Analyst

ROYAL SOCIETY OF CHEMISTRY

CORRECTION

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Cite this: *Analyst*, 2020, **145**, 4369

Correction: Glutamate sensing in biofluids: recent advances and research challenges of electrochemical sensors

Jessica Schultz,[a] Zakir Uddin,[b] Gurmit Singh[c] and Matiar M. R. Howlader*[a]

DOI: 10.1039/d0an90050h

rsc.li/analyst

Correction for 'Glutamate sensing in biofluids: recent advances and research challenges of electrochemical sensors' by Jessica Schultz *et al.*, *Analyst*, 2020, **145**, 321–347. DOI: 10.10.1039/C9AN01609K

The authors regret that several sections of the text are incorrect and require adjustments. These are detailed below. In addition, there are errors in Fig. 9, Table 3 and eqn (5).

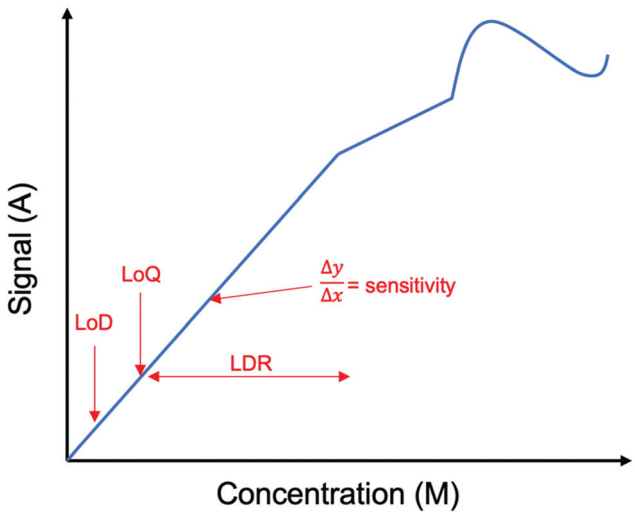

Fig. 9 Graphical representation of sensor performance properties. The *x*-axis is the concentration of glutamate and the *y*-axis is the signal measured, specifically current in electrochemical glutamate sensors. LoQ is limit of quantification and describes the limit of where the analyte is accurately measured in a linear response, or the lower bound of the linear detection range (LDR). Similarly, the slope or d*y*/d*x* of the linear detection range is the sensitivity.

The authors regret that Fig. 9 incorrectly gives the sensitivity as d*x*/d*y*. The correct version of Fig. 9 and its caption is presented here.

The authors regret that in Table 3 the 4th generation reactions are incorrect. The correct version of Table 3 is shown here.

The authors regret that eqn (5) was incorrect. The correct version of eqn (5) is given below. Eqn (6) has been added to clarify the dependencies of these processes on glutamate.

$$Ni(OH)_2 + OH^- \leftrightarrow NiO(OH) + H_2O + e^- \quad (5)$$

$$NiOOH + \text{glutamate} \rightarrow \text{oxoglutarate} + Ni(OH)_2 \quad (6)$$

[a]*Department of Electrical and Computer Engineering, McMaster University, 1280 Main Street West, Hamilton, ON, L8S 4K1, Canada. E-mail: mrhowlader@ece.mcmaster.ca*
[b]*School of Rehabilitation Science, McMaster University, 1400 Main St W, Hamilton, ON, L8S 1C7, Canada*
[c]*Department of Pathology and Molecular Medicine, McMaster University, 1280 Main Street West, Hamilton, ON, L8S 4 K1, Canada*

Table 3 Summary comparing the generations of electrochemical glutamate sensors

Generation	Reactions	Ref.	Performance comparison	Ref.
1st	$\text{Glutamate} + H_2O + O_2 \xrightarrow{\text{GluOx}} H_2O_2 + \alpha - \text{ketoglutarate} + NH_3$ $H_2O_2 \rightarrow H_2 + O_2 + 2e^-$	144	Detection of hydrogen peroxide break down Simple fabrication Good reproducibility Faster response time High sensitivity	136
2nd	$\text{Glutamate} + H_2O + O_2 \xrightarrow{\text{GluOx}} H_2O_2 + \alpha - \text{ketoglutarate} + NH_3$ $2Os^{2+} + H_2O_2 + 2H^+ \xrightarrow{\text{Horseradish peroxidase}} 2Os^{3+} + H_2O$ $2Os^{2+} + 2e^- \rightarrow 2Os^{2+}$	137	Redox mediator Lower oxidation potential (eliminate interfering current)	136
3rd	—		Direct measurement of enzyme/substrate pairings	145
4th	$Ni(OH)_2 + OH^- \leftrightarrow NiO(OH) + H_2O + e^-$ $NiOOH + \text{glutamate} \rightarrow \text{oxoglutarate} + Ni(OH)_2$	139	Enzyme-less Reduce complexities Cost effective	16

The authors regret that incorrect details were given for ref. 205 in the original article. The correct version of the reference is given below as ref. 1.

The following sentences in the Introduction require adjustment. The sentence beginning "Typically, electrochemical sensors consist of..." should be correctly given as "Typically, electrochemical glutamate sensors consist of a three-electrode system: working, reference and counter electrodes". The sentence beginning "During cyclic voltammetry, the sensor fabricated..." should be correctly given as "During cyclic voltammetry the sensor, fabricated with a NiO and glassy carbon electrode (GCE), required an OH^- during the oxidation of Ni, thus the solution requires high alkaline conditions".

The following sentences in section 2.1 should be corrected as follows: The sentence on page 322 beginning "Intracellular glutamate is generally inert..." should be correctly given as "While the binding of glutamate to transporters can trigger the propagation of intracellular signals, glutamate can also undergo glutamate uptake or diffusion". The sentence on page 322 beginning "Similarly, simple diffusion is another mode of..." should be correctly given as "Similarly, simple diffusion is another mode of removal of glutamate". The sentence on page 323 beginning "Ionotropic glutamate receptors are on..." should be correctly given as "Ionotropic glutamate receptors are on the postsynaptic membrane and include *N*-methyl-D-aspartate (NMDA), α-amino-3-hydroxy-5-methyl-4-isoxazole propionic acid (AMPA) and kainate receptors.[40]"

The sentence on page 325 beginning "This was determined through completing PCR..." should be correctly given as "This was determined through completing polymerase chain reaction (PCR) on the isolated mRNA from each section".

The following sentences in section 3.2 should be corrected as follows: The sentence on page 325 beginning "Glutamate concentrations are higher..." should be correctly given as "Glutamate concentrations are higher in the plasma at 5–100 μM and in whole blood at 150–300 μM in comparison to in the CSF". The sentence on page 326 beginning "W. Bai *et al.* reported elevated blood glutamate levels..." should be removed and the following sentence correctly given as "W. Bai *et al.* found blood glutamate concentrations increased...".

The sentence on page 328 beginning "Glutamate and glutamine were measured..." should be correctly given as "Glutamate and glutamine were measured in patients using isotope dilution GC-MS".

The sentence on page 329 beginning "Biosensors are the biological manipulation of..." should be correctly given as "Biosensors are the biological manipulation of sensors, where an analyte is detected on a bioreceptor or biological recognition element".

The following sentences in section 5.1 on page 330 should be corrected as follows: The sentence beginning "Potentiometric sensors can be fabricated..." should be correctly given as "Voltammetric or amperometric sensors can be fabricated with two or three-electrode systems". The sentence beginning "Biosensors have advanced tremendously". should be correctly given as "Biosensors have advanced tremendously in the past decades since the initial "true" biosensor was brought to life by Leland C. Clark.[134]" The sentence beginning "When the analyte is detected..." should be correctly given as "When the analyte is detected at the surface of the working electrode, a reduction–oxidation (redox) reaction occurs. This indirectly produces an electron through the production of hydrogen peroxide, and hence produces a current proportional to the concentration of glutamate".

The following sentences on page 333 should be corrected as follows: In section 5.2.1, the sentence beginning "A lower numerical value..." should be correctly given as "A higher numerical value results in a higher sensitivity, ideal for glutamate detection in healthcare applications. "In section 5.2.2, the sentences beginning "The limit of detection (LoD)..." should be correctly given as "The limit of detection (LoD) is the minimum concentration of glutamate that can be measured with reasonable certainty. According to the International Union of Pure and Applied Chemistry (IUPAC) Goldbook the LoD is calculated with the following equation: where μ_{blank} is the mean of blank measures and σ_{blank} is the standard deviation of blank measures and k is

the numerical factor based on the sought-after confidence level". In section 5.2.5, the sentence beginning "The limit of quantification..." should be correctly given as "The limit of quantification (LoQ) is higher than the LoD and is the minimum concentration of glutamate quantified to a desired level of precision.[148] It can be the lower bound of the LDR, or the lowest concentration of glutamate detected in a linear response". In section 5.3, the sentence beginning "Inkjet printers are a series of..." should be correctly given as "Inkjet printers produce a series of continuous droplets onto a material".

The following sentences in section 5.4.1 on pages 334 and 336 should be corrected as follows: The sentence beginning "Electrodes can be fabricated from..." should be correctly given as "Electrodes can be fabricated from a multitude of materials, commonly consisting of platinum (Pt), carbon, or gold (Au)". The sentence beginning "Analogous to chitosan, polypyrrole..." should be correctly given as "Polypyrrole (PPy) is a conducting polymer used for its ability to reject interference molecules". The sentence beginning "Variations of phenylenediamine specifically,..." should be correctly given as "Variations of phenylenediamine specifically, *meta*-phenylenediamine (*m*PD), *ortho*-phenylenediamine (*o*PD) to form poly(*o*-phenylenediamine) (P*o*PD) are commonly present among biosensors. Where *m*PD and *o*PD are isomers of phenylenediamine and *o*PD is the monomer used to synthesize P*o*PD.[181,182]"

The following sentences in section 5.4.2 on page 338 should be corrected as follows: The sentence beginning "The sensitivity was the second highest..." should be correctly given as "The sensitivity was the second lowest in Table 4 at 395 pA μM^{-1}". The sentence beginning "Wei *et al.*'s *in vivo* sensor..." should be correctly given as "Wei *et al.*'s *in vivo* sensor had the lowest sensitivity of 56 pA μM^{-1}". The sentence beginning "Consequently, the sensitivity improved in..." should be correctly given as "Consequently, the sensitivity improved in PBS, which mimics physiological conditions".

The sentences in section 5.5.2, on page 339, beginning "The sensor fabricated with a..." should be correctly given as "The sensor fabricated with a NiO electrode demonstrated a poorer sensitivity of 11 μA μM^{-1} cm^{-1}. However, the sensor with Co_3O_4 had a sensitivity of 9.5×10^{-5} μM, exhibiting the lowest sensitivity".

The Royal Society of Chemistry apologises for these errors and any consequent inconvenience to authors and readers.

References

1 H. M. N. Ahmad, B. Si, G. Dutta, J. R. Csoros, W. R. Seitz and E. Song, Non-Enzymatic Electrochemical Detection Of Glutamate Using Templated Polymer-Based Target Receptors, *2019 20th International Conference on Solid-State Sensors, Actuators and Microsystems & Eurosensors XXXIII (TRANSDUCERS & EUROSENSORS XXXIII)*, Berlin, Germany, 2019, pp. 613–616.