CERLIS Series

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CERLIS Series
Volume 5

Maurizio Gotti, Stefania M. Maci, Michele Sala (eds)

The Language of Medicine: Science, Practice and Academia

CELSB
Bergamo

CERLIS SERIES Vol. 5

CERLIS
Centro di Ricerca sui Linguaggi Specialistici
Research Centre on Languages for Specific Purposes
University of Bergamo
www.unibg.it/cerlis

THE LANGUAGE OF MEDICINE:
SCIENCE, PRACTICE AND ACADEMIA
Maurizio Gotti, Stefania Maci, Michele Sala (eds)
ISBN 978-88-89804-28-5
URL: http://hdl.handle.net/10446/35418

Published in Italy by CELSB Libreria Universitaria
Via Pignolo, 113 - 24121, Bergamo, Italy

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Focus on medical communication

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Formation Patterns of Denominative Variants in Biomedicine

1. Introduction

Concepts may be designated by several lexical units. According to Hatim and Mason's model of language variation (1990: 46), two dimensions may be distinguished: language user and language use. Language user refers to the aspects related to the user that participates in a language event such as geographical, temporal, idiolectal, social aspects, etc. Language use refers to the functional use of language or register, which is notably concerned with lexis. According to Biber et al. (1998: 135) *register* is "the cover term for varieties defined by their situational characteristics".

This study focuses on the description of variation as a result of language use. Our starting point is the general agreement on the part of several linguists (Firth 1935: 67; Gregory/Caroll 1978: 64; Halliday 1978:77; Biber/Finegan 1994: 33) regarding the importance of the co-relational nature of the situational characteristics (field, tenor and mode) and the linguistic expressions, so that recurrent situational characteristics may determine the selection of linguistic expressions and the latter may correspondingly shape the situation. This use-related framework for the description of language variation aims to uncover the general principles that lead to variation in situation types, so that it is possible to identify "what situational factors determine what linguistic features" (Halliday 1978: 32).

In the 1980's and, above all, in the 1990's, many scholars supporting descriptive theories of terminology adapted these ideas to specialized languages as opposed to the ideas of the prescriptive school of terminology, which were based on a fixed concept-designation relation:

> The recognition that terms occur in various linguistic contexts and that they have variants which are frequently context-conditioned shatters the idealized view that there can or should be only one designation for a concept and vice versa […] one concept can have as many linguistic representations as there are distinct communicative situations which require different forms. (Sager 1990: 58)

Guespin (1990) and Gaudin (1990) paid special attention to the link between sociolinguistics and terminology, whose combination resulted in Socioterminology. This theory takes into account the social dimension of terms and their variation in context. This school of thought supports synonymy within the description of terms as a result of the different levels of knowledge. According to Gaudin (1990: 631) popularization provokes a blurred frontier between general and specialized language.

Popularization has been defined in detail later on by Calsamiglia and Van Dijk (2004: 370) as "a vast class of various types of communicative events or genres that involve the transformation of specialized knowledge into 'everyday' or 'lay' knowledge […]". According to these authors, the lay versions of specialized knowledge can be achieved through different strategies, such as explanations, definitions or denominative variants.

The present work is based on the study of denominative variants (Faulstich 1998/1999, 2002; Freixa 2003; Suárez 2004; Daille 2005; Bowker/Hawkins 2006) in the biomedical field in two different communicative settings: expert to expert, and expert/semi-expert to non-expert. The first aim, then, is to identify denominative variants in each register, the former representing scientific communication between experts in the field and the latter representing popular science communication written by experts or scientific journalists and addressed to educated people or patients. According to Sager (1997: 25), the formation and selection of alternative denominations for each concept is a conscious activity because the main purpose of terms is to facilitate specialized communication and knowledge transfer; therefore we expect different denominations in each register as their use should depend on the degree of knowledge of the users in the communicative setting. The second aim of this study is to identify semantico-syntactic patterns for each register in order to help experts and semi-experts of a specialized field decide what term is more appropriate in each situation. Although it has been appreciated that linguistic variance or synonymy has been included in some recent medical dictionaries (e.g. Taber 2013, cf. Figure 1), there is no guidance on where and why one should use these variants (Bowker/ Hawkins 2006: 80).

Taber's Medical Dictionary

leukocyte
(loo′kŏ-sīt″)

[*leuko-* + *-cyte*]
Any of several kinds of colorless or nearly colorless cells of the immune system that circulate in the blood and lymph. Leukocytes comprise granulocytes and agranulocytes.
SYN: ***white blood cell; white cell; white blood corpuscle; white corpuscle***
SEE: *blood for illus*

Figure 1. Screenshot extracted from the online Taber's Medical Dictionary.

From our point of view, pragmatic information on variants is essential to enhance writers and translators' sociolinguistic competence. Bowker (2010: 157) supports this idea by emphasizing that terms can only be employed within the specialized discourse they are embedded in and, thus, cannot be examined out of it.

2. Methodology

For the detection and the analysis of variants, we will count on a 1,010,999 tokens English monolingual corpus made up of two subcorpora of similar size. Different genres have been used to represent different registers in each subcorpus: subcorpus 1 (S1) is made up of research articles whose writers and recipients have the greatest level of knowledge of the field; subcorpus 2 (S2) is composed of popular science articles, whose recipients' level of knowledge is usually low (e.g. educated people, patients, etc.).

English monolingual corpus		
Subcorpora	**Subcorpus 1**	**Subcorpus 2**
Communicative situation types	Expert to expert communication	Expert/semi-expert to non-expert communication
Genres	100 Research articles	481 popular science articles
Sources	Journals: *Nature, Cell, Cancer Cell, Developmental Cell, The New England Journal of Medicine, International Journal of Cardiology, Circulation, Circulation Research, Journal of American College of Cardiology, Neurology*	Popular science magazines: *New Scientist, Scientific American, Popular Science, Discover, American Scientist, Science News, The Scientist, Science Now, Nature News, Science Daily, Access Science, Neurology Now, Learn genetics.* Science section of newspapers: *The Saturday Evening Post, American Spectator, Time, Newsweek, USA Today magazine, The Globe and the Mail, New York Times, Chicago Tribune, CNN, ABC news, Harvard Magazine.* National institutions: *National Institutes of Health, American Heart Association, National Academies, National Cancer Institute*
Size	505.010 tokens	505.989 tokens

Table 1. Corpus design criteria.

In order to search for variants in different registers it is necessary to select the most standardized terms. For this purpose, a first selection of candidates has gone through three filters: grammatical category, frequency and lexicon. Candidate terms have been selected according to nominal category, frequency (20 occurrences), distribution (5 texts) and topic relevance (stem cell types) in subcorpus 1, where expert to expert communication takes place. We have focused on nouns because it is the most frequent grammatical category in specialized languages:

> Nominal groups are the most appropriate vehicles of condensed linguistic expression for scientists and technologists who are trained to perceive and consequently to speak about the physical world in terms of concepts, processes and quantifiable units. (Sager et al. 1980: 219)

The minimum frequency and distribution were set according to the results found in the corpus. We noticed that 15% of the words in the corpus exceeded the frequency limit and that, below it, other non-relevant words started to appear more and more frequently. Besides, we considered it important that candidate terms were used in several texts written by different authors.

The reason for focusing on the semantic set of stem cell types is due to the advances in the field and the need for disseminating new discoveries to all type of recipients. We have noticed that many classificatory denominations in the field are reduced, extended or substituted for meeting the different writers' intentions, which are linked to the recipient's degree of knowledge.

Using these criteria, the wordlist function from the lexical analysis software WordSmith Tools 6.0 (WST 6.0, Scott 2008) has been used to select candidate terms. It can be pointed out that in the very beginning, stem cell types were searched by checking *cell* or *stem cell* in concordances provided by means of the WST 6.0 function Concord, but then we realized that this search was not enough as many cells have monolexematic denomination as Greek and Latin roots have been used in their formation (e.g. *cardiomyocyte, hepatocyte* etc.).

Secondly, the resulting candidate terms from S1 were checked against specialized glossaries. Terms were identified by their inclusion in at least one specialized glossary published by specialized associations, universities or well-known journals; for example, we can cite the glossaries elaborated by the International Society for Stem Cell Research (ISSSCR), Harvard Stem Cell Institute (HSCI), National Institute of Health (NIH), George Town University (GTU), and Nature (N). These terms are considered by the medical community the most standardized units for concepts referring to cell types. These terms are the bases for identifying variants, which may be more or less terminologized upon use in each register.

Thirdly, variants have been identified in concordances through reformulative discourse markers placed around terms. The resulting variants from the reformulation of terms have been called *explicit variants* in previous studies (Freixa 2001, 2003; Suárez 2004). Reformulation allows setting semantic equivalence, in different degrees, between terms and variants (Cruse 1986; Bach et al. 2003; De Santiago 2013).

In order to find explicit variants, concordance lines of terms have been observed through the Concord function of WST 6.0.

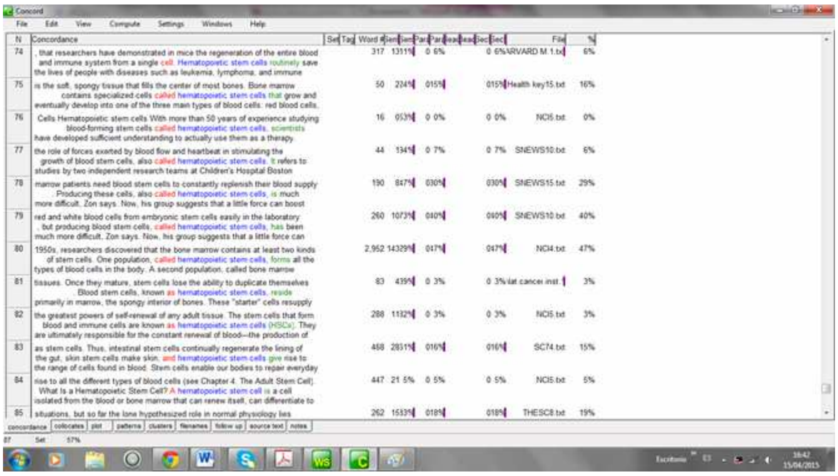

Figure 2. Screenshot of Concord function (WST 6.0): concordance lines.

Some examples might be helpful for understanding the method to identify explicit variants. Concordance lines using *hematopoietic stem cell** as the *key word* in context has provided interesting results:

(1) Blood stem cells, known as hematopoietic stem cells, reside primarily in marrow, spongy interior of bones. (National Cancer Institute)

(2) The stem cells that form blood and immune cells are known as hematopoietic stem cells (**HSCs**). (National Institute of Health)

(3) With more than 50 years of experience studying **blood-forming stem cells** called hematopoietic stem cells, scientists have developed sufficient understanding to actually use them as a therapy. (National Institute of Health)

According to the examples of use of *hematopoietic stem cell*, it is possible to observe three variants (e.g. *blood stem cell, HSC, blood forming stem cell)* linked to the term through different reformulative discourse markers of metalinguistic (e.g. *known as, called*) and typographic (e.g. parenthesis) type.

Finally, from the observation of variants, semantico-syntactic patterns and their reasons for using them will be defined. This final aim is probably the most important in terms of application; however, from our point of view, this cannot be achieved without the previously cited steps. According to Bowker and Hawkins (2006: 87) many available resources on medical terminology do include variants; although relevant, this information can sometimes be misleading for users because they should be provided with the different circumstances in which those variants should or could be used and why. The choice of variants is not arbitrary; it results from situational characteristics to fulfill a specific purpose. Temmerman (2000: 151) also highlights the problematic use of synonyms as they are not always interchangeable in all contexts. The selection of the appropriate lexis in each context is essential as it is one of the conventions that facilitate the construction of textual models: textual genres.

3. Results

35 candidate terms with a frequency between 2,185 occurrences (e.g. *stem cell*) and 20 occurrences (e.g. *epithelial cell*) were selected from S1:

CANDIDATE TERMS	FREQUENCY
1 stem cell	2,185
2 cardiomyocyte	697
3 T cell	339
4 hematopoietic stem cell	231
6 satellite cell	222
….	…
33 neutrophil	31
34 inner cell mass	22
35 cardiac stem cell	22
37 epithelial cell	20

Table 2. Candidate terms in S1.

Then, terms were obtained by checking the presence of candidate terms in at least one renowned specialized glossary. The following table includes the 21 actual terms:

TERMS (S1)	ISSCR	HSCI	NIH	GTU	N
1. stem cell		√	√	√	√
2. cardiomyocyte	√			√	
3. T cell				√	
4. hematopoietic stem cell	√	√		√	
5. mesenchymal stem cell	√		√	√	
6. fibroblast	√			√	
7. endothelial cell				√	
8. embryonic stem cell	√	√	√	√	√
9. cancer stem cell		√			√
10. iPS cell		√			
11. neuron	√				
12. germ cell			√	√	
13. somatic cell	√	√	√		
14. osteoblast	√				
15. hepatocyte	√			√	
16. astrocyte			√	√	
17. neural stem cell	√		√		
18. lymphocyte				√	
19. natural killer cell				√	
20. adipocyte	√				
21. inner cell mass		√	√	√	

Table 3. Checking terms selected from S1 across specialized glossaries.

With the help of different subcorpora, it has been possible to find variants for terms in different registers. Using each term as the search pattern has made it possible to retrieve all occurrences and its immediate context. Each context provided by concordance lines has been the source for identifying explicit variants, that is variants linked to terms by means of reformulative discourse markers (cf. Table 4). As opposed to Daille (2005: 183) who considers that term variants are noun phrases composed of a head noun and a nominal or adjectival modifier, in this study all nominal syntagmatic units, including acronyms, have been taken into account.

TERMS	**EXPLICIT VARIANTS (S1)**	**EXPLICIT VARIANTS (S2)**
1. stem cell		mother cell, body's master cells, nature's master cell, unspecialized cell, therapeutic cell, veritable fountain of youth, dividing cell, primitive cell
2. cardiomyocyte		heart muscle cell, heart cell, heart repairing cell
3. T cell		thymus-derived lymphocytes
4. hematopoietic stem cell	HSC	blood stem cell, blood cell, HSC, blood-forming cell; basic building blocks of blood, blood-forming stem cells in bone marrow, blood-making cell, blood-producing stem cell
5. mesenchymal stem cell	MSC, bone-marrow stromal stem cell, bone marrow stromal cell, skeletal stem cell, bone marrow-derived stromal cell	MSC, bone marrow cell, precursor of bone, muscle and many other tissue types, bone marrow stromal cell
6. fibroblast		skin cell, loose arrangement of cells, connective tissue cell
7. endothelial cell	EC	blood vessel cell
8. embryonic stem cell	ESC, ES cell	ES cell, ESC, building blocks of life, undifferentiated precursor for other cell types
9.iPS cell		induced pluripotent stem cell
10. neuron		nerve cell
11. germ cell	pole cell	reproductive cell

12. somatic cell		adult cell, adult stem cell, non-reproductive cell, adult tissue cell
13. osteoblast		bone-forming cell, bone stem cell
14. hepatocyte		liver cell
15. neural stem cell	NSC	
16. lymphocyte		white blood cell
17. natural killer cell	NK cell	
18. adipocyte		fat cell, fat stem cell, adipose derived stem cell, adipose fat stem cell, adipose fat cell, adipose derived regenerative cell, fat-derived stem cell
19. inner cell mass	ICM	ICM, cluster of cells on the interior (of the blastocyst)

Table 4. Explicit variants in S1 and in S2.

19 terms out of 21 have explicit variants in S1 and/or in S2. A different number and type of explicit variants have been found in S1 and in S2. While 8 terms (40%) in S1 have explicit variants, 17 terms (85%) in S2 have them. Furthermore, as can be observed in Table 5, each term has a different number of variants: terms in S1 have from 1 to 5 variants while terms in S2 have from 1 to 8 variants. These data evidence that a greater number of terms in S2 have explicit variants and that a greater number of variants in S2 are assigned to a term.

	CASES IN S1	% IN S1	CASES IN S2	% IN S2
1 variant	6 cases	30%	7 cases	35%
2 variants	1 case	5%	2 cases	10%
3 variants	0	0	2 cases	10%
4 variants	0	0	3 cases	15%
5 variants	1 case	5%	0	
6 variants	0	0	0	0
7 variants	0	0	2 cases	10%
8 variants	0	0	1 case	5%

Table 5. Number of explicit variants in S1 and in S2.

The total amount of variants in S2 is 52 while in S1 it is only 13. Their analyses have offered interesting results. Syntactically, the majority of variants in S2 have been formed by composition (90%) and only a few by truncation[1] (10%). For example, the term *embryonic stem cell* has produced both syntactic variant types: *building blocks of life* and *ESC*. On the contrary, the majority of variants in S1 are truncated (70%) and the rest are compounds (30%). It should be highlighted that all the compound variants – *bone-marrow stromal stem cell, bone marrow stromal cell, skeletal stem cell, bone marrow-derived stromal cell* – in S1 are assigned to the same term *mesenchymal stem cell*.

The truncated forms in both subcorpora correspond to fully reduced forms (e.g. *embryonic stem cell* > *ESC*) and partially reduced forms of key terms (e.g. *embryonic stem cell* > *ES cell*). The main difference between the truncated forms in S1 and in S2 is that most truncated forms in S2 belong to most known types of cells as they are hyperonyms of many other specific types (e.g. *hematopoietic stem cell* > *HSC*; *mesenchymal stem cell* > *MSC*) and truncated forms in S1 also correspond to specific types of cells (e.g. *natural killer cell* > *NK cell*).

Semantically, truncated forms do not imply change in meaning as they are simply reducing the corresponding complete form; however. many compounds do change or add meaning as new words are being used to refer to the same notion. All the compounds from the resulting data have been further subclassified according to the process terms have gone through to result in alternative denominations. The greatest number of compounds has been found in S2 (47), and therefore they have been described in the first place:

- 18 variants out of 52 (34%) reproduce compounds built from Greek or Latin roots in the English language (e.g. *cardiomyocyte* > *heart muscle cell*). They do not lead to semantic differences but they are a sign of a change in register. These English counterparts appear sometimes in reduced forms (e.g. *cardiomyocyte* > *heart muscle cell* > *heart cell*).
- 23 variants (44%) are paraphrases (e.g. *inner cell mass* > cluster of cell on the interior of the blastocyst; *cardiomyocyte* > *heart repairing cell*). These variants are restatements of words that clarify or simplify the underlying concept. Different words are

1 In this study, truncation is understood as a formal means by which a lexematic unit is reduced to an acronym or an abbreviated form.

introduced so that concepts are easier to be retained by the reader. Paraphrastic variants imply a slight change in meaning as some semantic aspect of the key term is highlighted.

- 6 variants (12%) are figurative expressions. These variants present creative ways to describe different cell types. Metaphors (e.g. *stem cell* > *veritable fountain of youth*), hyperboles (e.g. *stem cell* > *nature's master cell*) and similes (e.g. *embryonic stem cell* > *building blocks of life*) have been found. These expressions facilitate the understanding of concepts while readers move into familiar grounds. Although there is still semantic equivalence between the key term and the variant, differences in meaning are the most notable.

In S1, only four compounds were identified as variants of one term out of the selected 19; all of them are paraphrastic variants (e.g. *mesenchymal stem cell* > *bone marrow-derived stromal cells*).

4. Discussion

In agreement with already cited authors such as Gaudin (1990), Sager (1990), Bowker and Hawkins (2006), neither terms nor their variants are context free. The amount of variants and the type of variants used in each register show that biomedical language is determined by situational factors. Specifically, variants in these registers are triggered by the intention of the writers and the level of knowledge of the recipients in each situation type. In return, the use of variants is a contribution to the building of specific textual genres. Variants are much more frequent in media discourse than in expert-expert communication. Based on the results extracted from our corpus it seems to be possible to infer regular patterns of variation and the specific motivations behind term choice.

The number of variants in S2 (52) is six times greater than the one in S1 (8). Scientific popularization implies a reformulation process in which most Greco-Latin terms have at least an alternative expression. Terms composed of Greek or Latin roots are difficult to be understood by lay people and therefore are replaced by more comprehensive lexical units. In this sense, Gotti (2014: 19) states that popularization "does not alter the disciplinary content […] as much as its language, which needs to be remodeled to suit a new target audience". The aim of experts and semi-experts writing for a lay audience is that recipients can continue reading without finding conceptual barriers and that they overall understand the message. In order to achieve their aim, they use above all paraphrases; secondly they use English counterparts which sometimes strictly follow the order of Greco-Latin roots of terms, and others are reduced forms. With certain frequency they also use figurative expressions to provide readers with images and analogies that facilitate the understanding of notions. Finally they use a few acronyms for the most frequent and broadly known terms as they are hyperonyms.

The most common type of variant in S1 consists of acronyms. The reason for their use lies in the characteristic linguistic economy of expert to expert communication. They are effective if users are familiarized with them. In this regard Sager et al. (1980: 16) state:

> In special communication economy can be maximally achieved because of the prior agreement in a relatively small group, the confined subject areas involved and the frequency of occurrence of certain messages and lexical items.

5. Conclusion

Terminology is used at all levels of specialized communication. The difference is on the means that convey specialized knowledge. The description of variants in this study shows hints of the appropriateness of variants in certain settings characterized by different users and a particular purpose. The methodology carried out in this study can be applied to other specialized languages and the resulting variants can contribute to the improvement of terminology-oriented applications:

specialized dictionaries, computer-assisted translations, etc. From our point of view, variants and information on them, such as the context where they tend to appear, the semantico-syntactic patterns, etc. have a reasoned position in future resources for helping language professionals or other users that need to take advantage of the dynamism of a specialized language such as the biomedical one.

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Appendix 1: Description of explicit variants in S1

EXPLICIT VARIANTS (S1)	Formal pattern	Semantic pattern
1. HSC	Truncation	
2. MSC	Truncation	
3. bone-marrow stromal stem cells	Composition	Paraphrasis
4. bone marrow stromal cell	Composition	Paraphrasis
5. skeletal stem cells	Composition	Paraphrasis
6. bone marrow-derived stromal cells	Composition	Paraphrasis
7. EC	Truncation	
8. ESC	Truncation	
9. ES cell	Truncation	
10. pole cells	Composition	
11. NSC	Truncation	
12. NK cell	Truncation	
13. ICM	Truncation	

Appendix 2: Description of explicit variants in S2

EXPLICIT VARIANTS (S2)	Formal pattern	Semantic pattern
1. mother cell	Composition	Paraphrasis
2. body's master cells	Composition	Figurative expression
3. nature's master cell	Composition	Figurative expression
4. unspecialized cell	Composition	Paraphrasis
5. therapeutic cell	Composition	Paraphrasis
6. veritable fountain of youth	Composition	Figurative expression
7. dividing cell	Composition	Paraphasis
8. primitive cell	Composition	Paraphrasis
9. heart cell	Composition	English reduced counterpart
10. heart muscle cell	Composition	English counterpart
11. heart repairing cell	Composition	Paraphrasis
12. thymus-derived lymphocytes	Composition	English counterpart
13. blood stem cell	Composition	English counterpart
14. blood cell	Composition	English reduced counterpart
15. HSC	Truncation	
16. blood-forming cell	Composition	Paraphrasis

17. basic building blocks of blood	Composition	Figurative expression
18. blood-forming stem cells in bone marrow	Composition	Paraphrasis
19. blood-making cell	Composition	Paraphrasis
20. blood- producing stem cell	Composition	Paraphrasis
21. MSC	Truncation	
22. bone marrow cell	Composition	English counterpart
23. precursor of bone muscle and many other tissue types	Composition	Paraphrasis
24. bone marrow stromal cell	Composition	Paraphrasis
25. skin cell	Composition	English counterpart
26. loose arrangement of cells	Composition	Figurative expression
27. connective tissue cell	Composition	English counterpart
28. blood vessel cell	Composition	English counterpart
29. ES cell	Truncation	
30. ESC	Truncation	
31. undifferentiated precursor for other cell types	Composition	Paraphrasis
32. building blocks of life	Composition	Figurative expression
33. induced pluripotent stem cell	Composition	English counterpart
34. nerve cell	Composition	English counterpart
35. reproductive cell	Composition	Paraphrasis
36. adult cell	Composition	English reduced counterpart
37. adult stem cell	Composition	English counterpart
38. non-reproductive cell	Composition	Paraphrasis
39. adult tissue cell	Composition	Paraphrasis
40. bone-forming cell,	Composition	Paraphrasis
41. bone stem cell	Composition	English counterpart
42. liver cell	Composition	English counterpart
43. white blood cell	Composition	English counterpart
44. fat cell	Composition	English reduced counterpart
45. fat stem cell	Composition	English counterpart
46. adipose derived stem cell	Composition	Paraphrasis
47. adipose fat stem cell	Composition	Paraphrasis
48. adipose fat cell	Composition	Paraphrasis
49. adipose derived regenerative cell	Composition	Paraphrasis
50. fat-derived stem cell	Composition	Paraphrasis
51. ICM	Truncation	
52. cluster of cells on the interior (of the blastocyst)	Composition	Paraphrasis