INTRODUCTION
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“Inspiration from nature is expected to continue leading to technological improvements and the impact is expected to be felt in every aspect of our lives.”¹ Nature is the constant driving force behind every aspect of our lives. Through the ages, it has provided us with a large number of extremely assorted materials which have been developed with only a handful of building blocks.² The biological materials or structures are commonly based on fibers which subsequently aid in the development of functional hierarchies.³ Recognition elements and receptors are also a class of materials which are employed for synthesizing biological materials or structures. In both the instances, materials science is continually emphasizing on initiating a generation of artificial platforms influenced by nature, thereby employing a biomimetic approach. Studies in the field of biomimetics witnessed a meteoric rise in the past decade and its veritable prospects towards the establishment of novel biomaterials shall only be perceived via interdisciplinary examination based on a comprehensive understanding of the nature that surrounds us.

The field of biomimetics has only recently begun to garner a huge degree of attention; however, the concept has existed for millennia now. There have been numerous examples such as synthesizing artificial silk dating back to over 300 years where we humans have taken a cue from nature and attempted to mimic the same. Another very popular example of biomimicking lies in successful designing of airplane by the Right brothers which is based on the critical observation that birds, instead of continuously flapping their wings, glide on air currents. In addition, one more very famous exemplification of biomimetics is the invention of a textile product, Velcro by de Mestral.
Biomimetic materials are biologically inspired nano-/micro-scale materials. This field of material chemistry is growing by leaps and bounds. Some of the reasons justifying their popularity are advancement in regenerative medicine, need for the development of avant-garde materials with a host of properties such as self-assembly and self-healing and lastly the increase in the understanding of the basis of recognition pathways in the biological system. One of the most magnificent examples of nature being an inspiration for the evolution of biomimetic materials for sensing is a cell. At the sub-molecular levels, cells are comprised of several functional biological materials; e.g., receptors and membrane proteins which continuously sense the milieu with great selectivity and prompt a reaction for the outer environment.\textsuperscript{4-6}

Taking in consideration the most austere explications of biomimicry, it is a process of imitating the ways of nature for seeking a solution which is inclusive of design and development with minimal ecological setbacks. Recent advancements in the field of material chemistry and its associated technologies have made the whole process of design and development of materials/systems much more viable, while simultaneously being inspired from nature.

On the whole, the primary motive is not to mirror a singular natural/biological framework or process, rather to employ the expertise in order to build foundations and doctrines. The outlook, therefore is to combine the known methodologies and the already existent complex biofunctionalities and receptor abilities of the biosystems to subsequently design promising applications in the arena of nanodevices like biosensors.

The primary requirement for the successful fabrication of a biosensor is highly dependent on the specificity levels of the recognition moieties and their selectivity towards the desired molecule.
The strategies which derive the biomimetic detection of biological species can be broadly classified into four categories, namely:

1. Molecularly imprinted polymers (MIPs).
2. Catalyst based biomolecular materials (e.g. porphyrins) and other natural receptors in artificial milieu.
3. Carbon nanomaterials, nanoparticles, nanostructured materials and nanocomposites,
4. Self-assembled monolayers (SAMs) and membrane mimics.

MIPs focus on developing artificial “antibodies” or “receptors” which possess biological activity regardless of being comprised of fully synthetic matrices. The MIPs bind to the analyte of interest via non-covalent interactions as is the case in biological systems, however their framework is absolutely disparate. Catalyst based biomaterials (e.g. porphyrins) aim at designing only the functional moiety of the biological molecule and thus simplifying its synthesis route. Nanostructured materials, nanoparticles, carbon nanomaterials, and composites consequently are not biomimetic in nature, nonetheless in conjugation with varied receptors, they pave the way for innovative and modern biosensing approaches. Lastly, the SAMs and membrane mimics target the mimicking of biological cell membranes with methods such as Langmuir-Blodgett techniques and immobilization of (natural) receptors along with them.

1.A BIOSENSING OF DOPAMINE

Dopamine (DA) is one of the most pivotal neurotransmitter representatives of catecholamine family. Under physiological conditions, DA is present in abundance as a large cationic molecule and regulates brain-body co-ordination (fig. I.A). It is a precursor for two more neurotransmitters, i.e. adrenaline and noradrenaline. It is known to play central roles in many
spheres of neuromodulation (circuitry, plasticity, etc.), stress regulation, memory, and attention span.\textsuperscript{10-13} DA is also known to affect the renal and cardiovascular systems\textsuperscript{14-16} along with an array of other behavioral responses. Variation in the optimum levels of DA in central nervous system is cited as one of the major reasons behind many neurological disorders such as Parkinson’s disease, Schizophrenia, and ADHD/ADD.\textsuperscript{17-20} DA is an extra-synaptic messenger which regulates the neurotransmission by volume transmission so as to go and attach itself to transporters and G-protein coupled receptors (also known as extra synaptic receptors) (fig. I.B).\textsuperscript{21-25}

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**Fig. I.A Stress induced brain-body regulation modulated by neurotransmitter dopamine.**
As DA has a broad range of biological (physiological/pathophysiological) ramifications, the development of a sensor for the specific and selective determination of DA has been drawing a lot of attention. Some of the most commonly employed techniques for DA sensing includes mass spectrometry, liquid chromatography, enzyme assays, capillary electrophoresis, and optical and electrochemical detections. Moreover, since DA is an electrochemically active molecule, electrochemical sensing (biosensing) for the measurement of the electroactive neurotransmitter has become the most favored and facile technique.

**Fig. 1.B** Dopamine regulation at synapse.
Electrochemical techniques have been extensively employed for the rapid, sensitive, and selective determination of DA along with displaying a relative ease of operation. However, early works by various groups revealed the side effects of factors like orientation of molecules adsorbed and concentration and/or type of supporting electrolyte used in the electrochemistry of our model analyte (DA). Additionally, the relatively large oxidation potential employed and its effect on the electrode surface, phenoxy radical formation, and passivation of the electrode due to subsequent radical coupling are some more limitations that are encountered during electrochemical sensing of DA. The more important problems which need further focus in this field of DA biosensing include selective determination of DA in the presence of several other co-existent interfering species like ascorbic acid (AA), uric acid (UA) and epinephrine (EP). Among these, AA and UA are the most critical ones as their oxidation potentials lie very close to that of DA, thereby resulting in an overlap of voltammetric signals. It therefore is of paramount importance to establish an electrochemical route for the selective sensing of DA with exceptional sensitivity and low detection limit (LOD).

In the past decade several efforts have been made to set up such a procedure. In the process, numerous biomaterials for electrode fabrication have been explored such as glassy carbon, carbon nanotube-intercalated graphite, polymer modified glassy carbon, MWCNTs, nafion modified, acetylcholine modified glassy carbon, and electrochemically pre-treated glassy carbon.
I.A.1 Electrochemical Sensors

Electrochemical sensors are broadly classified into two categories:

i. Chemical sensors

ii. Biosensors

As per the definition given by IUAC, “the electrochemical biosensor is a self-contained integrated device, which is capable of providing specific quantitative or semi-quantitative analytical information using a biological recognition element (biochemical receptor) which is retained in direct spatial contact with an electrochemical transduction element.” Biosensors when compared with chemical sensors comprise of active non-biological moieties, thereby resulting in the enhancement of their sensitivity as well as selectivity towards the detection of analyte of interest. These as-mentioned electrodes can be fabricated by utilizing various inorganic or organic materials possessing excellent electrical conductivity and electrocatalytic properties.

I.A.2 Biosensors in Dopamine Detection

Recently, a lot of work has been carried out to improve the electrocatalytic properties, selectivity, and sensitivity of the electrochemical sensors by using nanomaterials (e.g. nanotubes, nanowires, nanoparticles) or by utilizing advance membrane materials (lipid membranes, hydrogels, sol-gel composites) for immobilization of biomolecules. The critical points which need to be catered to when developing an electrochemical biosensor is the immobilization of the
nanoelectrocatalyst on the conductive surface. There are a handful of pre-requisites that need to be fulfilled. They are:

i. It should be immobilized efficiently on the conductive surface, without affecting the structure and property of the nanomaterials.

ii. It must be non-toxic and biocompatible.

iii. Should be easily available for analyte adsorption.

The matrices employed in electrode fabrication also need to possess certain attributes; which are:

i. Matrix should ideally be chemically stable in nature while being inert towards the nanomaterial or the analyte to be detected.

ii. Matrix should display high electrical conductivity.

iii. The procedure to develop the matrix should be economic and reproducible in nature.

Furthermore, a biosensor should comprise of important attributes like long term sensor stability, lifetime, and reproducibility along with repeatability to be a successful practical sensor.

In the past, enzyme tyrosinase based biosensor have been employed for successful, selective sensing of DA in the presence of interfering species AA and UA. Unfortunately, these enzyme based sensors exhibited poor long-term stability and reproducibility. Several other attempts to enhance the sensing abilities of the biosensor towards DA detection included improving the loading capacity of the matrix by utilizing conductive materials with enhanced catalytic affinity, enlargement of surface-to-volume ratio, etc. Extensive studies have been performed in the past five years, on the basis of which Compton et.al.\textsuperscript{49} provided a concise description of the electrode modification materials: carbon nanotubes, graphene, polymers, and nanoparticles.\textsuperscript{50-89}
I.A.3 Chemical biosensing materials for dopamine

1.A.3.1 Graphene

One of the most promising materials for the electrochemical detection is graphene. This is ascribed to the economic synthesis route, large surface-volume ratio, and good electrical conductivity. Various forms of graphene, like graphene powder, suspensions, and graphene nanocomposites have been used to modify electrode surfaces. Recently, reduced graphene oxide (rGO) has been examined as a potential material for DA sensing.

It is now an established fact that rGO leads to enhancement of the electrochemical sensing abilities of the material due to the reduction of oxygenated functionalities present on the graphene oxide (GO) surface. So far, the best LOD and linearity for DA sensing have been obtained by electrodes fabricated with reduced graphene forms.

1.A.3.2 Metal and Semiconductor Nanoparticles

The past few years have witnessed a consequential growth in the usage of metals and semiconductor nanoparticles for the purpose of electroanalysis. These nanoparticles play a central role in numerous ways by increasing the surface area available for sensing and facilitation of electron transfer rate. The nanoparticles are also known to electrically develop a contact between the electrode’s surface and redox center of the analyte of interest. However, they come with a set of drawbacks like toxicity and expensive methodology.
I.A.4 In vitro and In vivo Sensing Miniaturization

Till date, except for a few biosensors developed for the determination of DA, most have their employability limited to the laboratory. The primary reason behind their restricted usage is due to the inferior sensitivity and selectivity. There are various other reasons which are responsible for restricting their use, such as:

i. Electrode fouling
ii. Repeatability and reproducibility
iii. Compromised biocompatibility
iv. Size and polarity of sensors

Current developments in the field of nanotechnology have resulted in the synthesis of electrochemical sensors with their diameters ranging up to about 30 µm only. Additionally, the inclusion of apt electrochemical sensing techniques like cyclic voltammetry (CV) have initiated real-time monitoring of the neurotransmitter, \textit{in vivo}. as well as \textit{in vitro}. with high spatial temporal resolution and low LOD. The benefits of miniaturized electrochemical biosensing are as follows:

i. Enhanced signal-to-noise ratio
ii. Rapid response time
iii. Low rate of charge transfer resistance
I.A.4.1 Ionic Liquid composite Electrodes

Ionic liquids are unique salts with near room temperature melting points, broad electrochemical windows and increased ionic conductivity. However, almost all the ionic liquids/ionic liquid composite electrodes showed low LOD, poor reproducibility, repeatability, and stability along with compromised sensitivity and selectivity.

Taking all these parameters and studies in account, it was seen that simultaneous detection of DA in the presence of interferences without the electrochemical properties being affected are best obtained with chemical sensors with conducting properties, like nanoclusters or nanoparticles. Although, the electrode surface modification also aids in enhancing the sensing abilities of the biosensor; the surface modifications and nanoparticle composites make the whole process more expensive and cumbersome.

In short, the search for a suitable electrode material which can be prepared via facile, green, and economic route without undermining the properties like high sensitivity, selectivity, reproducibility, repeatability, stability, and biocompatibility is still going on.
I.B BIOSENSING OF NITRIC OXIDE

Nitric oxide has a pivotal role in numerous human physiological pathways like blood pressure regulation, neuronal signaling, immune responses, and vasodilatation. Variations in the optimal levels of NO are known to be responsible for various pathological disorders such as cardiovascular diseases,\textsuperscript{90} vaginitis,\textsuperscript{91} respiratory disorders,\textsuperscript{92,93} and cancer.\textsuperscript{94} For instance, NO can act as both, a tumor suppressor or a tumor progressor, depending on the lifetime and concentration of the molecule in the organism.\textsuperscript{94} Owing to the relevance and significance of NO in biological processes, it is of paramount importance to develop a real-time, \textit{in vivo}, biocompatible, rapid, and highly sensitive NO sensing procedure. However, because of the extremely short half-life of NO (half-a-second only), it reacts rapidly with reactive oxygen species, thereby making the determination of NO in its native form extremely difficult. The existing methods which are employed for NO sensing include chemiluminescence,\textsuperscript{95} Griess assay,\textsuperscript{96} electron spin resonance (ESR),\textsuperscript{97-99} quantum cascade laser,\textsuperscript{100,101} and fluorescent probe.\textsuperscript{102,103} Among these methods, Griess assay is the most prevalent procedures to analyze NO and is favored due to its properties like simplicity and economic ease. ESR and fluorescent probes are an efficient route for real-time NO sensing at cellular levels; however, quantification is very difficult \textit{via} these procedures. Chemiluminescence and Quantum Cascade Laser are highly favored for NO quantification. All these techniques mentioned here have several disadvantages which hinder their applicability. However, an electrochemical sensor proves to be an efficient way to determine NO \textit{in vivo} even in the presence of several interfering species usually encountered while sensing NO in complex biological systems.\textsuperscript{104,105}

Electrochemical sensors are extremely popular in the field of biosensing as they offer several advantages over other detection methods such as quick response, portability, low detection limit,
and cost-effectiveness. Recently, a lot of work is being focused on biofunctionalization of nanomaterials for the fabrication of electrode modification materials.

**I.B.1 NO in Biological System**

NO, a messenger molecule, is generated in the mammalian system by the catalysis of L-arginine and oxygen *via* the enzyme Nitric oxide synthase (NOS). NOS in humans is present in four forms, namely:

1. Immunological or inducible NOS (iNOS)
2. Neuronal NOS (nNOS)
3. Mitochondrial NOS (mtNOS)
4. Endothelial NOS (eNOS)

NO is known to play numerous key roles in hormone regulation, vasodilation, inflammatory response, neurotransmission, respiratory functions, and immunity. On the contrary, it is also suspected that NO may have certain cytotoxic or cytostatic effects on the host cell line.\[106,107\]

Tumor cytokines or tumor necrosis factor – α (TNF-α) stimulate macrophages which have been infiltrated by tumor, resulting in an over expression of iNOS leading to excessive NO production. The high levels of NO are seen to hinder cell proliferation but whether this increase in NO concentration suppresses or over expresses a tumor is dependent on the NO-induced apoptosis pathways activation in the cells.\[108\]
I.B.2 Electrochemical Oxidation of NO

A three electrode system comprising of a reference electrode, a working electrode and a counter electrode is classically employed for NO sensing. Due to the presence of a single unpaired electron in the NO molecule, it can get oxidized and result in a redox current of $\sim +0.860$ V Ag/AgCl and a nitrosonium ion:

$$\text{NO} - e^- \rightarrow \text{NO}^+$$

In the presence of OH$, the nitrosonium ion (NO$^+$) being a relatively stronger lewis acid, gets converted to nitrite (NO$_2^-$).

$$\text{NO}^+ + \text{OH}^- \rightarrow \text{HNO}_2$$

$$\text{HNO}_2 \rightarrow \text{H}^+ + \text{NO}_2^-$$

NO can further be oxidized into nitrate via a two electron transfer process. Single electron reduction of NO occurs at a potential of -0.45V Ag/AgCl. The most commonly employed method for the detection of NO is via amperometry. This technique has several advantages such as quick response time, extremely sensitive, quantitative measurements, and selectivity. Numerous other techniques like linear sweep voltammetry (LSV), fast scan voltammetry (FSV), differential pulse voltammetry (DPV), and square wave voltammetry (SWV) have also been used to estimate the NO levels.
I.B.3 Electrode Materials for NO Sensing

The electrode modification is absolutely necessary for achieving selective sensing of NO in the presence of numerous interferences which co-exist in the biological milieu. Over the years, broad variety of electrochemical sensors have been examined including glassy carbon electrodes, gold electrodes, graphite electrodes, screen printed electrodes, and platinum electrodes.

I.B.3.1 Pt-Based Electrode for NO detection

Pt is one of the most extensively used noble metals in the field of electroanalysis. The bare Pt electrode, when employed in electrochemical sensing procedures without any modification displayed poor sensing performance. Therefore, several transition metals and nanomaterial composites have been employed to modify the bare Pt electrode to enhance its electrochemical properties. Pt electrodes sense NO by adsorbing the molecule irreversibly via two plausible routes, first being an EC (sp. out) pathway by reaction between NO adsorbed onto the electrode surface and the adsorbed H (Langmuir-Hinshelwood reaction). Second one is an EE (sp. out) path, which includes a direct transfer of proton to NO from the solution (Eley-Rideal Reaction). Once NO is successfully adsorbed onto the Pt electrode surface, the two kinds of NO adsorbates get reduced separately at different potentials.
I.B.3.2 Au-Based Electrodes for NO Detection

Au-electrodes are another very popular choice of electrodes for NO detection. A range of functional moieties can be immobilized onto the Au-electrode surface to enhance the sensitivity of the electrode. However, it has recently been established that Au-nanoparticles are cytotoxic in nature.\textsuperscript{119}

I.B.3.3 GCE Based Electrodes for NO Detection

Glassy Carbon electrode (GCE) is a very popular choice for NO sensing, which is credited to its properties like good electrical conductivity, inert nature, chemical stability, and high hydrogen overpotential. Additionally, it can be easily modified with various materials (e.g. AUNPs, SWNT, chitosan, etc.) and be employed for NO determination in biological samples.

I.B.3.4 Electrode Modification by Selective Membranes

There are several electrode surface modifications that have been made by utilizing an array of membranes, thereby making the already existing NO sensors even more sensitive, selective as well as biocompatible. In general, some of the most commonly used modification membranes comprise of organic molecules, protective membranes, and biomolecules.
I.B.3.5 Biomolecules Modified Electrodes

The past two decades have seen the rise of protein–based NO sensors. Chitosan and cytochrome C (Cyt. C) are the most widely studied protein based sensing/electrode modification materials for the determination of NO. Cyt. C, a stable hemoprotein was immobilized onto a gold electrode modified with L-cysteine, and glassy carbon electrode was coated with DNA for the measurement of NO. Chitosan (CS), on the other hand is a highly blood compatible biomolecule with microbial degradation properties. Therefore, the sensors that have been fabricated by using chitosan as the electrode modification material can be employed for sensing NO from real-time, biological samples.

I.B.3.6 Organic Molecules Modified Electrodes

Recently, porphyrins or phthalocyanines with Fe(II), Co(II), Pt(II) or Ni(II) as central metal have been employed for fabricating NO sensors. Malinski and Taha, in the early 1990s employed a porphyrin-based microsensor for the determination of NO from a singular cell. They achieved a response time of <10 mins with a LOD of ~10 nM with their microsensor for NO sensing. In contrast to free-base porphyrin, metalloporphyrins are known to typically lower the overpotential for NO sensing by about 0.15 V along with displaying an approximately 3 fold increase in the electroanalytical properties.

Some of the popular metalloporphyrins for nitric oxide sensing include the electopolymerized NiTMHPP (Nickel tetrakis(3-methoxy-4-hydrophenyl)porphyrin).
Moreover, a number of protective membranes like cellular acetate or nafion are used to enhance the selectivity of the sensor. The most expansively used permeable membrane for NO detection is nafion, as it can prevent several major interferents that are encountered during NO sensing. Nafion membrane’s mode of action is governed by factors such as membrane thickness and the presence of their electropolymerized films.\(^\text{116}\) Although, nafion is made up of both hydrophilic (-SO\(_3\)H) as well as hydrophobic moieties as a part of its polymeric framework, it is the hydrophobic functionalities which play the dominant role towards predetermining the selectivity along with sensitivity of the NO sensor. Therefore, NO can be concentrated onto the nafion coated surface via hydrophobic interactions while the hydrophilic functionalities would hinder its diffusion into the electrode’s surface.\(^\text{111}\) Nickel (II) meso-tetrakis (3- methoxy-4-hydrophenyl)porphyrin (Ni-TMPP) modified electrodes, further coated with nafion and D-phenyl diamine (O-PD) displayed remarkable sensitivity toward NO sensing, with a LOD of 35±7 nM. Furthermore, these electrodes also exhibited excellent sensitivity against AA, DA, and nitrite. However, in the absence of nafion, the Ni-TMPP electrode displayed poorer electroanalytical properties.\(^\text{128}\)

**I.B.3.7 Nanomaterials Based Electrochemical Sensors**

Due to their large surface-to-volume ratio, smaller size, high sensitivity, and high reactivity; nanotechnology is the most recent advancement in the field of electrochemistry. Gold nanoparticle films were grown by chemical liquid deposition method for the modification of quartz fiber. The as-modified quartz fiber electrode displayed a LOD of 3.6 nM with a S/N = 3
along with enhanced sensitivity and electrocatalytic activity.\textsuperscript{129} Functionalized carbon nanotubes (SWCNTs and MWCNTs) have also been employed for NO sensing.\textsuperscript{114,130-134}

A GCE, modified by coating it with a polyazocarmine B (PACB) nafion film-water soluble MWNTs composites was utilized for successfully determining NO in rat hepatocytes.\textsuperscript{130} Furthermore, nafion/MWNTs-CS-AUNPs composite films modified GCE with a LOD of 7.6 nM was able to successfully sense NO in rat liver, spleen, heart and kidney. Additionally, this NO sensor could also detect NO released from NO donors at micromolar level.\textsuperscript{132}

**I.B.4 Electrochemical Detection of NO Level in Cells**

As discussed earlier, NO is known to be central for proper vasculature. eNOS acts upon L-arg and catalyzes it to synthesize L-cit along with releasing NO. Some cardiac disorders are associated with improper endothelial functioning.\textsuperscript{135} Precise measurement of the NO produced by eNOS is absolutely necessary to examine the mechanisms of vasculature associated diseases; thus the requirement of exceptionally specific, selective, and biocompatible NO sensors. Electrochemical detection of NO is one of the most proficient methods to sense NO levels in a cell culture or single cell without causing any significant damage. Another isoform of NOS, i.e. iNOS unlike nNOS or eNOS is not dependent on calcium. When a cell is infected, it produces cytokines which act as a messenger for the infectious state to the neighboring cells, triggering the release of iNOS. Subsequently, this will result in iNOS producing huge amounts of NO for long durations of time. Recently, J774 murine macrophage cells coated biocompatible murine macrophages were used for the sensing of NO and protective antigen (PA) binding.
We, therefore can conclude that the available electrochemical sensors for both DA and NO determination are providing an approach to sense the model analyte with average sensitivity, selectivity, and good LODs. However, there is an urgent requirement of a more sensitive and selective biosensor which is exceptionally biocompatible in nature and possesses several other attributes such as large surface-to-volume ration and portability while also presenting a facile, green, and economic route of developing the biosensor for the same.

**I.C Graphene in Biosensing**

Graphene, a sp² bonded one atom thick material, resembles a honeycomb structure and is credited with an array of interesting and important properties such as high elasticity, high mechanical strength, good thermal conductivity, tunable band gap, and optical properties. A few layered graphene is also known to exhibit similarly attractive attributes as are displayed by single-layer graphene sheets. Furthermore, due to its transparent and conductive nature, along with its synthesis being green and economic, it is a quintessential material for the fabrication of biosensors.

There are various types of graphene based nanomaterials and their attributes are very intimately associated to their mode of synthesis. For instance, graphene prepared via chemical vapour deposition or by mechanical exploitation possess very few defects. However, graphene sheets produced by methods like thermal exfoliation, chemical exfoliation or electrochemical exfoliation leading to the synthesis of reduced forms of graphene, contain large quantities of structural defects and is very different from pristine graphene. The presence of defects in the framework of the as-synthesized graphene is not detrimental. On the contrary, it is a very well
established fact that the edge plane defects promote heterogeneous electron transfer rate in sp² carbons.¹⁴²

**I.C.1 Graphene in Electrochemical Biosensing**

Graphene is a very promising material for highly sensitive electrochemical biosensing of electroactive materials. Along with being sensitive, graphene also shows remarkable selectivity due to its ability of oxidizing/reducing different molecules at different potential. Graphene is also known to promote heterogeneous electron transfer rate (HET), as HET requires edge plane defects and higher the surface area (which graphene provides), more is the number of electroactive regions due to large number of defects.¹⁴³ Additionally, it has also been seen that in comparison with undoped graphene, nitrogen doped (N-doped) graphene sheets resulted in an enhanced electrochemical response.¹⁴⁴ It has also been demonstrated that non-covalent bonding augments the redox current and results in lowering the overpotential.¹⁴⁵ Furthermore, graphene has been employed as an electrochemical sensor in the field of immunosensing and electrochemiluminescence.¹⁴⁶,¹⁴⁷ Therefore, as has been discussed, graphene being an electroactive, zero band gap semiconductor promises a wide range of plausible application potentials in the area of biosensing. However, this area of study is still in its nascent stage and is expected to offshoot into many more potential applications in the field of biosafety, health care, and environment protection.

We, therefore decided to utilize graphene as a precursor of our parent biosensing biomaterial/electrode modification material for the development of a remarkably sensitive,
selective, and exceptionally biocompatible biosensor for electrochemically detecting our model neurotransmitter analytes of interest i.e. Dopamine (DA) and Nitric oxide (NO).
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