

Glycated or glycosylated?

The term glycation should be used when referring to the non-enzymatic reaction, while glycosylation should be used for an enzyme-catalysed reaction.

HbA1c, an index of long-term blood glucose levels, is the abbreviation for glycated haemoglobin, where glucose is bound to the haemoglobin molecule.

But we also frequently see HbA1c expressed as «glycosylated haemoglobin», for example on the Norwegian Diabetes Association homepage (1), in the laboratory manuals of Oslo University Hospital (2) and the University Hospital of North Norway (3), in Wikipedia (4) and in this journal's glossary (5). In the list of laboratory analyses performed at St. Olav's Hospital, both glycosylated haemoglobin and glycated haemoglobin are used (6). A search for «glycosylated haemoglobin» on this journal's website results in 14 hits, while «glycated haemoglobin» shows up only one article, published in February of this year (7).

Can the two concepts «glycated» and «glycosylated» be used synonymously, and if not – what is the difference?

Different processes

Glycation is a non-enzymatic reaction, irreversible and concentration-dependent, in which glucose or other carbohydrates are added onto proteins, lipids or DNA. Glycated molecules can be further processed to form advanced glycation end products (AGEs). Glycosylation, on the other hand, is a post-translational process in which the addition of carbohydrates to proteins or lipids is catalysed by enzymes. Glycosylation is used as a synonym for glycosylation (8). The modification is important for proper protein folding and therefore function. A familiar example is erythropoietin (EPO), which is heavily glycosylated. It is possible to distinguish endogenous from recombinant EPO on the basis of the glycosylation pattern (9).

In the earlier scientific literature, the term glycosylated was used for the binding of glucose to haemoglobin, since it was

unclear whether the reaction was enzyme-dependent; [it is] «probably nonenzymatic in nature» (10). In 1977, Stevens and colleagues reported that haemoglobin A can be glycosylated non-enzymatically (11), and in 1984 the first article to refer to non-enzymatic «glycosylation» as «glycation» was published (12). The year before, a letter to the editor had appeared in *Clinical Chemistry* where the author explained the differences between and pointed out the incorrect usage of the two terms (13). A search in PubMed on 10 September 2014 with the keyword «glycated» resulted in 7 932 hits.

Although there has been a linguistic improvement in recent years, the concepts glycation and glycosylation are still used interchangeably in both the English and Norwegian scientific literatures. In many of the older dictionaries, glycation is equated with glycosylation, but in the most recent edition of the Norwegian medical dictionary («*Medisinsk ordbok*») (14, 15) and in the Norwegian online medical encyclopedia («*Store medisinske leksikon*») (8, 16), the two concepts are distinguished.

Hospitals should ensure that the correct term for HbA1c – glycated haemoglobin – is now to be found in laboratory manuals.

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