures and line them across mRNA.

3. Where is tRNA synthesized from?

Another alternative conception regarding tRNA, which were observed among the pre-service teachers, is related to "the structure which synthesizes tRNAs". Table 3 demonstrates the alternative conceptions related to this theme.

Table 3: Alternative conceptions of pre- service teachers about where is tRNA synthesized from?

Topics	Alternative Conceptions	
Where is tRNA synthesized from?	**3.1.**	tRNA is manufacture from the whole of a strand of DNA.
	3.2.	tRNAs are synthesized from mRNA.

One of the alternative conceptions observed in this theme assumes that "tRNA is synthesized through mRNA".

…"mRNAs come as triple codons. This slips inside the ribosome until it comes across the stopper codon. mRNA slips. tRNAs are synthesized through mRNAs. Afterwards, a peptide bond is created between tRNAs.
From this expression of the pre-service teacher, it can be inferred that he/she thinks tRNA is synthesized by mRNA.

Another alternative conception is demonstrated as follows:
S: tRNA obtains the codes from DNA.
R: How does tRNA obtain the code from DNA?

S: tRNA takes one of the DNA strands and modifies it according to itself. There is urasil instead of thymine.. For instance; A C T.
R: Why do you draw them as triplets?
S: As triple codes.
R: Is tRNA only produced from this triple code?
S: No, it is produced from all of it.

This expression suggests that the pre-service teacher thinks tRNA is produced from the whole of a DNA one strands.

4. The structure and location of tRNA

Another alternative conception regarding tRNA, which were observed among the pre-service teachers, is about the Structure and Position of tRNA. Table 4 presents the alternative conceptions related to this theme.

Table 4: Alternative conceptions of Pre- service teachers about the structure and location of tRNA

Topics	Alternative Conceptions	
The structure and location of tRNA	**4.1.**	tRNA consists of 3 nucleotides.
	4.2.	tRNAs are connected to each other with peptide ties.
	4.3.	tRNA is in the ribosome.

One of the alternative conceptions about this theme supposes that "tRNAs are interconnected via peptide bonds".
…"mRNAs come as triple codons. This slips inside the ribosome until it comes across the stopper codon. mRNA slips. tRNAs are synthesized through mRNAs. Afterwards, a peptide bond is created between tRNAs.
Considering the expression of the pre-service teacher, it can be inferred that he/she assumes tRNAs are interconnected via peptide bonds.

CONCLUSIONS AND DISCUSSION

In consequence of this research, which was conducted so as to determine the alternative conceptions for tRNA and its role in protein synthesis, teacher candidates were found to have several alternative conceptions. The relevant categories and codes are shown in Tables 1,2,3,4.

Although the pre-service teachers knew tRNA as the carrier RNA, they could not comprehend its function in relation to protein synthesis accurately, and put forward various alternative views. Accordingly, they perceived tRNA as a strand of DNA in protein synthesis, or as a structure responsible for carrying such things as the code received from DNA and nucleotides. Moreover, some of the candidate teachers held the view that protein was synthesized in consequence of tRNA's emergence with amino acids, and thus it was included in protein structure. Apart from that, some thought that tRNA brought about protein synthesis by arranging the nucleotides brought by tRNA opposite mRNA or rRNA. Another misunderstanding commonly seen among the pre-service teachers was about where tRNA was synthesized from. Mostly it was thought to be synthesized from the whole of a DNA strand whereas some thought it to be synthesized from mRNA. As to the structure of tRNA and its location, it was found that some believed that tRNA was composed of 3 nucleotides and that they were connected through peptides ties, and that they were located in ribosome.

One of the most significant reasons for the formation of alternative concepts concerning the topic was that the pre-service teachers could not grasp the concepts of DNA and gene accurately. A couple of studies carried out in the past made it clear that pre-service teachers had limited understanding in relation to the structure, functions and location of genes (Lewis, Leach & Wood-Robinson, 2000). Another reason was that DNA was drawn as two lines and both mRNA and tRNA were represented in

accordance with the nucleotides in a DNA strand, due to its practicalness in teaching. The tRNA or mRNA produced in the drawing is usually the same length as a strand of DNA; a case which may result in pre-service teachers' believing that tRNA is synthesized from the whole of a strand of DNA.

Still another reason for misconception regarding tRNA was overemphasis laid on base matches in the issue of protein synthesis. Due to test questions (as in university entrance exam, ÖSS) about the base arrangement in mRNA and in tRNA according to the base arrangement in DNA, pre-service teachers think about the order bases are arranged opposite a strand. In consequence, they think that tRNA is composed of mRNAs, or that they comprise proteins by forming a series opposite mRNA, which is wrong. Besides, since tRNA is a carrier, they wrongly think that single or triple nucleotides are carried by tRNA opposite a single mRNA strand. In brief, pre-service teachers consider it necessary to put a second strand opposite a strand owing to the fact that base matches are overemphasized in teaching. In other words, this overemphasis may lead to the belief that protein synthesis occurs only through such base matches, which in turn may result in pre-service teachers' forming alternative conceptions for tRNA as in other matters of protein synthesis. Moreover, the main actions and structures in protein synthesis are overlooked due to pre-service teachers' over engagement with the details of base matches.

Alternative conceptions in relation to tRNA as in other subjects of biology were detected among pre-service teachers. Unless these misconceptions are corrected, they will probably transfer those misleading thoughts to their pre-service teachers in their future teaching career (Soyibo, 1993). Hence, the alternative misconceptions held by pre-service teachers must be determined and removed immediately.

The different alternative concepts determined about the tRNA concept prevent student and teacher candidates from correctly perceiving protein synthesis. Therefore, alternative conceptions on tRNA as well as on other issues of biology should be determined and rapidly corrected.

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