

Kolkata Centre
कोलकत्ता केन्द्र

UGC-DAE Consortium for Scientific Research

विश्वविद्यालय अनुदान आयोग - परमाणु ऊर्जा विभाग वैज्ञानिक अनुसंधान संकुल

(An autonomous institution of UGC, New Delhi)

(विश्वविद्यालय अनुदान आयोग, नई दिल्ली द्वारा स्थापित स्वशासी संस्थान)

(Formerly Inter University Consortium for DAE Facilities; IUC-DAEF)

UGC-DAE-CSR-KC/CRS/19/MS06/ 0935

Date: 10.05.2019

To
The Principal
Narajole Raj College
Narajole, Midnapore West
West Bengal-721211, INDIA

Sub: Collaborative Research Schemes (Research Project) entitled "*Synthesis of Biocompatible Magnetic Nanoparticles and their Applications in Nanotherapy and Prevention of Environmental Water Pollution*" of Dr. Tapanendu Kamilya, Assistant Professor of Physics, Narajole Raj College, Narajole, Midnapore West, West Bengal-721211, INDIA

Dear Sir/Madam,

This is to inform you that based on recommendations of the User Committee, UGC-DAE Consortium for Scientific Research, Kolkata Centre has approved the aforecaptioned proposal for partial support (contingency, consumables and travel) as a Collaborative Research Scheme (CRS) for the first year w.e.f. 01.06.2019. However, depending on the performance of first one year period, a scholar support may be approved from the second year.

It is envisaged that the research activities under this scheme be based on active academic collaboration with the respective in-house group(s) and is undertaken using the facilities outlined in the original proposal.

Terms and conditions of the sanction are outlined in Annexure-I. The other guidelines or rules stipulated by the UGC, if any, will be intimated to you accordingly.

All correspondences related to the CRS from the PI, be communicated to the respective Research Co-ordinator(s) mentioned below.

Yours sincerely,

MK Chakraborty,
Administrative Officer -I (Personnel),
Kolkata Centre of UGC DAE CSR

Principal
Narajole Raj College
Narajole, Pin-721 211

Copy to:

- Dr. Tapanendu Kamilya, Assistant Professor of Physics, Narajole Raj College
- Mr. R P Chattopadhyay, Administrative Officer-I (Accounts), Kolkata Centre of UGC DAE CSR.
- Dr. Souvik Chatterjee, Research Coordinator, Kolkata Centre of UGC DAE CSR



ANNEXURE- I

1. In principle CRS approval has **scientific sanction for three years and financial sanction for one year**. Financial sanction will be renewed on a yearly basis subject to receipt of satisfactory progress report, utilization certificate (U.C) for the previous year & claim bill for the current.
2. Grant for fellowship is approved for one research scholar for one year. Fellowship money will be released after joining of the fellow and will commence from the date of joining of the fellow.
3. The grant of Rs.30,000/- as consumable and Rs 15,000/- as contingency has been sanctioned for one year. This shall not cover any expenses related to travel and / registration for Workshop and Conference.
4. Travel will be supported (directly From the Centre) after prior approval from the centre, and travel fund can be utilized by the project PI and Student(s) under the scheme for their visit to the Centre either for discussion or performing experiment(s) related to the project/scheme following norms of University. Travel support will be also be provided to the PI/Student(s) for participation in conferences, workshop discussion meeting, seminar etc. associated with the collaborative program within the country after obtaining prior approval from the Centre. Field trips relevant to the present scheme would be considered on a case-to-case basis, and the PI is requested to submit the details (justification, itenary, proposed measurements etc) atleast one month in advance to the respective Research Co-ordinators electronically.
5. Users of Gamma Irradiation facility (for experiments related to the sanctioned CRS) are requested to fill in and submit the enclosed from.
6. Release of the grant for fellowship and contingency is subject to **receipt of Claim –bill (TR-42, enclosed as Annexure II) and also the Utilization Certificate (UC)** duly certified by the competent authority of the University / College (such as Finance Officer, Registrar) (in the successive years) .
7. Fellow recruitment should be made by an open selection and be as per UGC guideline. The recruitment procedure to be initiated within 3 months of the commencement of the CRS and appointment to be completed within 6 months of the same. Details of designations, requirements and fellowship rates are given below.

Designation	Remuneration	Minimum Qualifications
Project Fellow	Rs 14,000/pm + HRA	For Sciences : 2 nd Class M.Sc with a minimum of 55% marks in the subject concerned or For Engineering : 1 st Class B.E / B.Tech degree.
	Rs 16,000/- pm + HRA	After 2 years as a Project Fellow , if the research work is found satisfactory on assessment (by a 3 member expert committee with an external member) with at least one research paper in a reputed journal out of the work done under the project.
Project Associate-I	Rs 25,000/- pm + HRA	For Sciences : 2 nd Class M.Sc with a minimum of 55% marks in the subject concerned + GATE / NET-JRF / Lectureship (UGC-CSIR joint test) / SLET or For Engineering : M.E / M.Tech with minimum 55% marks. GATE is not a mandatory condition.
Project Associate-II	Rs 28,000/- pm + HRA	After 2 years as a Project Associate-I . If the research work is found satisfactory on assessment (by a 3 member expert committee with an external member) with at least one research paper in a reputed journal out of the work done under the project.

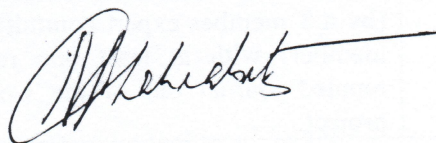
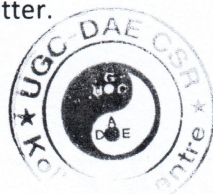
85/07/24
Principal
Marathwada College
Aurangabad (M.S.)



[Handwritten Signature]

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8. All recruitment should be authorised by a Selection Committee constituted as per rules of University/institution in which the Principal Investigator is working. The advertisement should be widely circulated atleast electronically. The Selection Committee selecting a Research Scholar, under the Collaborative Research Scheme (CRS) shall have a representative of this institution (To be nominated by the Centre Director). The PIs should inform the interview schedule to the Centre Director, **3 weeks in advance**. The Centre Director would then arrange for a nominee to be present. **The appointment cannot be made if the 3 weeks notice is not given**. The Centre Director may, with the approval of Director, waive the requirement of the nominee being present. Copy of the advertisement, details of the electronic circulation, minutes of the Selection Committee, appointment letter and joining report and other relevant documents of the fellow joining should be sent to respective program coordinator of the Centre for release of fellowship grant. Fellowship money will be released only after joining of the fellow. It is preferred / recommended that the research scholar have qualified National level Ph.D entrance exams such as UGC-CSIR NET, SLET etc.
9. In all cases of appointment under the scheme, it must be mentioned in the appointment letter that the appointment is purely temporary and will terminate automatically without any notice of compensation on termination of the research scheme and the appointed person will have no claim of appointment/absorption in UGC DAE CSR, KC. An undertaking must be taken from the appointed person in this effect. Leave rules for the appointed fellow will be as per the host institution of the PI.
10. Initiation of fellowship may not coincide with the initiation of the CRS, as such one year sanction of fellowship corroborates with 12 months of fellowship to be consumed from the date of joining of the fellow.
11. **No over head charges** would be payable to the Universities/Institutions since the Consortium is not a funding Agency but is a wholly funded unit of UGC.
12. Contingency fund to be utilised for computational work, purchase of stationery and other consumables pertaining to the concerned project. **No grant is allocated for any capital Equipment /Asset**.
13. Every research scheme will be reviewed towards the end of a year. Depending on the progress of the collaborative research scheme, a decision will be taken for the sanction of funds for the next year of the project. **An annual statement of Accounts and a Certificate of Utilization of money sent for the research scheme must be sent to the respective program coordinator of the Centre of completion of each year.**
14. The draft of the manuscript pertaining to the results (either partial or complete) obtained under this support should be circulated to all the collaborators/co-authors, prior to the final submission to a journal or conference. Any publication resulting from the studies, either in a journal or for a conference abstract, may be based on detailed discussions between all the collaborators. **The publication must be in SCI (JCR) journals.**
15. Every such paper should carry the following acknowledgement "This work (part of this work) was performed under the Collaborative Research Scheme no(*) of UGC DAE Consortium for Scientific Research (use of the specific facility at the concerned institute is to be acknowledged). In addition, if the author has received help from any personnel of the Centre, he/she may acknowledge the same suitably either in the acknowledgement or as a co-author.
16. One copy of reprint of the publication should be sent to the research program coordinator.
17. *Kindly refer the reference number of the sanction letter.

Principal
Narayana Raj College
Tirupattur, Pin-761 211





Kolkata Centre
कोलकता केन्द्र

UGC-DAE Consortium for Scientific Research

विश्वविद्यालय अनुदान आयोग - परमाणु ऊर्जा विभाग वैज्ञानिक अनुसंधान संकुल

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(Formerly Inter University Consortium for DAE Facilities; IUC-DAEF)

UGC-DAE-CSR-KC/CRS/19/MS-06/0466

Date: 15-10-2020

To
The Principal
Narajole Raj College
Narajole, Midnapore West
West Bengal-721211, INDIA

Sub: Extension Letter: UGC-DAE CSR, KC Collaborative Research Scheme (Research Project) entitled "*Synthesis of Biocompatible Magnetic Nanoparticles and their Applications in Nanotherapy and Prevention of Environmental Water Pollution*" of Dr. Tapanendu Kamilya, Assistant Professor of Physics, Narajole Raj College, Narajole, Midnapore West, West Bengal-721211, INDIA

Dear Sir / Madam,

This is to inform, that based on the recommendations of the Project Review Committee, on evaluation of the progress report submitted by the PI, UGC-DAE Consortium for Scientific Research Kolkata Centre, **has extended the aforementioned CRS, for partial support** (contingency, consumables and travel) for the second year **w.e.f 1st June 2020**.

It is requested that Utilization certificate, for the last year, if not submitted earlier, and the claim for the second year with filled TR42 form (enclosed herewith) may please be sent at the earliest for further financial processing at the Centre.

All communications pertaining to the CRS are to be made to the undersigned.

Yours sincerely,

S. Chatterjee 15/10/2020

Dr Souvik Chatterjee
Research Program Co-ordinator (Material Science)

S. Chatterjee 15/10/24
Principal
Narajole Raj College
Midnapore (Pin-721 211)



Copy to:

1. Dr. Tapanendu Kamilya, Assistant Professor of Physics, Narajole Raj College, Narajole, Midnapore West, West Bengal-721211, INDIA
2. Shri R. P. Chattopadhyay, A.O-I (Accounts), UGC-DAE CSR, Kolkata Centre.

NARAJOLE RAJ COLLEGE
NARAJOLE : : PASCHIM MEDINIPUR

PROJECT "Synthesis of Biocompatible Magnetic Nanoparticles and their Applications in Nanotherapy and Prevention of Environmental Water Pollution"

Project No: UGC-DAE-CSR-KC/CRS/19/MS-06/0466 dt. 15.10.2020.

RECEIPTS AND PAYMENTS ACCOUNT FOR THE PERIOD FROM 01.06.2020 TO 31.05.2021

<u>RECEIPTS</u>	<u>RS.</u> <u>P.</u>	<u>PAYMENTS</u>	<u>RS.</u> <u>P.</u>
To <u>Opening Balance:</u>		By <u>Consumables Expenses:</u>	
Cash in hand		Copper (II) Sulphate-Merck	585.03
" <u>Grant in Aid</u>	NIL	Tri-Sodium Citrate-Merck	431.01
Received from UGC-DAE Consortium		Bovine Serum Albumin-Sigma	10,369.79
Kolkata Centre		TEM Grid-Imported	11,197.77
Through NEFT Dated 12.02.2021	45,000.00	Aspirin-Sigma	3,385.93
		Copper (II) Chloride-Merck	960.33
		Iron (II) Chloride-Merck	260.01
		Ammonium Hydroxide-Merck	215.01
		Deionized Water-Merck	576.02
		Sodium Borohydride-Merck	2,019.10
		Paid through Cheque No.101253 dt.20/05/2021	30,000.00
		By <u>Contingency Expenses:</u>	
		Paper & Stationary	1,000.00
		Mouse, Laptop Keyboard	3,020.00
		Toner Cartidge (2), Antivirus	2,325.00
		Adapter	1,350.00
		SSD, USB Hub, Pen Drive	4,550.00
		Book from Lambert	2,463.00
		Pen, Highlighter & Xerox	292.00
		Paid through Cheque No.101252 dt.20/05/2021	15,000.00
		" <u>Closing Balance:</u>	
		Cash in hand	Nil
	<u>45,000.00</u>		<u>45,000.00</u>

AUDITORS' REPORT:

We report that we have examined the Receipts & Payments A/C of Project "Synthesis of Biocompatible Magnetic Nanoparticles and their Applications in Nanotherapy and Prevention of Environmental Water Pollution" for the period from 1st June, 2020 to 31st May, 2021 with Books and Accounts, Vouchers and Documents produced before us and the same are in agreement therewith.

Place : Midnapore
 Date : 23rd July, 2021

Tapanendu Kamilya
 27/07/2021
Dr. Tapanendu Kamilya
 Assistant Professor of Physics
 Narajole Raj College
 Narajole, Paschim Medinipur

Anupam Parua
 27-07-2021
DR. Anupam Parua
 Principal
 Narajole Raj College
 Narajole, Paschim Medinipur

Principal
Narajole Raj College
Narajole-721211

For RAMKRISHNA RAY & CO.
 Chartered Accountants
 FRN: 324330E
Ramkrishna Ray
(Ramkrishna Ray)
 Proprietor
 M. NO. 059795
 UDIN: 21059795AAAAIA7763



Principal
 27/07/2021
Principal
 Narajole Raj College
 Narajole Pin-721 211



NARAJOLE RAJ COLLEGE



NAAC Accredited 'B' Grade College

ESTD.- 1966

Narajole ⊕ Paschim Medinipur

P.O.- NARAJOLE
DIST.- PASCHIM MEDINIPUR
PIN CODE- 721211
WEST BENGAL

Email: narajolerajcollege@rediffmail.com
Ph.- 03225-259755

Memo No... NRC/69/UGC/2021

Date... 27-07-21

To
The Director
UGC DAE, Consortium for Scientific Research, Kolkata Centre
Sector III, LB-8, Bidhan Nagar, Kolkata 700 106

Subject: Submission of Audit Report of project "Synthesis of Biocompatible Magnetic Nanoparticles and their Applications in Nanotherapy and Prevention of Environmental Water Pollution" -Project No: Project No: UGC-DAE-CSR-KC/CRS/19/MS-06/0466 dt. 15.10.2020.

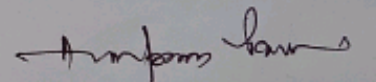
Dear Sir,

I am submitting the Audit Report for the expenditure of Research Grants of Rs. 45,000/- for the research project entitled "Synthesis of Biocompatible Magnetic Nanoparticles and their Applications in Nanotherapy and Prevention of Environmental Water Pollution" -Project No: Project No: UGC-DAE-CSR-KC/CRS/19/MS-06/0466 dt. 15.10.2020 of Dr. Tapanendu Kamilya, Assistant Professor, Narajole Raj College for the period from 01/06/2020 to 31/05/2021.

It is also declared that Rs. 30, 000/- was utilized for Consumable purposes and Rs. 15,000/- was utilized for contingency purposes. The details of consumable and contingency expanses are given in Audit Report.

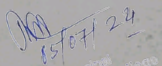
Thanking you,

Yours faithfully,


27-07-21

Dr. Anupam Parua
Principal
Narajole Raj College

Principal
Narajole Raj College
Narajole-721211


Principal
Narajole Raj College
Narajole Pin-721 211





Kolkata Centre
कोलकता केन्द्र

UGC-DAE Consortium for Scientific Research

विश्वविद्यालय अनुदान आयोग - परमाणु ऊर्जा विभाग वैज्ञानिक अनुसंधान संकुल

(An autonomous institution of UGC, New Delhi)

(विश्वविद्यालय अनुदान आयोग, नई दिल्ली द्वारा स्थापित स्वशासी संस्थान)

(Formerly Inter University Consortium for DAE Facilities; IUC-DAEF)

UGC-DAE-CSR-KC/CRS/19/MS-06/ 0401

Date: 25-10-2021

To
The Principal
Narajole Raj College
Narajole, Midnapore West
West Bengal-721211, INDIA

Sub: Extension Letter: UGC-DAE CSR, KC Collaborative Research Scheme (Research Project) entitled "*Synthesis of Biocompatible Magnetic Nanoparticles and their Applications in Nanotherapy and Prevention of Environmental Water Pollution*" of Dr. Tapanendu Kamilya, Assistant Professor of Physics, Narajole Raj College, Narajole, Midnapore West, West Bengal-721211, INDIA

Dear Sir / Madam,

This is to inform, that based on the recommendations of the Project Review Committee, on evaluation of the progress report submitted by the PI, UGC-DAE Consortium for Scientific Research Kolkata Centre, has **extended the aforementioned CRS, for partial support** (contingency, consumables and travel) for the third-year w.e.f 1st June 2021.

It is recommended that PIs update the status of publication (where there was no publication or manuscript was at the stage of communication / preparation) arising out of the CRS in SCI journal, if any, within 06 months of the date of the last report.

It is requested that Utilization certificate, for the last year, if not submitted earlier, and the claim for the third year with filled TR42 form (enclosed herewith) may please be sent at the earliest for further financial processing at the Centre.

All communications pertaining to the CRS are to be made to the undersigned.

Yours sincerely,

Shallya
25/10/2021

Dr Souvik Chatterjee
Research Program Co-ordinator (Material Science)

Copy to:

1. Dr. Tapanendu Kamilya, Assistant Professor of Physics, Narajole Raj College, Narajole, Midnapore West, West Bengal-721211, INDIA
2. Shri R. P. Chattopadhyay, A.O-I (Accounts), UGC-DAE CSR, Kolkata Centre.

Shallya
15/07/24



NARAJOLE RAJ COLLEGE



NAAC Accredited 'B' Grade College

ESTD. 1966

Narajole ⊕ Paschim Medinipur

P.O.- NARAJOLE
DIST.- PASCHIM MEDINIPUR
PIN CODE- 721211
WEST BENGAL
Email: narajolerajcollege@rediffmail.com
Ph.- 03225-259755

Memo No. NRC/74/DCR-DAE/2022

Date 03.06.2022

To,
The Director,
UGC DAE, Consortium for Scientific Research, Kolkata Centre,
Sector III, LB-8, Bidhan Nagar, Kolkata 700106

Subject: Submission of Audit Report of project "Synthesis of Biocompatible Magnetic Nanoparticles and their Applications in Nanotherapy and Prevention of Environmental Water Pollution" Project No: UGC-DAE-CSR-KC/CRS/19/MS-06/0401 dt. 25.10.2021.

Dear Sir,

I am submitting the Audit Report for the expenditure of Research Grants of Rs. 45/000/- for the Research project entitled "Synthesis of Biocompatible Magnetic Nanoparticles and their Applications in Nanotherapy and Prevention of Environmental Water Pollution" Project No: UGC-DAE-CSR-KC/CRS/19/MS-06/0401 dt. 25.10.2021 of Dr. Tapanendu Kamilya, Assistant Professor, Narajole Raj College for the period of 01/06/2021 to 31/05/2022.

It is also declared that Rs. 30,000/- was fully utilized for Consumable purposes and Rs. 15,000/- was fully utilized for contingency purposes. The details of consumable and contingency expenses are given in Audit Report.

Thanking you,

Yours faithfully,

15/07/22
Principal
Narajole Raj College
Narajole, Pin-721211



Ranajit
Dr. Ranajit Kumar Khalua
Vice Principal, Naarajole Raj College

Vice-Principal
Narajole Raj College
P.O.- Narajole
Dist.- Paschim Medinipur, 721211

Copy forwarded to:
Dr. Souvik Chatterjee
Scientist-E,
UGC DAE, Consortium for Scientific Research, Kolkata Centre

NARAJOLE RAJ COLLEGE
NARAJOLE :: PASCHIM MEDINIPUR

PROJECT "Synthesis of Biocompatible Magnetic Nanoparticles and their Applications in Nanotherapy and Prevention of Environmental Water Pollution"

Project No: UGC-DAE-CSR-KC/CRS/19/MS-06/0401 dt. 25.10.2021.

RECEIPTS AND PAYMENTS ACCOUNT FOR THE PERIOD FROM 01.06.2021 TO 31.05.2022

<u>RECEIPTS</u>	<u>RS.</u>	<u>P.</u>	<u>PAYMENTS</u>	<u>RS.</u>	<u>P.</u>
To Opening Balance:			By Consumables Expenses:		
Cash in hand	NIL		Copper (II) Nitrate-Merck	1,840.80	
			Copper (II) Acetate-Merck	1,847.98	
* Grant in Aid			Distilled Water Pure	649.00	
Received from UGC-DAE Consortium			Lysozyme-Sigma	6,051.28	
Kolkata Centre			Human Hemoglobin-Sigma	8,038.66	
Through NEFT Dated 12.01.2022	45,000.00		DPPC-Sigma	7,235.59	
			Stearic Acid- Sigma	4,336.69	30,000.00
			Paid through Cheque No.101257dt.15/03/2022		
			By Contingency Expenses:		
			Paper & Stationary	937.00	
			Beaker, Meas. Cyl., Acetone	3,576.47	
			Antivirus,SSD,keyboard,pendrive	5,275.43	
			Ph Paper, Ethanol, thermometer	3,016.30	
			Funnl, flask, teflon, filter paper	2,194.80	15,000.00
			Paid through Cheque No.101254dt.11/02/2022		
			" Closing Balance:		
			Cash in hand		Nil
				<u>45,000.00</u>	<u>45,000.00</u>

AUDITORS' REPORT:

We report that we have examined the Receipts & Payments A/C of Project "Synthesis of Biocompatible Magnetic Nanoparticles and their Applications in Nanotherapy and Prevention of Environmental Water Pollution" for the period from 1st June, 2021 to 31st May, 2022 with Books and Accounts, Vouchers and Documents produced before us and the same are in agreement therewith.

Place : Midnapore
 Date : 02nd June, 2022

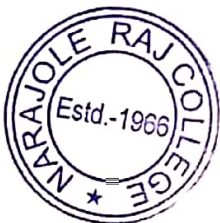
Tapanendu Kamilya
 Dr. Tapanendu Kamilya
 Assistant Professor of Physics
 Narajole Raj College
 Narajole, Paschim Medinipur

For **RAMKRISHNA RAY & CO.**
 Chartered Accountants
 FRN: 324330E



Ramkrishna Ray · 02.06.22

(Ramkrishna Ray)
 Proprietor
 M. NO. 059795
 UDIN: 22059795AKEGFT3042



Ranajit Kumar Khalua
 Dr. Ranajit Kumar Khalua
 Vice Principal
 Narajole Raj College
 Narajole, Paschim Medinipur

Vice-Principal
Narajole Raj College
 P.O.- Narajole
 Dist.- Paschim Medinipur, 721211

Ranajit Kumar Khalua
 15/07/22
 Principal
 Narajole Raj College
 Narajole Pin-721 211



Final Brief Report

Title of Project:

“Synthesis of biocompatible magnetic nanoparticles and their applications in nanotherapy and prevention of environmental water pollution”-Project No: UGC-DAE-CSR-KC/CRS/19/MS-06/0401 dt. 25/10/2021.

The following works are done as per submitted year wise experimental plan.

(i) **Synthesis of gold (Au), gold silver core shell, Iron oxide, citrate capped iron oxide, albumin coated biocompatible iron oxide and Gold coated Iron oxide Nanoparticles:**

We have also synthesized colloidal citrate capped gold (Au) with diameter 13.6 nm, gold-silver core-shell nanoparticles (Au@AgNPs) without any functionalization. Synthesis of core shell Au@AgNPs is confirmed from the TEM and HRTEM images showing clearly the Ag shell formed on Au core and from the SAED pattern representing the fcc crystalline structure of both Au and Ag. The bare, citrate functionalised and bovine serum albumin coated Fe₃O₄ nanoparticles (Fe₃O₄NPs, CFe₃O₄NPs and BFe₃O₄NPs) are synthesized. The XRD profile of the as prepared Fe₃O₄NPs as well as SQUID study confirms the synthesis of Fe₃O₄NPs. Along with the FTIR study confirms the synthesis of CFe₃O₄NPs and BFe₃O₄NPs. We have synthesized novel star shaped α -Fe₂O₃/Au nanocomposites. The α -Fe₂O₃/Au nano-composites are well crystalline in nature with excellent star/flower shaped particles having uniform arms/petals of length ~ 174 nm and maximum width ~ 51 nm.

(ii) **Study of the interaction of the gold, gold silver core shell, Iron oxide, citrate capped iron oxide, albumin coated biocompatible iron oxide nanoparticles with protein/enzyme:**

The interaction of Au NPs with a protein/enzyme lysozyme (Lyz) is studied through spectroscopic and microscopic studies. Corona formation of Lyz on Au NPs surfaces and its effect on the optical properties of Lyz as well as effect of aggregation of Au NPs on their plasmonic properties are analysed. Moreover, we have developed an open eye colorimetric method, based on quantitative analysis of RGB fractions of colorimetric changes of Au NPs to find the correlation with the corona formation of Lyz on surfaces of Au NPs. Molecular docking simulation endorses that, basic arginine are the binding sites of Lyz which have high binding affinity with tri-citrate ions of citrate capped Au NPs. The ground state complex formation between Lyz and Au NPs occurs with stoichiometric ratio 1:1, after time interval 11 minute of mixing. The nature of time dependence of intensity and resonance wavelength of the surface plasmons of the Au NPs have been investigated with the change of medium dielectric constant, plasmon coupling and electrostatic interaction with Lyz.

The ratio of UV-Vis absorbance of Au@AgNPs at two suitable wavelengths in presence of different concentrations of Lyz has been measured. Along with the relative increase in the absorbance ratio per nanomol/L increase in Lyz concentration has been determined. Moreover, we have performed sensitivity study of Au@AgNPs and AuNPs in colorimetric identification of Lyz solution in water among solutions of equal concentrations of several low and high isoelectric point (PI) proteins, namely, pepsin (PEP, PI=3.24), Bovine serum albumin (BSA, PI=4.7), Hemoglobin (Hb, PI=6.8), Cytochrome-C (Cyt-C, PI=10.2) and Lysozyme (Lyz, PI=11.1). Colorimetric identification have been done in respect of visible colours of the samples by naked eye observation as well as by comparison of the values of red, green and blue (RGB) components of the colours. The colorimetric selectivity of the Au@AgNPs, in detecting Lyz is observed to be better compared to that of AuNPs in this study.

We have studied the binding of bare, citrate functionalized and bovine serum albumin coated Fe₃O₄ nanoparticles (Fe₃O₄NPs, CFe₃O₄NPs and BFe₃O₄NPs) with human hemoglobin (Hb), their effect on the secondary structure of Hb and a comparative study of their hemolytic effects on erythrocytes. Spectroscopic studies reveal that both the amino acid groups and the heme group of Hb participate in ground state complex formation with all the NPs with 1:1 stoichiometric ratio. While amino acid groups of Hb strongly bind with CFe₃O₄NPs, heme group strongly binds with bare Fe₃O₄NPs. Binding constant and changes in Gibbs free energy are noticeably small for of BFe₃O₄NPs, indicating its weak interaction with Hb. Fluorescence quenching of Hb in presence of the nanoparticles appears to be due to FRET with an additional factor in case of CFe₃O₄NPs - the hindering of energy transfer from tyrosine to tryptophan by the COO⁻ group. Among the nanoparticles, BFe₃O₄NPs have smallest effect on the secondary structure of Hb and also they are least hemolytic.



[ICAMBC_2020]

Synthesis and Characterization of Star Shaped α -Fe₂O₃/Au Nanocomposites

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Abstract

Novel star shaped α -Fe₂O₃/Au nanocomposites have been synthesized by following a low cost as well as simple two-step method through chemical precipitation and seed growing technique. α -Fe₂O₃ nanoparticles have been precipitated from Iron (III) nitrate nonahydrate by ammonia solution and subsequently citrate capped and then Au has been deposited on the surface of the nanoparticles through reduction of Gold (III) chloride trihydrate by Hydroxylammonium chloride. The α -Fe₂O₃/Au nanocomposites are well crystalline in nature with excellent star/flower shaped particles having uniform arms/petals of length \sim 174 nm and maximum width \sim 51 nm. XRD of nanocomposites show peaks representing all the crystal planes of Au and major crystal planes of α -Fe₂O₃. The optical absorbance band of the α -Fe₂O₃ nanoparticles is observed to shift considerably towards higher wavelength on their composite formation with gold. Magnetic measurements show that both α -Fe₂O₃ nanoparticles and α -Fe₂O₃/Au nanocomposites are weakly ferromagnetic, having values of magnetization, respectively, 0.99 emu/g and 0.36 emu/g at a magnetizing field of 50 kOe.

Keywords: Nanocomposite; Star shaped; α -Fe₂O₃; Optical absorbance.

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NANO: Brief Reports and Reviews
Vol. 15, No. 1 (2020) 2050008 (24 pages)
© World Scientific Publishing Company
DOI: 10.1142/S1793292020500083



Dynamics of Binding of Lysozyme with Gold Nanoparticles: Corona Formation and its Correlation with a Naked-Eye-Based Colorimetric Approach

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Received 13 September 2019

Accepted 24 November 2019

Published

The interaction between colloidal gold nanoparticles (AuNPs) and lysozyme (Lyz) has been studied through spectroscopic and microscopic measurements, molecular docking simulation and colorimetric measurements to investigate corona formation and the mechanism, affinity, number of sites and stoichiometry of binding. Molecular docking simulation endorses that, at physiological pH, the interaction between basic NH_2 group of arginine and citrate ions is predominant than the interaction between citrate ions and the positive surface charge of the bare AuNPs that result in the desorption of citrate ions from Au surfaces and finally, electrostatic interaction between $-\text{COO}^-$ group of arginine and positive charge surface of AuNPs results in the adsorption of Lyz on Au surfaces. As observed from Benesi–Hildebrand and fluorescence analyses, the ground state complex formation between Lyz and AuNPs requires several minutes, which is approximately 11 min in the present work to attain stoichiometric ratio 1:1. CD spectra indicate insignificant or no conformational change in the secondary structure of Lyz in the presence of AuNPs. The time variation of LSPR peak position and peak height in the presence of Lyz have been studied extensively through spectroscopic and microscopic measurements. Detailed discussion on the probable time-specific roles of change in local dielectric constant, plasmon coupling and electrostatic interaction on these variations has been presented. Colorimetric change of the AuNPs-Lyz system with time has been analyzed by measuring the red, blue and green color fractions as well as its correlation with the process of corona formation and aggregation has been investigated to propose a novel naked eye colorimetric approach of studying these processes in AuNPs-Lyz system.

Keywords: Protein–nanoparticle interaction; molecular docking; time variation LSPR; corona; colorimetric study.

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RESEARCH ARTICLE

Sensitivity Enhancement in the Colorimetric/Spectroscopic Determination of Lysozyme Concentration in Nanomolar Level with Colloidal Citrate Capped Au@Ag Core-Shell Nanoparticles

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Abstract: Background: Lysozyme level in body fluids is a significant indicator of various diseases. Cheap and simple colorimetric detection of lysozyme, in biological sample, by gold and silver nanoparticles is a field of interest of nanoparticle research for more than a decade.

Objective: We report here an attempt to improve the sensitivity part of the colorimetric lysozyme detection process by using citrate capped gold-silver core-shell nanoparticles without any functionalization.

Method: Performance of gold-silver core-shell nanoparticles in determining of lysozyme concentration in water is done using colorimetric/spectroscopic technique. Gold nanoparticles, silver nanoparticles and mixed colloidal suspension of gold and silver nanoparticles, for comparison have also been studied. Selectivity study has been performed through spectroscopic analysis, red-green-blue colour component analysis and fractal dimension analysis of the nanoparticles interacted with several low and high isoelectric point proteins.

Results: Gold-silver core-shell nanoparticles showed higher sensitivity for a wider range of lysozyme concentration compared to gold and silver nanoparticles prepared by us or reported in literature. Gold nanoparticles showed higher sensitivity compared to the core-shell nanoparticles, but for a narrow concentration range of lysozyme. For silver nanoparticles and the mixed nanoparticle system, both sensitivity and range of determination of lysozyme concentration were much smaller compared to the core-shell nanoparticles. Core-shell nanoparticles showed better selectivity compared to gold nanoparticles in identifying aquatic solution of lysozyme from that of other proteins.

Conclusion: Gold-silver core-shell nanoparticles have higher sensitivity in determining wide range of lysozyme concentration in water compared to gold and silver nanoparticles reported in literature.

Keywords: Lysozyme, Core-Shell Nanoparticles, Spectroscopic, Plasmon coupling, Colorimetric, Sensitivity.

1. INTRODUCTION

Lysozyme (Lyz), a protein/enzyme that is present in different living things, including humans, defends several microbial and viral invasions in the host organism, including

human body as well as facilitates the activity of the instinctive immune system [1-4]. Owing to its antibacterial activity, Lyz is often called the “body’s own antibiotic” [5-6], along with its anti HIV activity in human body has also been reported [7]. In humans, Lyz is present in different body fluids like- saliva, mucus, tears, serum, mother’s milk, urine, tracheal wall secretion, etc. with different levels [8-9]. Elevated levels of Lyz in different human body fluids have been observed to be related to the occurrences of various life threat-

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RESEARCH ARTICLE

Spectroscopic Study of Interaction of Bare, Citrate Capped and BSA Capped Fe₃O₄ Nanoparticles with Hemoglobin

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Abstract: Background: Fe₃O₄ nanoparticles have great potential in different biomedical applications. The study of the interaction of bare, and capped Fe₃O₄ nanoparticles with common blood proteins is a field of interest for understanding the underlying mechanism and biocompatibility.

Objective: This work aims at studying the nature of binding of bare, citrate functionalised and bovine serum albumin coated Fe₃O₄ nanoparticles (Fe₃O₄NPs, CFe₃O₄NPs and BFe₃O₄NPs) with human hemoglobin (Hb), and their instantaneous effect on amino acid group, heme group and secondary structure of Hb.

Method: Nanoparticles were prepared by the chemical route and characterised by TEM, XRD and UV-Visible and FTIR spectroscopy. UV-Visible absorbance and fluorescence emission/excitation spectroscopy and circular dichroism were performed to study the interaction of nanoparticles with Hb.

Results: UV-Visible absorbance spectroscopy showed no blue or red shift of absorption peaks. Benesi-Hildebrand curves for the amino acid band and soret band of Hb absorbance spectrum were straight lines with positive intercepts; apparent binding constants and Gibbs free energy change were within a moderate level; they were larger for amino acid band in the presence of CFe₃O₄NPs, and for soret band in the presence of Fe₃O₄NPs, but noticeably small for both bands in the presence of BFe₃O₄NPs. Fluorescence emission/excitation spectra showed no noticeable shift of emission/excitation peak position of Hb in the presence of the three nanoparticles. Multiple peak fitting, done for the L-peak of the excitation spectrum of Hb, showed a major increase in the percentage of peak area of Tyr in the presence of CFe₃O₄NPs. Circular dichroism measurement showed that CFe₃O₄NPs, Fe₃O₄NPs and BFe₃O₄NPs reduced the α -helix content of Hb in decreasing order.

Conclusion: Ground state complex formation of human hemoglobin with the studied nanoparticles with 1:1 stoichiometric ratio is suggested. Moreover, it has been observed that CFe₃O₄NPs may have a stronger interaction with the amino acid group while bare Fe₃O₄NPs may have a stronger interaction with the heme group of Hb. Hinderance of the energy transfer from tyrosine to tryptophan of Hb in the presence of CFe₃O₄NPs is also suggested. CFe₃O₄NPs may also have some effect on the secondary structure of Hb as indicated through reduction of the α -helix content. BFe₃O₄NPs have shown very weak interaction with Hb in the UV-Visible absorbance spectroscopy, fluorescence emission/excitation spectroscopy and circular dichroism experiment.

Keywords: Protein-nanoparticle interaction; citrate capped Fe₃O₄NPs; BSA Capped Fe₃O₄NPs; spectroscopic study; amino acid group; heme group.

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