



OFFICE OF THE PRINCIPAL GOVT. SHIVNATH SCIENCE COLLEGE,
NAAC Grade- B, GAURAV PATH RAJNANDGAON (C.G.)

E-mail - shivnathcollege@gmail.com, website - www.govtshivnathcollege.in, Phone no. 07744-291599

L.No/192 /Coll./2021

Rajnandgaon, Date- 24/ 09/2021

To,

The Principal
Govt. R. R. M. PG College
Surajpur (C.G.)

Subject: Regarding Collaboration between Govt. Shivnath Science College,
Rajnandgaon (C.G.) and Govt. R. R. M. PG College, Surajpur (C.G.)

Sir,

Govt. Shivnath Science College, Rajnandgaon Chhattisgarh, here by wishes to foster academic exchange and Co-operation between the two institutions. The Collaboration letter is attached herewith.

(Dr. I. R. Sonwani)
Principal

Govt. Shivnath Science College,
Rajnandgaon (C.G.)

Dr. V.K. Jha
S.S.E.
07.9.2021



Letter of Collaboration

Between

Govt. Shivnath Science College, Rajnandgaon (C.G.)

Affiliated to

Hemchandra Yadav University, Durg (C.G.)

&

Govt. R. R. M. PG College Surajpur (C.G.)

Affiliated to

Sant Gahira Guru Vishwavidyalaya Sarguja Ambikapur (C.G.)



This letter of collaboration is designed to foster a academic relationship through mutual cooperation in teaching & research between Govt. Shivnath Science College, Rajnandgaon & Govt. R. R. M. PG College Surajpur. No financial obligations are assumed under this agreement.

Govt. Shivnath Science College, Rajnandgaon & Govt. R. R. M. PG College Surajpur have reached agreement on the following areas of cooperation, subject to mutual consent and the availability of sufficient funding.

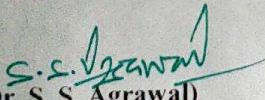
- Exchange of faculty
- Joint research activities
- Participation in seminars and academic meetings
- Exchange of academic materials and other information
- Special short term academic programs
- Students exchange for research and study

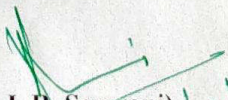
The terms of such mutual assistance and funding for any specific program and activity shall be mutually discussed and agreed upon in writing by both parties prior to the initiation of a particular program.

Each institution will designate an individual to coordinate this program and all endeavors that may drive from it. For this purpose, Govt. Shivnath Science College, Rajnandgaon designates Dr. A. K. Jha of Department of Chemistry & Govt. R. R. M. PG College Surajpur designates Dr. Vikesh Kumar Jha of Department of Chemistry.

No amendment, consent, or waiver of terms of this letter of collaboration shall bind either party unless in writing and signed by all parties. Any such amendment, consent, or waiver shall be effective only in the specific instance and for the specified purpose given.

This Letter of collaboration shall commence on the date of latest signature and be in effect for five years, at which time it shall be reviewed for possible extension. Either party may terminate this Letter by written notification signed by the appropriate official of the institution initiating the notice. However, such notification must be received by the other party at least six months prior to the effective date of termination.


(Dr. S. S. Agrawal)
Principal
Govt. R.R.M. PG College
Surajpur (C.G.)


(Dr. I. R. Sonwani)
Principal 24/9/21
Govt. Shivnath Science College,
Rajnandgaon (C.G.)



छत्तीसगढ़ CHHATTISGARH

N 369054

MEMORANDUM OF UNDERSTANDING WITH RESPECT TO TRAINING PROGRAMME FOR STUDENTS BETWEEN Government Rewati Raman Mishra P.G. College, Surajpur & CIPET-Korba

The MOU made on 22/07/2021 between Government Rewati Raman Mishra P.G. College, Navapara, Surajpur-497229 (Chhattisgarh) having principal business address at Navapara, Surajpur, Chhattisgarh-497229 ("hereinafter referred to as "Government Rewati Raman Mishra P.G. College") and Central Institute of Plastics Engineering & Technology (CIPET) Ministry of Chemicals & Fertilizers, Govt. of India, Education Hub, Syahimudi, Post- Gopalpur, Korba-459450 (hereinafter will be referred as "CIPET-Korba").

WHEREAS

"Government Rewati Raman Mishra P.G. College" is specially providing B.A, B.Com, B.Sc, BCA, PGDCA, DCA & P.G. courses in Art, Science & Commerce to students from technical & Nontechnical background.

AND "CIPET-Korba" is conducting various skill development & Skill Upgradation Program, short term training Programme for various students apart from regular diploma Programmes.

AND WHEREAS the parties wish to collaborate with each other for providing outsourcing services on training to students of "Government Rewati Raman Mishra P.G. College, Navapara, Surajpur, Chhattisgarh" for a period of Two years from the date of signing of this MOU.

The Parties here to agree as follows:-

1. **Payment:** CIPET will offer Skill Upgradation Training Program to the students of Government Rewati Raman Mishra P.G. College, Navapara, Surajpur, and the cost of Training shall be borne by "Government Rewati Raman Mishra P.G. College, Navapara, Surajpur".

Page 1 of 2



S.S. Raman
22/07/2021

राजाय
राजकीय र.र.मि महाविद्यालय
सुरजपुर (छ.ग.)

U.S.

3587 19 July 2021 100
 प्राचार्य स्वामी
 श्रीमान् श्री डा० लाला
 अकार

Handwritten signature

दुर्गा प्रसाद सिंह
 मुख्यालय
 सहस्री शिक्षा निगम (छ.ग.)

दिनांक काबालातः ०६ जुलै २०२१
 6 JUL 2021
 शाखा काबालातः ०६ जुलै २०२१

श्रीमान् चिह्नाङ्कितः

MEMORANDUM OF UNDERSTANDING WITH RESPECT TO TRAINING PROGRAMME FOR STUDENTS BETWEEN Government Rewari Raina Mishra P.G. College, Sutajpur & CIPET Korba

The MoU is made on 07/07/2021 between Government Rewari Raina P.G. College, Sutajpur, District Sonbhadra, Uttar Pradesh (GRC) and CIPET Korba, Ministry of Education, Government of India. The MoU is made for the purpose of providing training to the students of Government Rewari Raina P.G. College, Sutajpur, District Sonbhadra, Uttar Pradesh in the field of Engineering and Technology. The MoU is made for a period of 05 years from the date of signing.

The MoU is made for the purpose of providing training to the students of Government Rewari Raina P.G. College, Sutajpur, District Sonbhadra, Uttar Pradesh in the field of Engineering and Technology. The MoU is made for a period of 05 years from the date of signing.

The MoU is made for the purpose of providing training to the students of Government Rewari Raina P.G. College, Sutajpur, District Sonbhadra, Uttar Pradesh in the field of Engineering and Technology. The MoU is made for a period of 05 years from the date of signing.



- a. Basic Cost will be Rs. 1000 each student.
- b. Taxes will be extra as applicable.
- c. Certificate charges are inclusive.
- d. Advance: 50% of order value will be provided on basis of Performa Invoice and balance 50% on completion of training period.
- e. Credit Period: Credit period will be 15-30 days from invoice date.
1. Duration of the training of "Skill Upgradation Training Program" courses is 16 hours with carrier and job guidance on concern program.
 2. Amendments: This MoU can be amended by the mutual consultation of both the parties within the permissible limits of both the client and customer administrations and can be void by mutual consultation of both parties any time.
 3. Jurisdiction: The jurisdiction for the Memorandum of Understanding (MoU) is within the jurisdiction of Korba, Chhattisgarh.
 4. "CIPET-Korba" will impart training through online / Offline mode from CIPET-Korba Premises.
 5. CIPET, Korba shall provide the lab facilities for Practical Training Program.
 6. The Training Material, Schedule and curriculum will be developed by CIPET-Korba and the same will be provided to Government Rewati Raman Mishra P.G. College, Surajpur. Government Rewati Raman Mishra P.G. College, Surajpur agrees hereunder that any training material developed pursuant to this (MOU) will be solely owned by CIPET-Korba which shall have all the control or ownership in any form or manner whatsoever in the title, copyright or other proprietary rights to the materials, Products, methodologies and deliverables developed by its employees/consultants pursuant to this "MOU".
 7. Each party agrees not to issue press releases or public announcements concerning the terms of this "MOU" without the prior written approval of the other party.
 8. Government Rewati Raman Mishra P.G. College, Surajpur has the responsibility to arrange the students and to send the list and database of the students to CIPET Korba for conducting training Programme.
 9. The payment shall be made by Government Rewati Raman Mishra P.G. College, Surajpur to CIPET-Korba in the form of online mode, DD/Cheque in favor of CIPET Korba.
 10. Bank details of CIPET Korba

NAME OF ACCOUNT. CIPET KORBA
 Account no 38014099322
 IFSC code SBIN0007454
 Bank name: SBI HTPS VIDYUT NAGAR DARRI KORBA

Course Details:


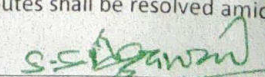
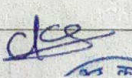
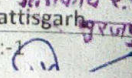
The program contents and fee structure are as follows.

SR.	Course Title	Course Fee	Duration	Eligibility
01	Skill Upgradation Program (Online/ Offline Mode)	Rs. 1000.00 (Taxes Extra)	16 hours	Any Graduate Student from the college

Validity

This agreement is valid for a period of Two year from 22/07/2021 to 21/07/2023. Unless otherwise renewed, the agreement stands expired automatically on completion of the above period.

For any dispute arising out of this MOU between the two parties, the disputes shall be resolved amicably by mutual discussion.

 Director & Head CIPET -Korba	 Proprietor Government Rewati Raman Mishra P.G. College Surajpur, Chhattisgarh
Witness:-1 	Witness:-1 

अधिसूचना

विश्वविद्यालय विद्यापरिषद् की स्थायी समिति की बैठक दिनांक 07.09.2021 की अनुसंधानानुसार एवं कार्यपरिषद् की बैठक दिनांक 16.09.2021 के विषय क्रमांक 31 के निर्णयानुसार निम्नांकित संकायों के अन्तर्गत आने वाले विभिन्न विषयों में शोध कार्य के निर्देशन हेतु मान्य/अर्हता प्राप्त शोध निर्देशकों की सूची निम्नानुसार जारी की जाती है :

क्र.	संकाय	विषय	शोध निर्देशक का नाम एवं पता
1	कला संकाय	हिन्दी	डॉ. राम आशीष तिवारी सहायक प्राध्यापक हिन्दी शासकीय महाविद्यालय, लखनपुर जिला—सरगुजा (छ.ग.)
			डॉ. दीपक सिंह सहायक प्राध्यापक हिन्दी शासकीय मां महामाया महाविद्यालय, खड़गवां जिला—कोरिया (छ.ग.)
			डॉ. विजय लक्ष्मी शास्त्री सहायक प्राध्यापक हिन्दी राजीव गांधी शासकीय स्नातकोत्तर महाविद्यालय, अम्बिकापुर जिला—सरगुजा (छ.ग.)
			डॉ. ब्रिजेश कुमार पाण्डेय सहायक प्राध्यापक हिन्दी शासकीय रामानुज प्रताप सिंहदेव स्नातकोत्तर महाविद्यालय, बैकुण्ठपुर जिला—कोरिया (छ.ग.)
2	समाज विज्ञान संकाय	भूगोल	डॉ. रमेश कुमार जायसवाल सहायक प्राध्यापक भूगोल राजीव गांधी शासकीय स्नातकोत्तर महाविद्यालय, अम्बिकापुर जिला—सरगुजा (छ.ग.)
			डॉ. सेवन कुमार भारती सहायक प्राध्यापक भूगोल शासकीय महाविद्यालय, प्रेमनगर जिला—सूरजपुर (छ.ग.)
		भूगोल	डॉ. कुंतल किशोर सहायक प्राध्यापक भूगोल शासकीय महाविद्यालय, विश्रामपुर जिला—सूरजपुर (छ.ग.)
		राजनीतिशास्त्र	डॉ. अर्चना गुप्ता सहायक प्राध्यापक राजनीतिशास्त्र शासकीय नवीन महाविद्यालय, बलरामपुर जिला—बलरामपुर—रामानुजगंज (छ.ग.)
3	विज्ञान संकाय	रसायनशास्त्र	डॉ. विकेश कुमार झा सहायक प्राध्यापक रसायनशास्त्र शासकीय रेवती रमण मिश्र स्नातकोत्तर महाविद्यालय, सूरजपुर जिला—सूरजपुर (छ.ग.)
		गणित	डॉ. प्रवीण कुमार साहू सहायक प्राध्यापक गणित शासकीय श्यामा प्रसाद मुखर्जी महाविद्यालय, सीतापुर जिला—सरगुजा (छ.ग.)

4	जीवन विज्ञान संकाय	प्राणिशास्त्र	डॉ. राजकिशोर सिंह बघेल सहायक प्राध्यापक प्राणिशास्त्र राजीव गांधी शासकीय स्नातकोत्तर महाविद्यालय, अम्बिकापुर जिला-सरगुजा (छ.ग.)
			डॉ. चन्दन कुमार सहायक प्राध्यापक प्राणिशास्त्र शासकीय रेवती रमण मिश्र स्नातकोत्तर महाविद्यालय, सूरजपुर जिला-सूरजपुर (छ.ग.)
		पर्यावरण विज्ञान	डॉ. जयत्सु दत्ता सहायक प्राध्यापक पर्यावरण विज्ञान विश्वविद्यालय शिक्षण विभाग, संत गहिरा गुरु विश्वविद्यालय, सरगुजा अम्बिकापुर (छ.ग.)
5	वाणिज्य संकाय	वाणिज्य	डॉ. शम्भू तिर्की सहायक प्राध्यापक वाणिज्य राजीव गांधी शासकीय स्नातकोत्तर महाविद्यालय, अम्बिकापुर जिला-सरगुजा (छ.ग.)
			डॉ. हीरा प्रसाद यादव सहायक प्राध्यापक वाणिज्य शासकीय राजमोहिनी देवी कन्या स्नातकोत्तर महाविद्यालय, अम्बिकापुर जिला-सरगुजा (छ.ग.)
			डॉ. सत्यनारायण साहू सहायक प्राध्यापक वाणिज्य शासकीय नवीन महाविद्यालय, बलरामपुर जिला-बलरामपुर-रामानुजगंज (छ.ग.)

आदेशानुसार

कुलसचिव
अम्बिकापुर, दिनांक 21.10.2021

पृ. क्रमांक: 967 / अकादमिक / शोध निर्देशक / 2021

प्रतिलिपि :-

1. कुलपति के सचिव/कुलसचिव के निज सहायक, संत गहिरा गुरु विश्वविद्यालय, सरगुजा अम्बिकापुर (छ.ग.)
2. समस्त सम्बन्धित शोध निर्देशक, संत गहिरा गुरु विश्वविद्यालय, सरगुजा अम्बिकापुर (छ.ग.)
3. संकायाध्यक्ष, समस्त सम्बन्धित संकाय, संत गहिरा गुरु विश्वविद्यालय, सरगुजा अम्बिकापुर (छ.ग.)
4. समस्त विभागाध्यक्ष/प्राचार्य, विश्वविद्यालय शिक्षण विभाग/समस्त सम्बद्ध महाविद्यालय, संत गहिरा गुरु विश्वविद्यालय, सरगुजा अम्बिकापुर (छ.ग.)।
की ओर सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित
5. कार्यालयीन प्रति।

सहायक कुलसचिव (अकादमिक)

Department of Chemistry



Chemistry Lab-1



Chemistry Lab-2

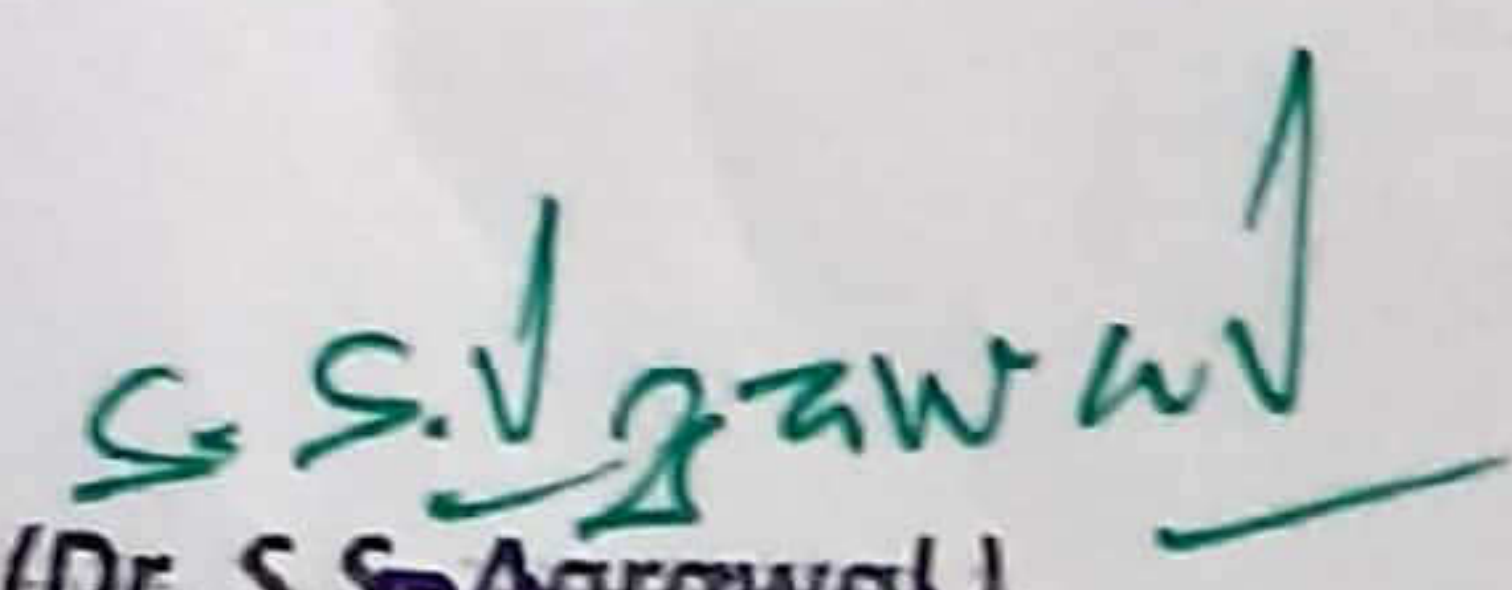


Govt. R. R. M. PG College Surajpur
Chemistry Department
List of Instruments

SR.NO.	NAME OF INSTRUMENTS
1	Microprocessor Nephelo/Turbidity Meter
2	Digital Potentometer
3	Digital pH Meter
4	Heating Mantle
5	Chemical Balance
6	Digital Photo Colorimeter
7	Digital Conductometer
8	Centrifuge Machine
9	Melting/Boiling Point Apparatus
10	Magnetic Stirrer With Hot Plate
11	Micro Incubator
12	Rectangular Water Bath 6 Chamber
13	Rectangular Water Bath 8 Chamber
14	Digital Weighing Machine
15	Digital Flame Photometer
16	Hot Air Oven
17	Vacuum Pump
18	Ultra Violet Cabinet
19	Digital TDS Meter
20	Muffle Furnace
21	Rotary Vacuum Evaporator
22	Digital Melting Point Apparatus
23	Vacuum Oven
24	Digital Polarimeter
25	Rotary Flask Shaker
26	Rectangular Water Bath
27	Water Distillation Apparatus
28	Double beam UV-Vis Spectrophotometer (Lab India)
29	Digital Refractometer

Journals Subscription	
1	N- List
2	American Chemical Society Membership
3	SciFinder


Department of HOD
Dr. Vikesh Kumar Jha


(Dr. S.S. Agrawal)
Principal
Govt R.R.M. College
Surajpur (C.G.)

01 Micro Processor Nephelo/Turbidity Meter



4 Heating mantle



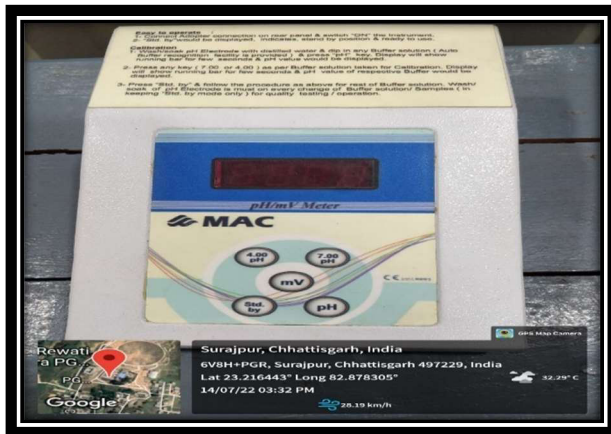
2 Digital Potentiometer



5 Chemical Balance



03 Digital PH Meter



6 Digital Photocolorimeter



7 Digital Conductometer



10 Magnetic Stirrer with hot plate



08 Centrifuge Machine



11 Micro Incubator



09 Melting/ Boiling Point Apparatus



12 Rectangular water bath 6 chamber



13 Rectangular water bath 8 chamber



16 Hot Air Oven



14 Digital Weighing Machine



17 Vacuum Pump



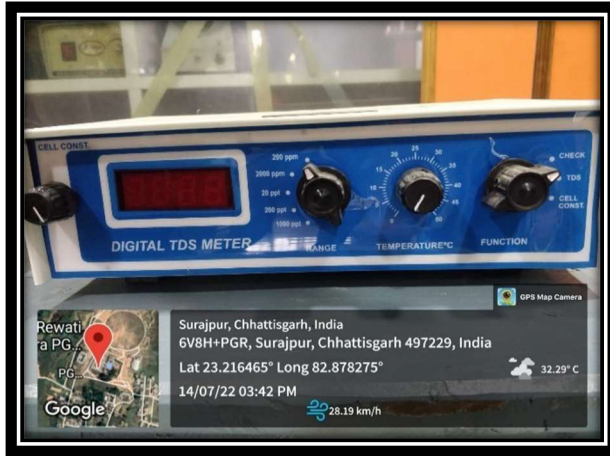
15 Digital Flame Photo meter



18 UV Cabinet



19 Digital TDS meter



22 Digital Melting Point Apparatus



20 Muffle Furnace



23 Vacuum Oven



21 Rotary Vacuum Evaporator



24 Digital Polarimeter



25 Rotary Flask Shaker



28 Double Beam UV/VIS Spectrophotometer



26 Rectangular water bath 12 chamber



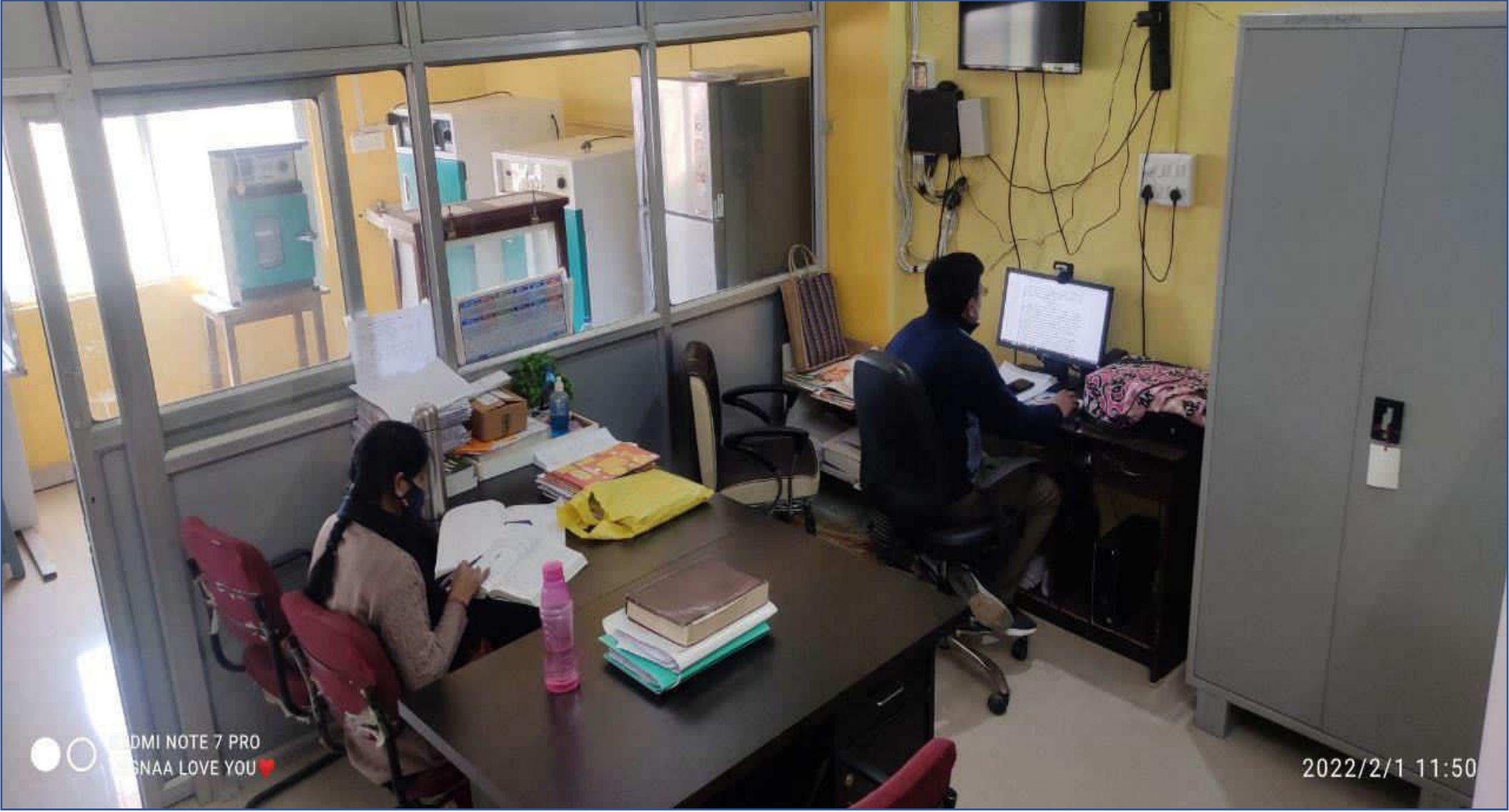
29 Digital Refractometer



27 Water Distillation Apparatus



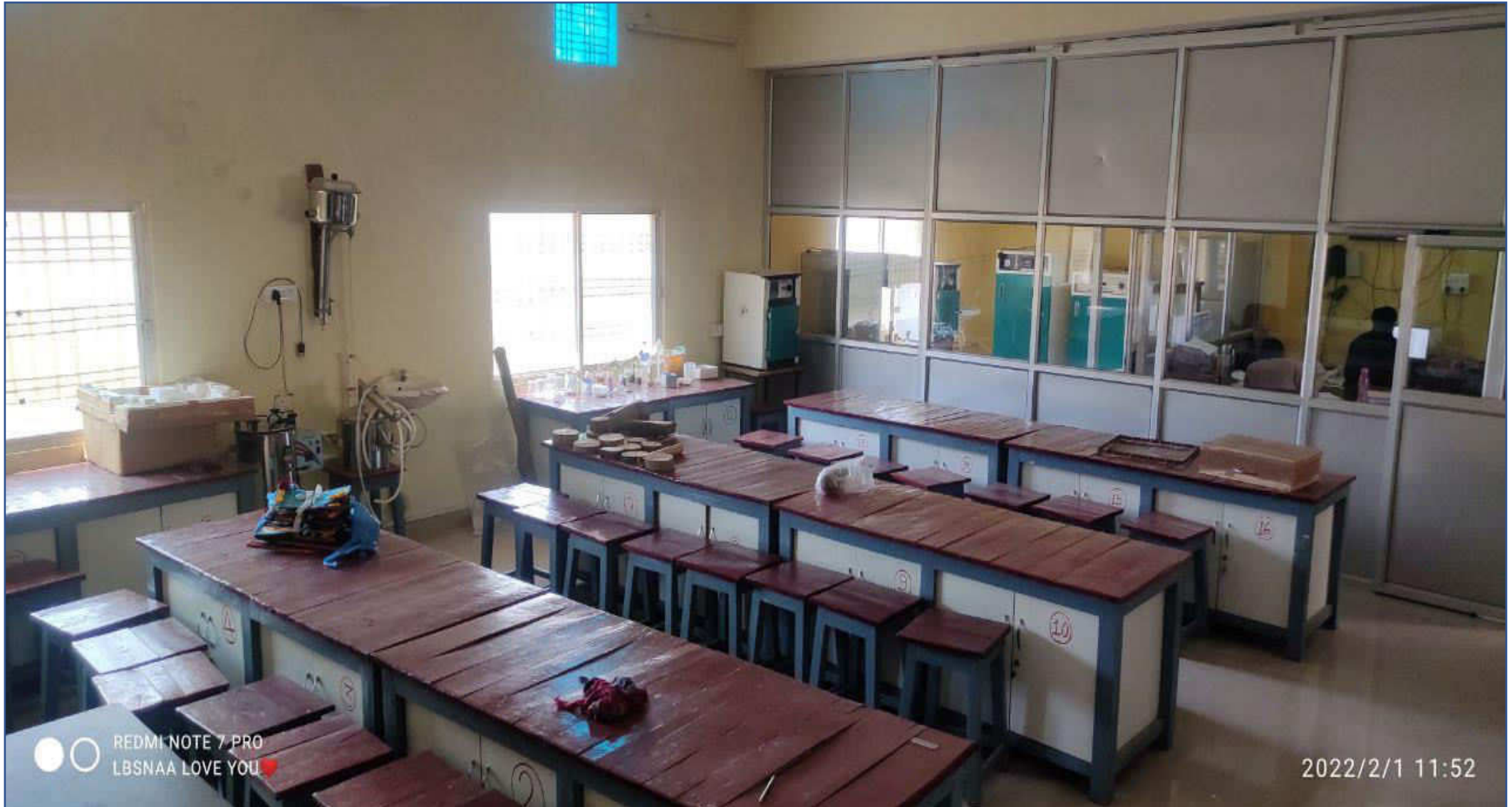
Botany Department



MI NOTE 7 PRO
SNA LOVE YOU ❤️

2022/2/1 11:50

Botany Lab



Botany Lab



Botany Lab



Govt. Rewati Raman Mishra P.G. College Surajpur, Dist-Surajpur

Research Center , Department of Botany

Lab Equipments/Apparatus List 2020-21

S.No.	Name of the Articl	Nos.
1	Laminar air flow (Stanless Steel)	
2	Phase contrast Microscope	
3	Digital pH Meter	
4	Hot air Oven	
5	Autoclave	
6	Water Bath	
7	Binocular Microscope	
8	Compound Microscope	
9	Dissecting Microscope	
10	Micrometer	
11	Photocolorimeter	
12	Chrometographic Chamber (For paper chrometography)	
13	BOD Inculcator	
14	Refrigeretor	
15	Humidity Chamber	
16	Distilatiion Unit	
17	Mini rotator Flask Shaker	
18	TDS meter	
19	UV Cabinete	
20	Centrifngation	
21	Bacteriological Incubator	
22	Magnatic Stiror with hot Plate	
23	Camera Lucida	

HOD OF BOTANY
Mr. I.R. Rahangdale

S.S. Agrawal
Dr. S.S. Agrawal
Principal
Govt. R. R. M. PG College
Surajpur

01 Laminar air Flow



04 Hot Air Oven



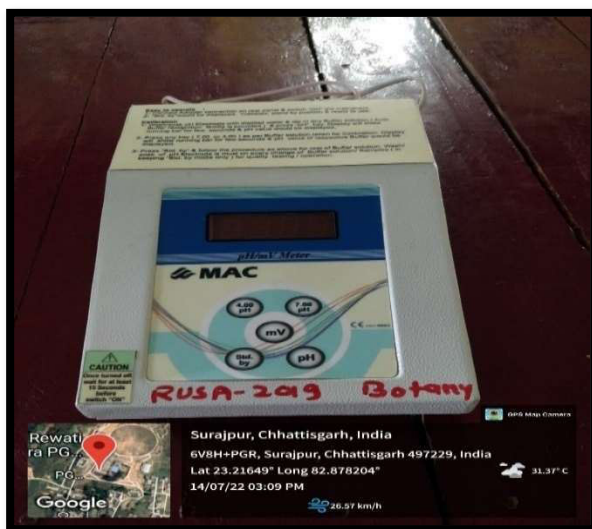
2 Phase contrast Microscope



05 Autoclave



03 Digital PH meter



06 Water Bath



7 Binocular Microscope



10 Micrometer



8 Compound Microscope



11 Photocolorimeter



09 Dissecting Microscope



12 Chrometographic chamber



13 BOD Incubator



16 Didtilatiion Unit



14

Refrigeretor



17 Rotary Flask Shaker



15

Humidity

Chamber



18 TDS meter



19 UV Cabinet



22 Magnatic Stiror with Hot Plate



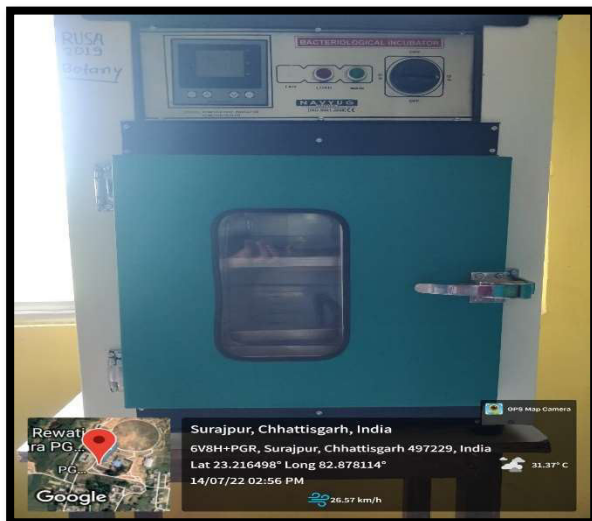
20 Centrifugation



23 Camera Lucida



21 Bacteriological incubator



Physics Dark Room and Lab



Physics Lab



Physics Lab



GOVT. R.R.M. P.G. COLLEGE SURAJPUR

DEPARTMENT OF PHYSICS

S. NO.	INSTRUMENT NAME	REMARK
1	PN JUNCTION DIODE	
2	TUNNEL DIODE	
3	ZENER DIODE	
4	TRANSISTOR APPARATUS	
5	STEFAN'S CONSTANT LAW	
6	F.E.T. APPARATUS	
7	LOGIC GATES	
8	COMPUTER'S FOR C PROGRAMMING	
9	ENERGY BAND GAP	
10	FLYWHEEL	
11	CENTILEVER	
12	OHM'S LAW	
13	HALF/FULL ADDER	
14	SPECTROMETER	
15	MAXWELL'S NEEDLE	
16	COMPOUND PENDULUM	
17	SPRING CONSTANT	
18	CARRY FOSTER'S BRIDGE	
19	MOMENT OF INERTIA INSTRUMENT	
20	JAEGER'S METHOD EXPERIMENT	
21	PHOTO CELL EXPERIMENT	
22	NEWTON'S RING EXPERIMENT	



H.O.D.

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PRINCIPAL

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01 PN Junction diode



04 Transistor



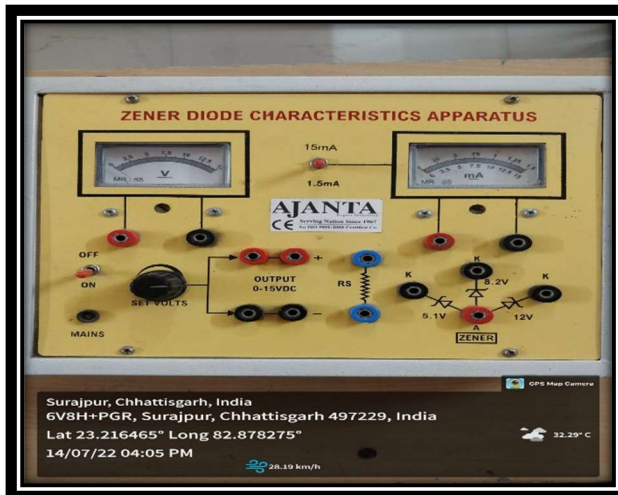
02 Tunnel diode



05 Stefan's Constant apparatus



03 Zener Diode

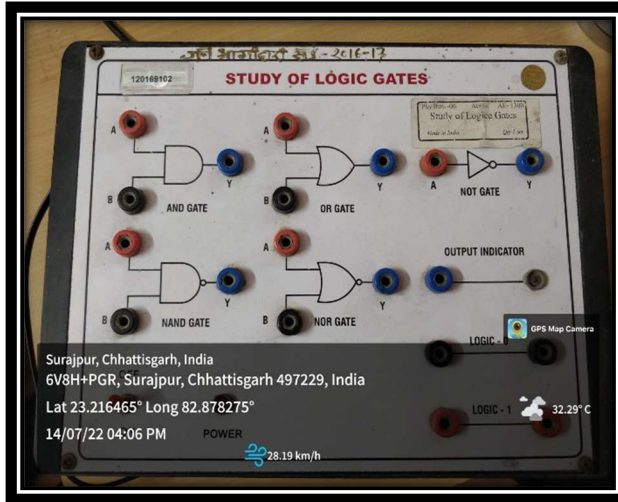


6 F.E.T. apparatus



07

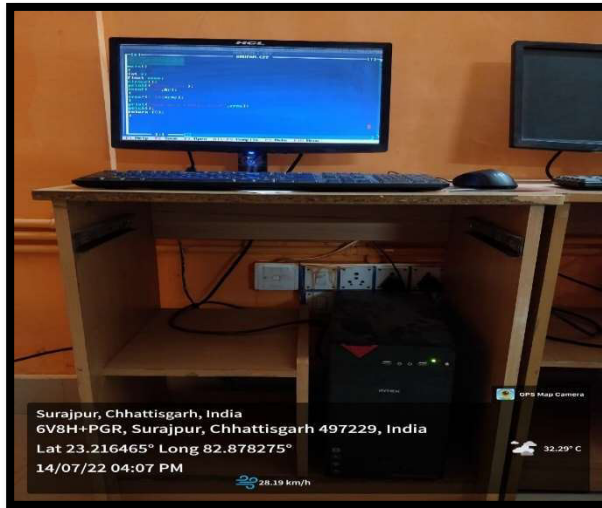
Logic gates



10 Fly Wheel



8 Computer for C Programming



11 Cantilever



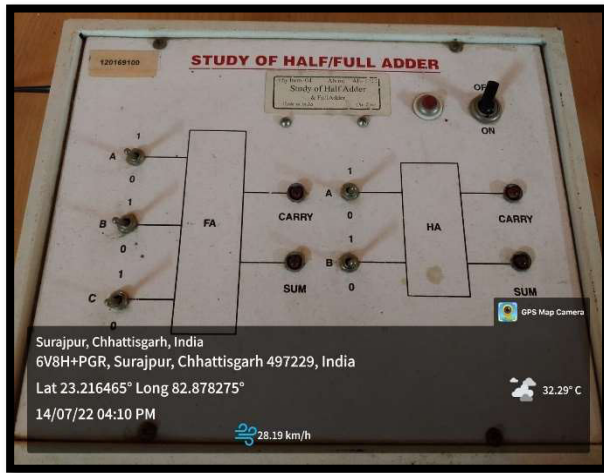
09 Energy Band Gap



12 Ohm's law apparatus



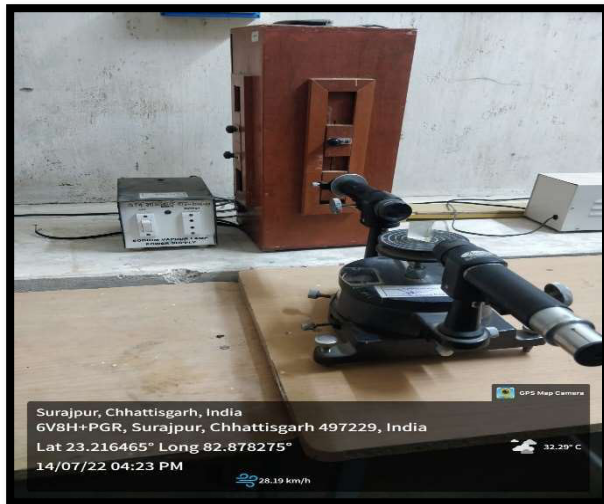
13 Half /Full Adder



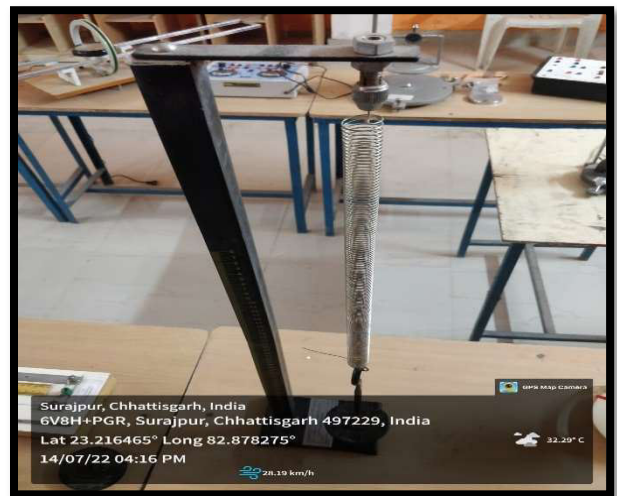
16 Compound pendulum-Bar pendulum



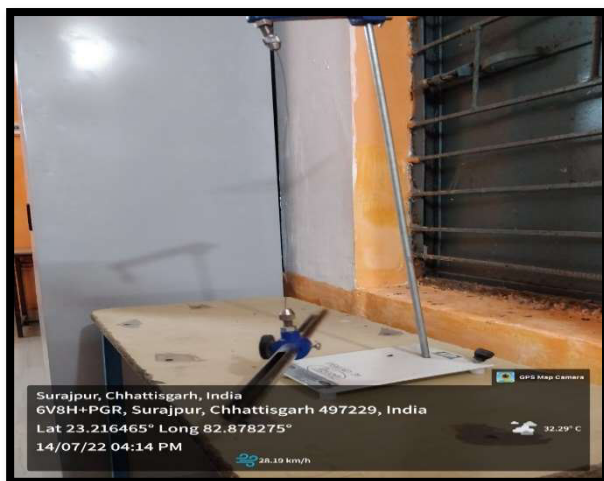
14 Spectrometer



17 Spring constant



15 Maxwells needle



18 Carry fosters bridge



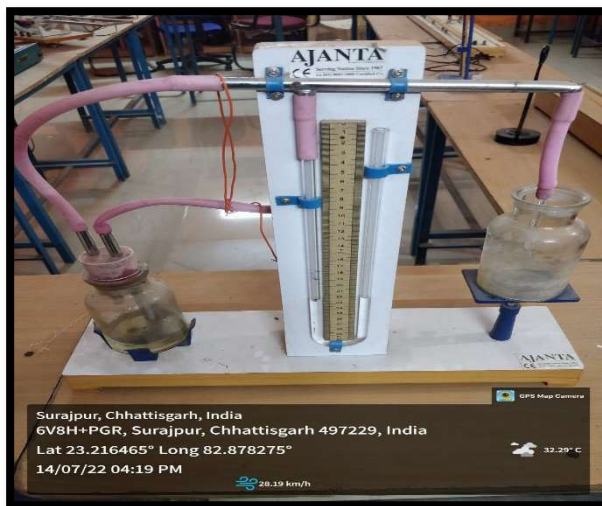
19 Moment of inertia instrument



22 Newtons rings Experiment



20 Jaegers method Experiment



21 Photo cell Experiment



GOVERNMENT RRM P.G COLLEGE, SURAJPUR (C.G)

DEPARTMENT OF ZOOLOGY

LIST OF LABORATORY EQUIPMENTS

1. BINOCULAR COMPOUND MICROSCOPE

2. BENCH TOP CENTRIFUGAL MACHINE

3. DIGITAL PH METER

4. DIGITAL PHOTOCOLORIMETER

5. ELECTRONIC PAN BALANCE MACHINE

6. SIMPLE DESSECTING MICROSCOPE

7. COMPOUND MICROSCOPE

8. ROTATORY MICROTOME SPENCER

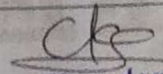
9. DIGITAL BLOOD PRESSURE MONITOR

10. DIGITAL BLOOD GLUCOSE MONITOR

11. DIGITAL WATER TDS METER

12. DIGITAL WATER THERMOMETER

13. HAEMOMETER


Dr. Chandan Kumar
(Asst. Professor)

H. O. D., Dept. of Zoology
Govt. RRM, P.G. College, Surajpur (C.G.)

1 Bino cular compound microscope



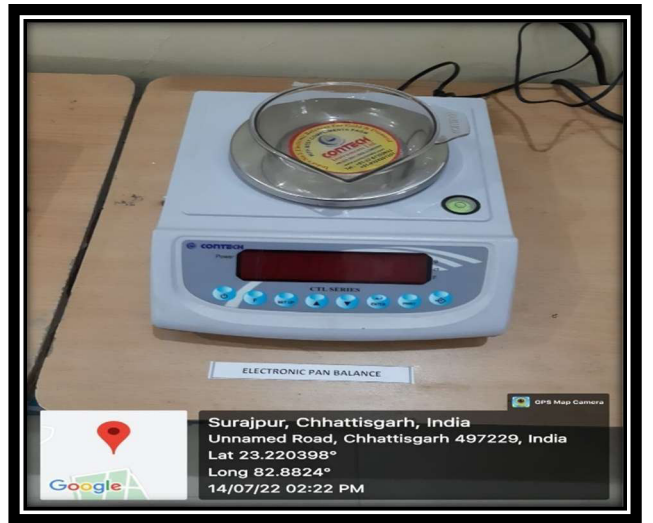
4 Digital Photocolorimeter



2 Bench top centrifugal machine



5 Electronic pan balance



3 Digital PH Meter



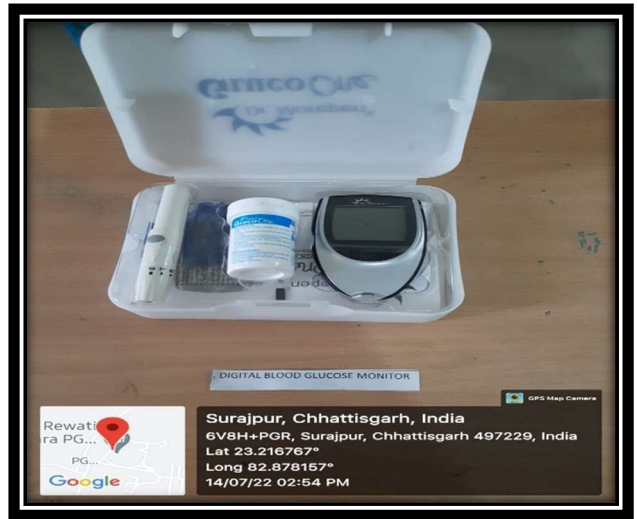
6 Simple dessecting microscope



07 Compound Microscope



10 Digital blood glucose monitor



08 Rotatory microtome spencer



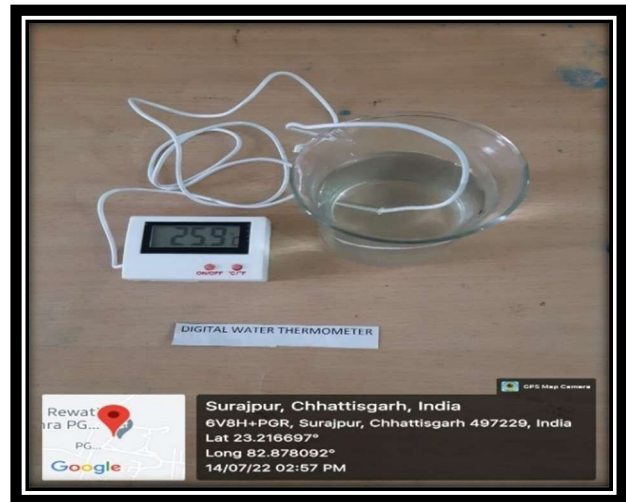
11 Digital water TDS meter



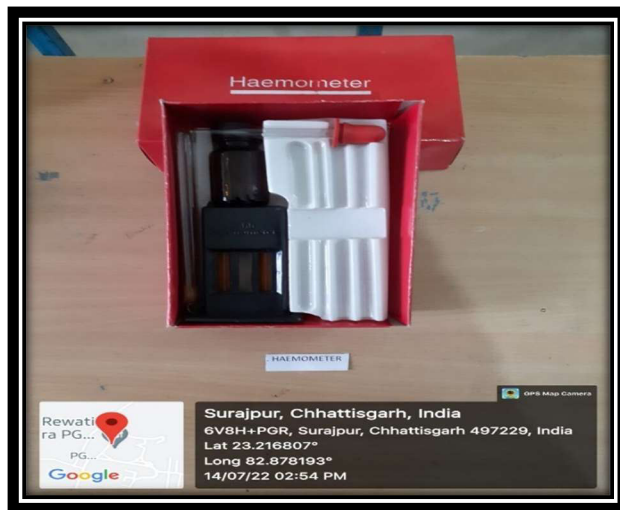
09 Digital blood Pressure monitor



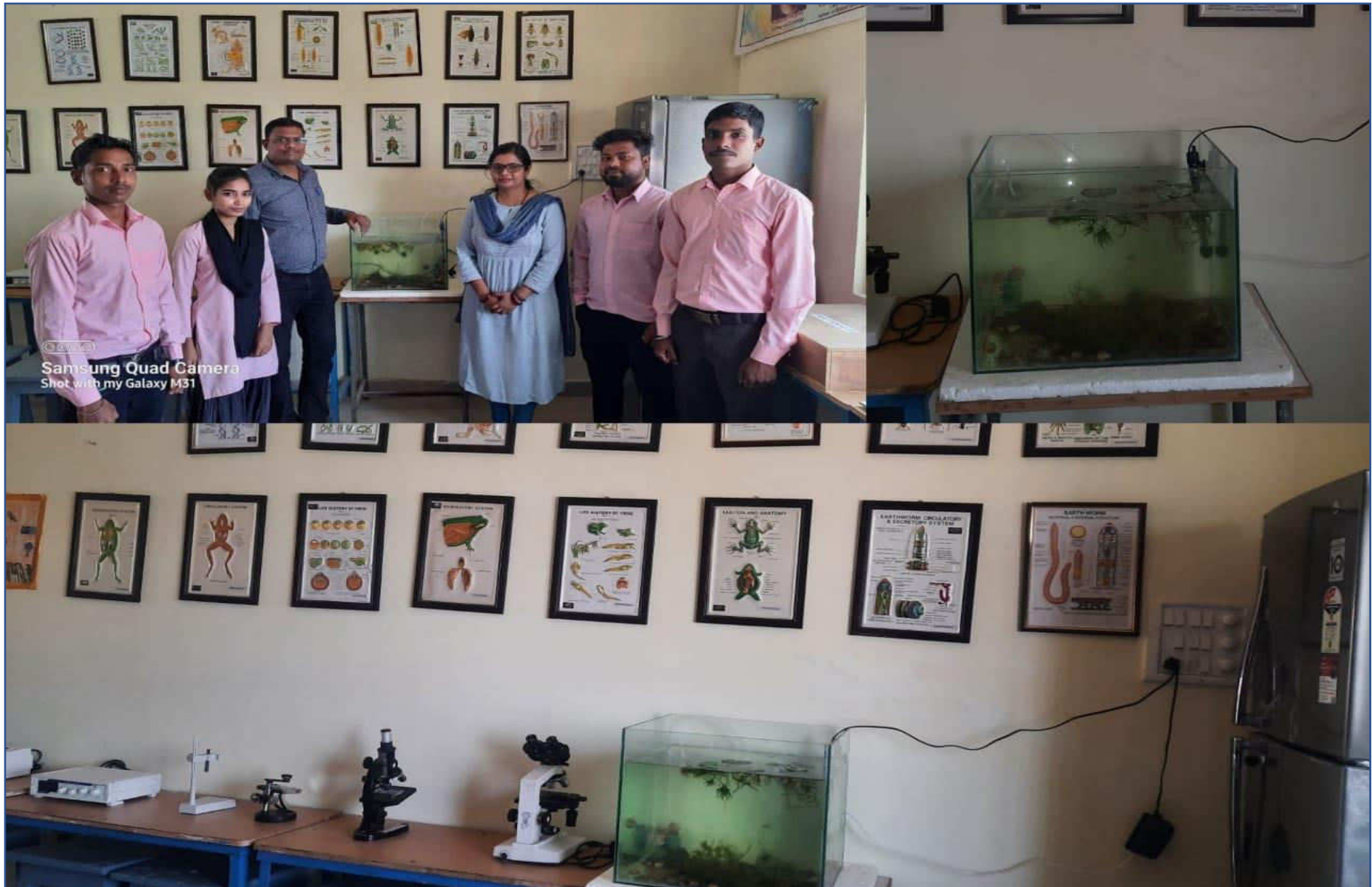
12 Digital Water Thermometer



13 Haemometer



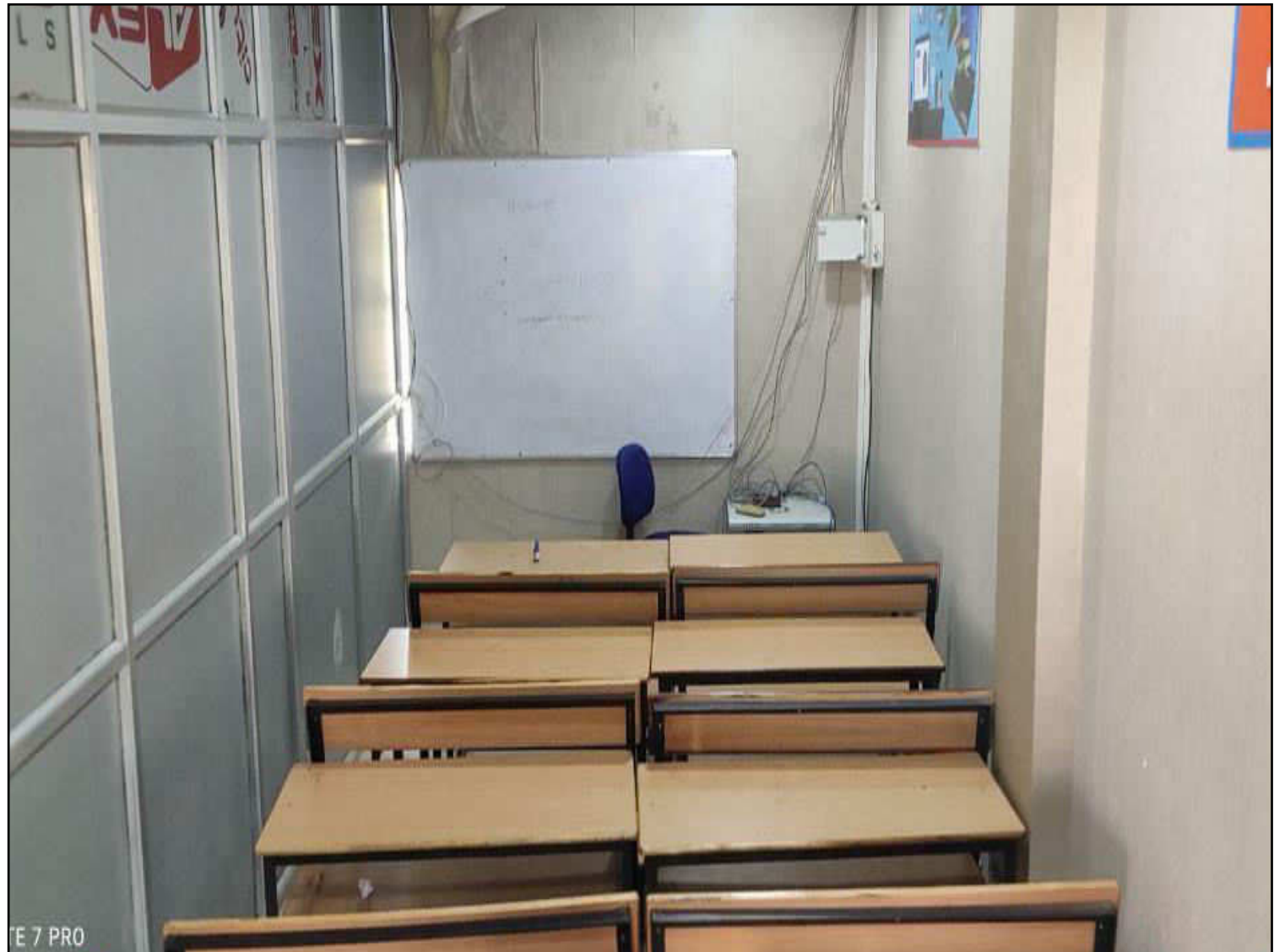
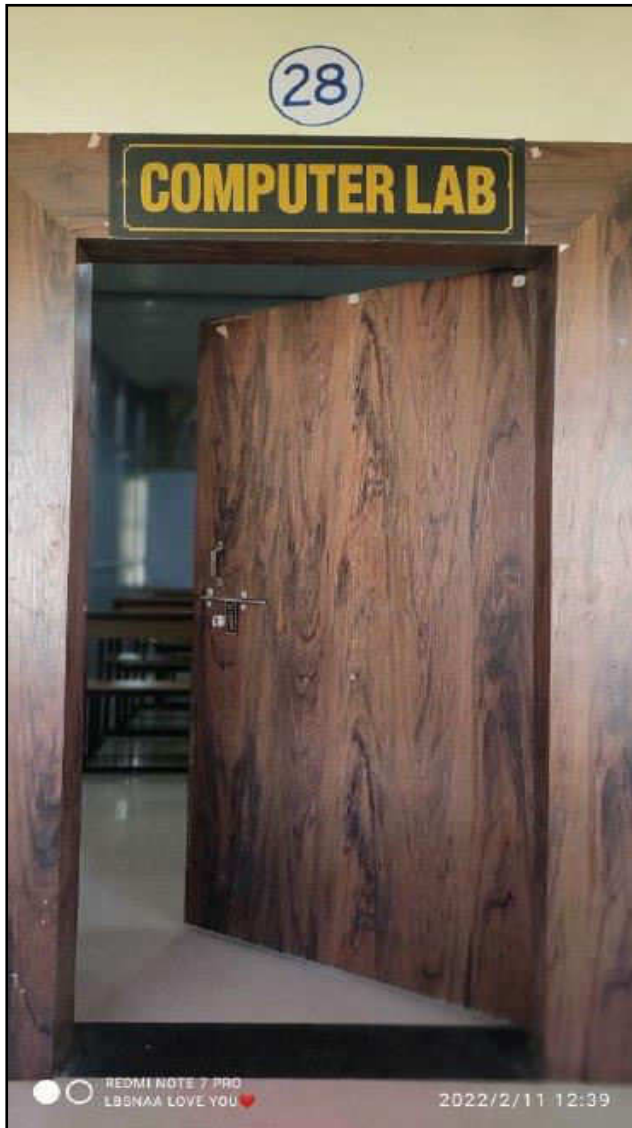
Zoology Department Aquarium



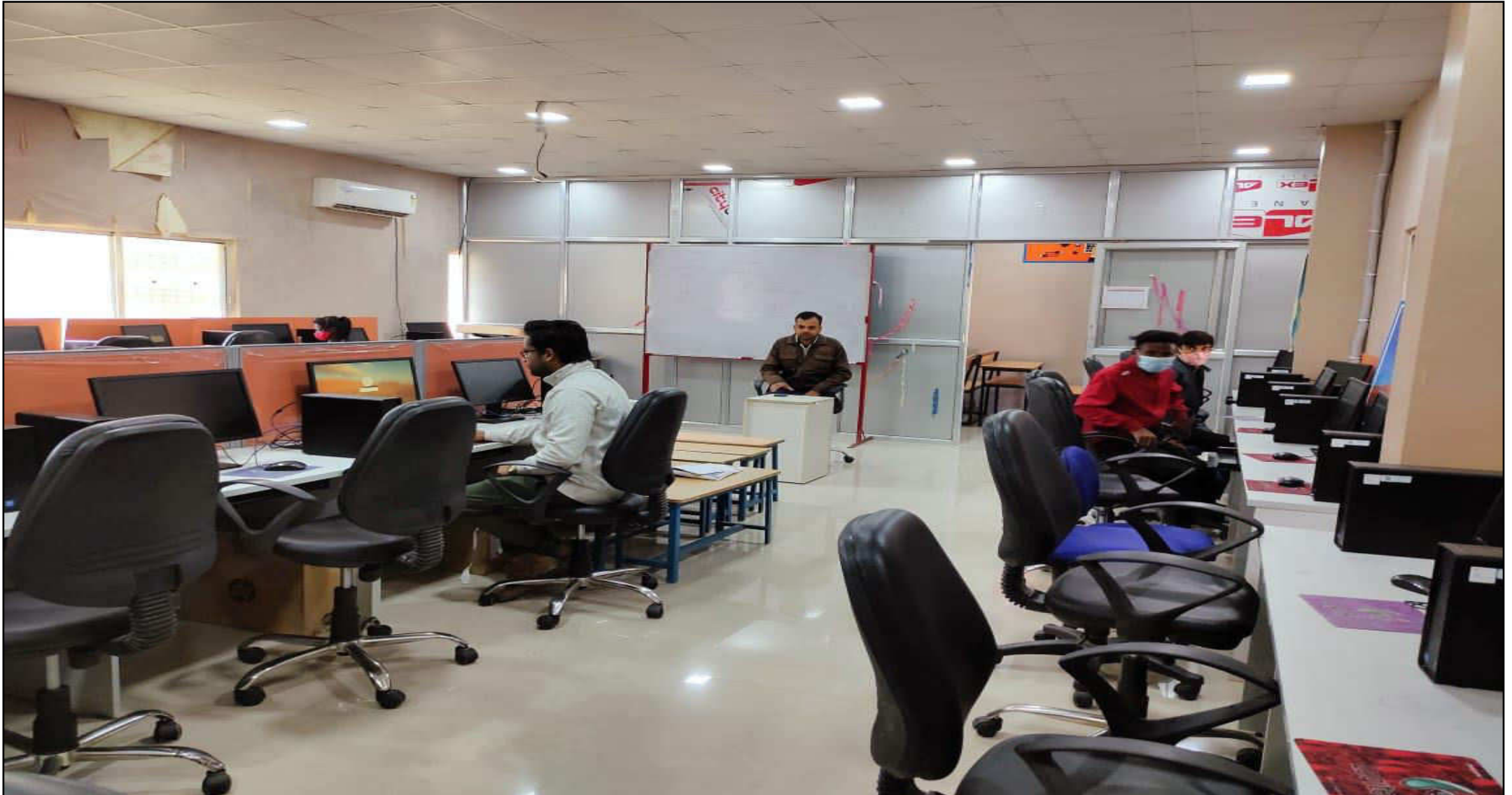
Botany Department Seed box



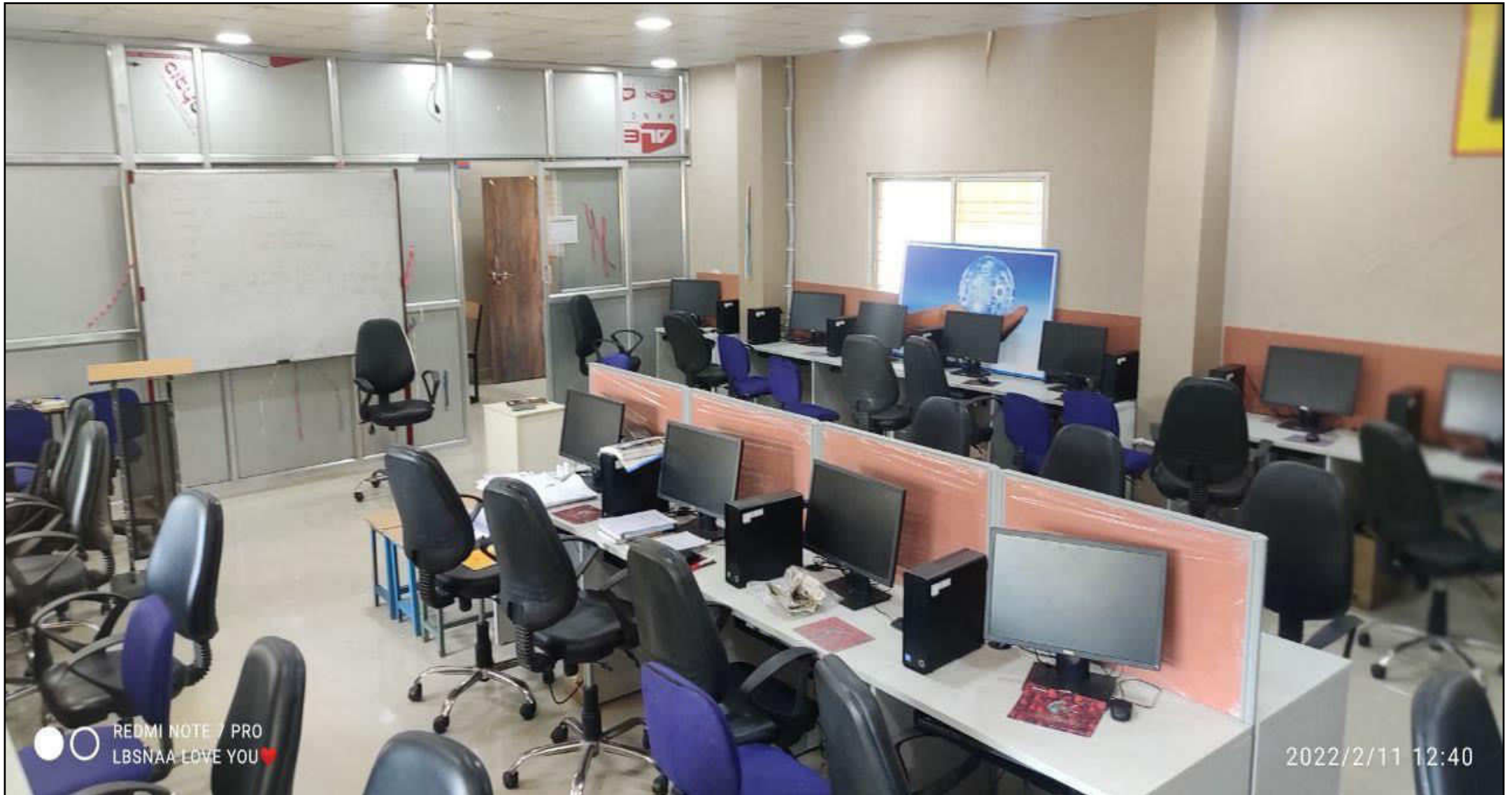
Computer Department & Computer of Theory Classroom



Computer Lab



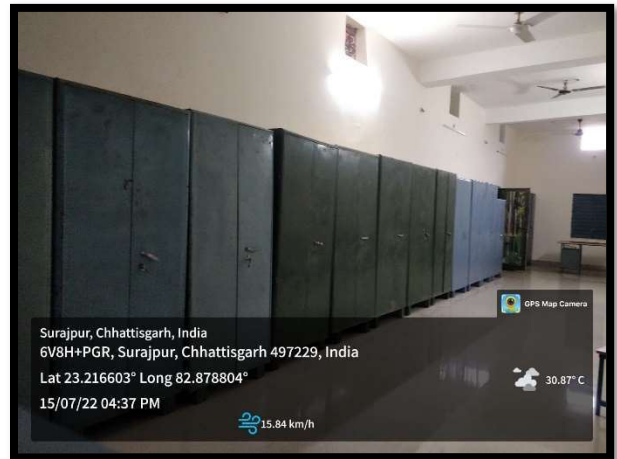
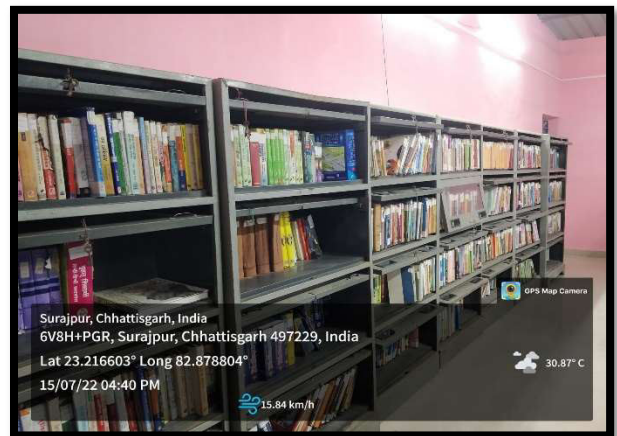
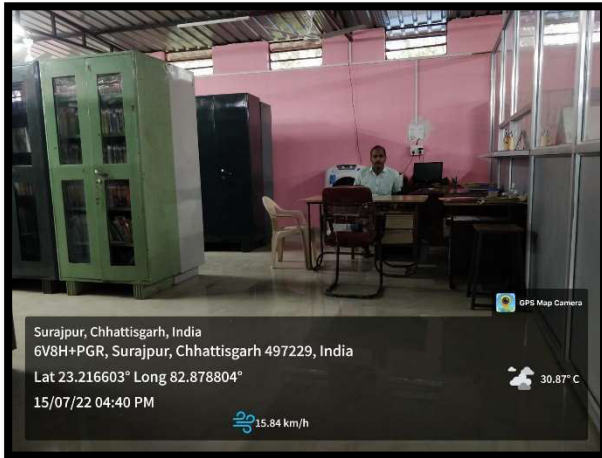
Computer Lab



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Cite this: DOI: 10.1039/d1dt01091c

Synthesis, structural characterization, and bonding analysis of two-coordinate copper(i) and silver(i) complexes of pyrrole-based bis(phosphinimine): new metal–pyrrole ring π -interactions†

Vikesh Kumar Jha,^a Sanghamitra Das,^a Vasudevan Subramanian,^a Tapas Guchhait,^a Kishan Kumar Dakua,^a Sabyashachi Mishra^b and Ganesan Mani^{b*}

The reaction between 2,5-bis(diphenylphosphinomethyl)pyrrole and Me_3SiN_3 gave the new pyrrole-based bis(phosphinimine) **L1H** in an excellent yield. **L1H** reacts with $[\text{CuCl}(\text{COD})]_2$, AgBF_4 , or AgOTf to give the corresponding two-coordinate mononuclear ionic complex formulated as $[\text{M}(\text{L1H})-\kappa^2\text{N,N}]^+[\text{X}]^-$ where $\text{M} = \text{Cu}$ and Ag ; $\text{X} = [\text{CuCl}_2]$, BF_4 or OTf . Their single crystal X-ray diffraction studies confirmed the two-coordinate geometry formed by the chelate bonding mode of **L1H**. These 10-membered metalacycles exhibit planar chirality and were also characterized by spectroscopic methods. In addition, in all three structures, there exists a hitherto unknown π -interaction between the pyrrole ring atoms and metal, represented as $\eta^2-(\text{C}_\alpha-\text{N})$ in the copper(i) complex, and $\eta^3-(\text{C}_\alpha-\text{N}-\text{C}_\alpha)$ in the silver(i) complexes. These weak interactions were supported by DFT calculations in terms of their electron densities, non-covalent interaction plots and the decrease in the aromaticity of the pyrrole ring.

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Introduction

In 1919, Staudinger and Meyer reported a clean synthetic method for an iminophosphorane from phosphine and azide.¹ Although the $\text{P}=\text{N}$ bond is susceptible to undergo hydrolysis² and silylated phosphoraneimines readily react with halide or oxide to give species of the type $\text{HN}=\text{PR}_3$,³ the phosphinimine moiety appended molecules have extensively been used as ligands in main group,⁴ transition,⁵ lanthanide⁶ and actinide⁷ metal chemistry. To mention a few interesting results, the double deprotonation of the methylene group and the formation of the $\text{M}=\text{C}$ double bond have been reported using phosphinimine ligands.⁸ In addition, some of these complexes have been used as precatalysts for several catalytic reactions such as hydroamination⁹ and polymerization of olefins¹⁰ and lactides.¹¹ Notably, Hayes and coworkers have worked on

carbazole^{4g,6a,12} and dibenzofuran^{11a-e} based and pyrrole ring bridged^{6c,7a,13} bis(phosphinimine) ligands.

Pincer framework ligands with a pyrrole ring as the central anchoring unit for transition metal complexes have attracted attention in recent years.¹⁴ Similar to pincer ligands containing a central aryl ring, pyrrole-based ligands are versatile and a variety of complexes containing metals across the periodic table have been reported.^{14a} Yet, the difference lies in the presence of an electron rich five-membered pyrrole ring which promotes its ligand systems to form not only a σ bond, but also to form π bonds.¹⁵ This behavior helps in building multinuclear complexes by the bridging mode of this ligand system. In relevance to this topic of research, a few years back, 2,5-bis(diphenylphosphinomethyl)pyrrole **1** has been reported and it adopts the bridging mode of coordination when forming binuclear copper(i) and silver(i) complexes.¹⁶ The analogous 3,5-dimethylpyrazole substituted ligand¹⁷ and its dipyrrolylmethane analogue 1,9-bis(3,5-dimethylpyrazolylmethyl)dipyrrolylmethane¹⁸ form linear silver(i) coordination polymeric structures containing silver(i)–pyrrole ring π -interactions. These π -interactions have also been found in several multipyrrole ligand systems,¹⁹ however, they are relatively new findings represented as $\eta^2-\text{C}_\alpha-\text{C}_\beta$,^{17,18} $\eta^2-\text{C}_\beta-\text{C}_\beta$,²⁰ and $\eta^1-\text{C}_\beta$ ²¹ (Chart 1) as compared to silver(i)–arene π -interactions.²² These π -interactions have been aptly utilized for synthesizing diverse supramolecular architectures²³ and found important

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†Electronic supplementary information (ESI) available: NMR, IR, crystallographic and DFT diagrams and data. CCDC 2074436–2074439 for complexes 2–5. For ESI and crystallographic data in CIF or other electronic format see DOI: 10.1039/d1dt01091c

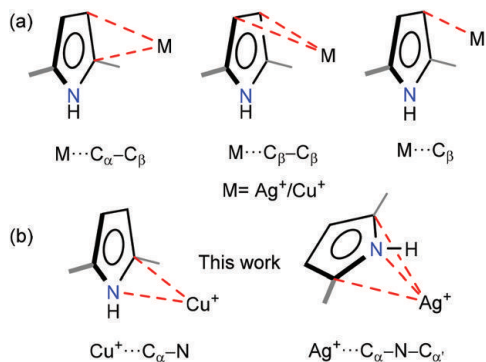


Chart 1 (a) The reported pyrrole ring π -interactions with the silver(i) or copper(i) cations and (b) the new metal–pyrrole ring π -interactions presented in this work.

applications such as in the separation of ethylene from paraffins.²⁴

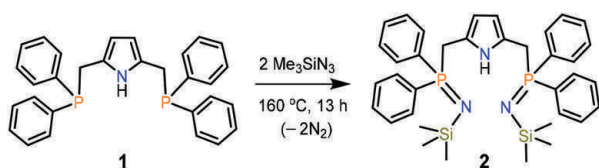
To expand the coordination chemistry of pyrrole containing ligands, we became curious to see what type of copper or silver complexes would form when P(III) bis(phosphine) **1** is changed to a P(V) bis(phosphinimine) derivative. Herein, we report a rather new coordination behavior of this new derivative when treated with the same copper(i) or silver(i) precursor. In addition, a hitherto unknown π -interaction of the pyrrole ring with the metal ion is also described with the support of DFT calculations.

Results and discussion

Bis(phosphinimine) ligand

The Staudinger reaction between 2,5-bis(diphenylphosphino)methylpyrrole **1** and Me₃SiN₃ in a 1 : 2 mole ratio at 160 °C afforded bis(phosphinimine) **2** in 80% yield as an air-sensitive colorless solid (Scheme 1). The ¹H NMR spectrum of **2** in CDCl₃ showed a fairly clean NMR spectrum. Its methylene protons resonate at δ 3.48 ppm, and shifted downfield as compared to that (3.30 ppm) of the parent phosphine **1**. The presence of a single environment for the phosphorus atoms at room temperature is shown by its ³¹P{¹H} NMR spectrum displaying a singlet at δ -0.4 ppm, which is also shifted downfield from that of the parent compound (-16.3 ppm).

The single crystal X-ray analysis of **2** was carried out for the comparison of bond distances with its metal complexes (see below). It crystallizes in the non-centrosymmetric orthorhombic space group C222₁ with one half of the molecule in



Scheme 1 Synthesis of bis(phosphinimine) ligand **2**.

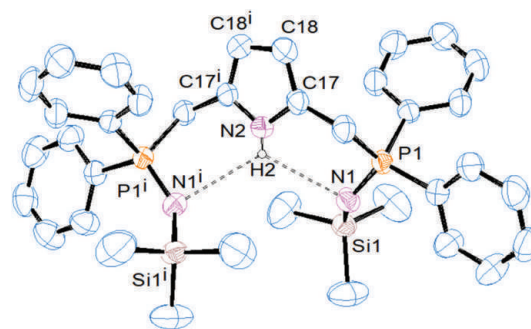


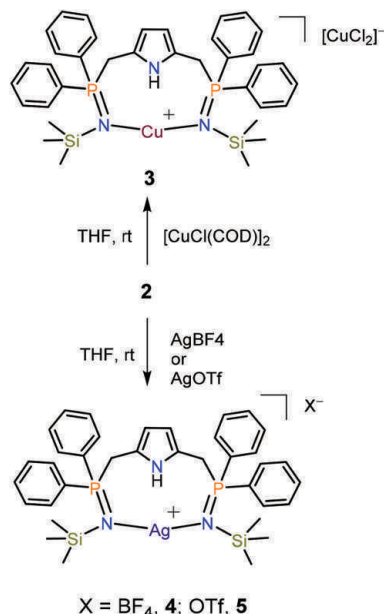
Fig. 1 ORTEP diagram of the X-ray structure of compound **2**. Most hydrogen atoms are omitted for clarity. Selected bond lengths [Å] and angles [°]: P1–N1 1.544(2), Si1–N1 1.682(2), N2–C17 1.363(3), C17–C18 1.360(4), C18–C18' 1.420(6), P1–N1–Si1 139.6(1), N1...N2 3.039(3), N1...H2 2.626(19), N2–H2...N1 119.3(8). Symmetry transformation 1 - X, +Y, 3/2 - Z.

the asymmetric unit. The full molecule was generated by the C₂ axis passing through the pyrrole nitrogen and the middle of β -carbons of the pyrrole ring. An ORTEP view is shown in Fig. 1 with selected bond distances and angles. It revealed that the trimethylsilylimine arms lie above and below the pyrrole ring plane to avoid steric conflicts and the pyrrole NH forms bifurcated hydrogen bonds with the imine nitrogens. The P1–N1 bond length of 1.544(2) Å remains close to the reported values ranging from 1.526(3) to 1.539(3) Å in phosphinimines containing the trimethylsilylimine group.^{3a,5e,g,25} The Si1–N1 bond distance of 1.682(2) Å is close to the reported value 1.679(3).²⁵ The P1–N1–Si1 bond angle of 139.6(1)° is lower than those (145.2(2),²⁵ 150.2(2)^{3a} and 160.7(2)^{5g}) found in the trimethylsilylated phosphinimines probably owing to the presence of bifurcated hydrogen bonding in the molecule.

Copper(i) and silver(i) complexes

The room temperature reaction between ligand **2** and [CuCl(COD)]₂ in a 1 : 1 molar ratio in THF gave the ionic copper(i) complex **3** as colorless crystals. The analogous reaction of AgBF₄ or AgOTf with **2** yielded similar two coordinate silver(i) complexes **4** or **5**, respectively, in good yields (Scheme 2). The ¹H NMR spectrum of **3** in CDCl₃ showed broad shifted peaks relative to those of the free ligand, indicating the coordination of the ligand. In support of this, the ³¹P{¹H} NMR spectrum showed a singlet at δ 35.7 ppm, shifted downfield (36.1 ppm) from that of ligand **2** (δ = -0.4 ppm). The silver complexes **4** and **5** also showed broad resonances in their ¹H NMR spectra and singlets at δ = 23.7 and 23.8 ppm, respectively, in their ³¹P{¹H} NMR spectra for the presence of one phosphorus environment in their structures.

Complex **3** crystallizes in the triclinic centrosymmetric space group P $\bar{1}$ and the asymmetric unit contains the full molecule. An ORTEP diagram along with selected bond lengths and angles is given in Fig. 2. The crystal refinement data are given in the ESI (Table S1†). The X-ray structure revealed the ionic nature of the complex. The cation consists



Scheme 2 Synthesis of the copper(I) and silver(I) complexes of ligand 2.

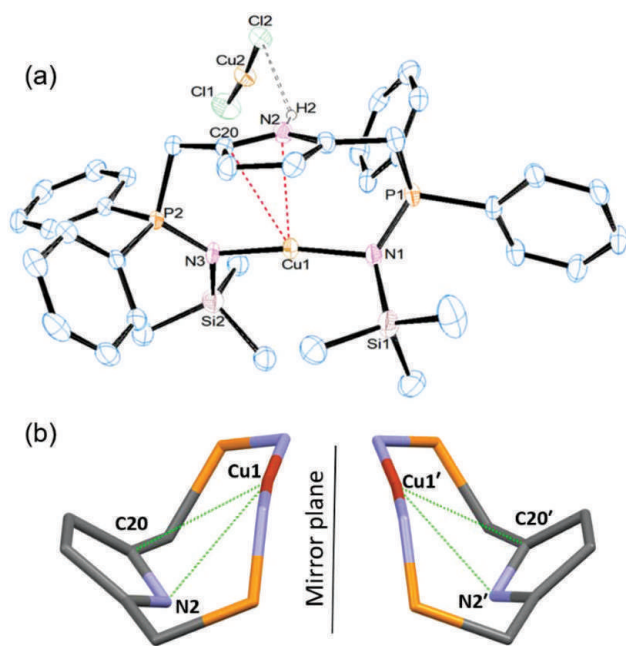


Fig. 2 (a) ORTEP diagram of the X-ray structure of copper(I) complex 3. Most hydrogen atoms are omitted for clarity. Selected bond lengths [Å] and angles [°]: N1–P1 1.593(3), N1–Si1 1.755(3), N1–Cu1 1.919(3), P2–N3 1.598(3), Cl1–Cu2 2.087(1), Cl2–Cu2 2.099(1), Cu1–N3 1.905(3), N3–Si2 1.792(6), Si1–N1–Cu1 111.0(2), P1–N1–Si1 127.6(2), P1–N1–Cu1 117.1(2), N3–Cu1–N1 170.8(1), Cl1–Cu2–Cl2 175.77(5), P2–N3–Cu1 123.1(2), P2–N3–Si2 126.5(3), Si2–N3–Cu1 110.3(3), N2...Cl2 3.247(3), H2...Cl2 2.55(4), N2–H2...Cl2 146(3). (b) The core structure of complex 3 exhibiting planar chirality.

of one copper(I) atom and one ligand 2, and is charge neutralized by the CuCl₂⁻ anion. The ligand adopts the chelation coordination mode *via* its two imine nitrogen atoms, resulting

in the formation of the 10-membered metalacycle containing the two-coordinate copper(I) atom. The geometry around the copper(I) atom is pseudolinear with an N3–Cu1–N1 angle of 170.8(1)°, which is close to the values (171.5(4)° and 171.2(2)°) reported for two-coordinate copper(I) complexes.²⁶ In addition, although the observed value is lower than the ideal 180.0(2)° reported for bis(acetonitrile),²⁷ and decaphyrin²⁸ copper(I) complexes and other values (173.8° and 178.2°),²⁹ it remains greater than the angles of 168.5°³⁰ and 167.9(1)°³¹ found in other two-coordinate copper(I) complexes. The N1–P1 and N3–P2 distances of 1.593(3) and 1.598(3) Å, respectively, are slightly longer than 1.544(2) Å found in the free ligand structure owing to the imine nitrogen coordination. One of the chlorine atoms of the CuCl₂⁻ anion is hydrogen bonded to the pyrrole NH with a Cl2...N distance of 3.247(3) Å which lies within the sum of the van der Waals radii of the N and Cl atoms.³² The Cu–Cl distances and the Cl–Cu–Cl angle in the CuCl₂⁻ anion are similar to those reported values.^{33,34}

The chelation mode of the ligand drives the pyrrole ring to face the copper atom (Cu1) in which one of the α-carbons (C20) and the nitrogen (N2) atoms have short contacts: Cu1–C20 = 3.066(3) Å and Cu1–N2 = 2.789(3) Å. This Cu1–C20 distance is longer than those (2.519(5) to 2.704(5) Å) reported for the pyrrole ring C_α–C_β π-interaction with the copper(I) atom.³³ However, both the distances are shorter than the sum of the van der Waals radii (3.10 Å and 2.95 Å, respectively)³² of the respective atoms and hence they represent a weak η²-(C_α–N) π interaction; it is new and analyzed by DFT calculations (see below). The trimethylsilyl groups are tilted about the N–Cu–N vector with a Si–N–Si torsion angle of –77.1(6)° owing to steric hindrance between the two Me₃Si groups. Interestingly, the molecule exhibits planar chirality with this Me₃Si group orientation and π-interaction (Fig. 2b), and both enantiomers are present in the crystal lattice (see the ESI, Fig. S16†).

It is noted that the binuclear complexes of the type [Cu(μ-Cl)(μ-L)]₂ containing the wide bite angle ligands L such as 2,5-bis(diphenylphosphinomethyl)pyrrole,¹⁶ 2,5-bis(3,5-dimethylpyrazolylmethyl)pyrrole¹⁷ and 1,6-bis(diphenylphosphino)hexane³⁵ have been reported. Although ligand 2 has a longer flexible link between the donor atoms, the non-formation of this type of binuclear complex can be attributed to the steric hindrance between the trimethylsilyl groups of two ligands when bridges two copper(I) or silver(I) atoms.

An ORTEP view of the X-ray structure of complex 4 and 5 is shown in Fig. 3 and the refinement data are given in the ESI (Table S1†). Their asymmetric units contain both the cationic and anionic parts of the complex, in addition to one THF in their crystal lattices. Like the structure of 3, the two-coordinate pseudolinear geometry around the silver(I) cation is charge neutralized by the BF₄⁻ or OTf⁻ anion. The N–Ag–N angle of 172.8(1)° and 174.6(1)° in 4 and 5, respectively, is slightly higher than that found in complex 3. However, these angles are smaller than the linear or nearly linear angles found in diammine silver(I) complexes [Ag(NH₃)₂]⁺ containing different anions;³⁶ it is attributed to the steric crowding around the

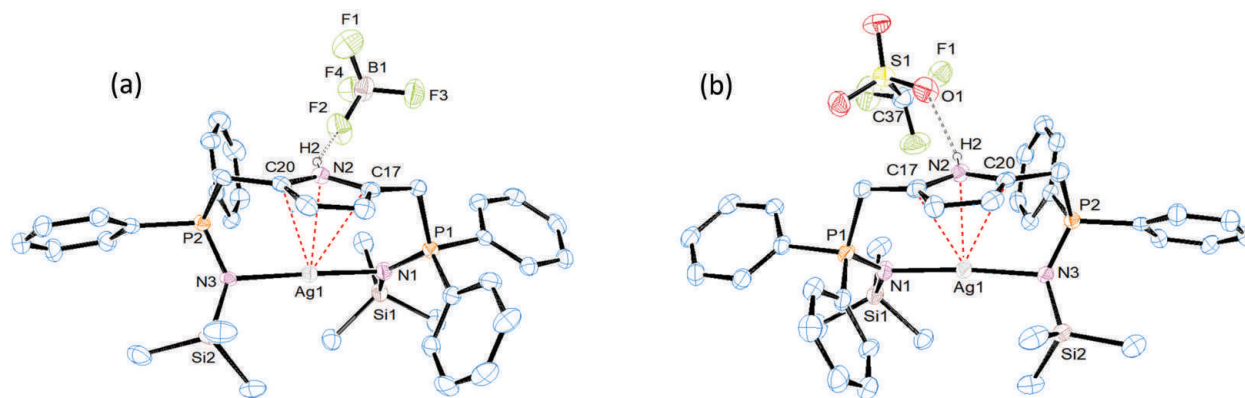


Fig. 3 ORTEP diagrams of the silver(I) complexes: (a) **4** and (b) **5**; most hydrogen atoms are omitted for clarity. Selected bond lengths [Å] and angles [°]: for **4**: N1–Si1 1.731(3), N1–P1 1.587(3), N1–Ag1 2.143(3), N3–Si2 1.733(3), N3–P2 1.588(3), N3–Ag1 2.151(3), F1–B1 1.383(6), F2–B1 1.403(5), F3–B1 1.372(5), F4–B1 1.371(5), Si1–N1–Ag1 109.5(2), P1–N1–Si1 132.3(2), P1–N1–Ag1 118.2(2), Si2–N3–Ag1 114.0(2), P2–N3–Si2 130.0(2), P2–N3–Ag1 111.2(2), N1–Ag1–N3 172.8(1), N2...F2 2.810(4), H2...F2 1.99(4), N2–H2...F2 156(4). For **5**: N1–P1 1.584(4), N1–Ag1 2.140(4), N1–Si1 1.737(4), N3–P2 1.584(4), N3–Ag1 2.153(4), N3–Si2 1.738(4), P1–N1–Ag1 115.4(2), P1–N1–Si1 132.1(2), Si1–N1–Ag1 112.3(2), P2–N3–Ag1 111.9(2), P2–N3–Si2 134.9(2), Si2–N3–Ag1 109.4(2), N1–Ag1–N3 174.6(1), N2...O1 2.896(5), H2...O1 2.15(5), N2–H2...O1 142(4).

imine nitrogen and the chelation coordination mode of ligand **2**. Furthermore, the Ag–N distances range from 2.143(3) to 2.153(4) Å and are slightly longer than those found in diammine silver(I) complexes, for example, 2.124(1) Å in [Ag(NH₃)₂][OAc].³⁶ The pyrrole NH is hydrogen bonded to the fluorine atom of the BF₄[−] ion in **4** and to the oxygen atom of the OTf[−] ion in **5** and their parameters are given in Fig. 3. Furthermore, the two trimethylsilyl groups are oriented along the N–Ag–N vector with the Si–N–N–Si torsion angle of 94.33 (19)° in **4** and −92.0(2)° in **5**. Both molecules exhibit planar chirality and both enantiomers are present in their crystal lattices (see the ESI, Fig. S17 and S18†).

Similar to complex **3**, the pyrrole ring plane faces the silver atom and provides short contacts to the silver atom. Of these, the Ag–N_{pyrrole} distance (2.809(3) Å in **4** and 2.795(3) Å in **5**) and the two Ag–C_α distances (3.142(3) Å and 3.193(4) Å in **4** and 3.117(4) Å and 3.226(5) Å in **5**) lie within the sum of the van der Waals radii of the respective atoms (Ag + C = 3.40 and Ag + N = 3.25),³² and can represent weak η³-(C_α–N–C_α) π-interactions with the silver atom. As a result, the pyrrole ring C_α–N distances (1.381(5) Å and 1.375(5) Å in **4** and 1.383(7) Å and 1.379(6) Å in **5**) are slightly longer than that in the free ligand (1.363(3) Å). Given the reported pyrrole ring interactions with silver ions,¹⁹ such as η²-C_α–C_β,^{17,18} η²-C_β–C_β²⁰ and η¹-C,²¹ the observed interaction is new and analysed using DFT calculations.

DFT calculations

The optimized structure of complex **3** compares well with that of the crystal structure. The coordination of the imine nitrogens with the copper atom is reflected by the calculated Cu1–N1/Cu1–N3 bond distance of 1.944/1.917 Å (Table S2†), which is marginally longer compared to their crystal structure values of 1.919(3)/1.905(3) Å. The electron density ($\rho \sim 0.1$ a.u.) and the Laplacian of the electron density values (Table 1) at the

Table 1 Electron density (ρ) and its Laplacian at metal (M)–nitrogen bond critical points

Complex	Electron density (ρ) in a.u. at the bond critical point			Laplacian of the electron density in a.u. at the bond critical point		
	M–N1	M–N3	M–N2	M–N1	M–N3	M–N2
3	0.0983	0.1017	0.0178	0.552	0.564	0.041
4	0.0826	0.0813	0.0213	0.362	0.354	0.071
5	0.0831	0.0813	0.0220	0.363	0.352	0.073

bond-critical point between the copper and imine nitrogen atoms support the Cu–N_{imine} bonds in the crystal structure. In addition, upon metalation, the P–N_{imine} and Si–N_{imine} distances increased by about 0.05 Å from their values in the optimized geometry of the free ligand. This is accompanied by a decrease in the bond order of the corresponding bonds (see Table S3†). In particular, the (Mayer) bond order calculated for the P–N_{imine} double bond decreased from 1.7 in the free ligand to 1.4 in metal complex **3**.

The calculated Cu–N_{pyrrole} distance of 2.837 Å is close to 2.789(3) Å found in the crystal structure. Similarly, the distances between the α -carbons of pyrrole and the copper atom are calculated to be 3.222 and 3.001 Å, which is in good agreement with the crystal structure distance (3.217(4) and 3.066(3) Å). However, from the QTAIM analysis, only the Cu–N_{pyrrole} distance exhibits a bond critical point with an electron density value of 0.01 a.u., suggesting an order of magnitude weaker interaction as compared to the Cu–N_{imine} bonds (Table 1 and Fig. 4a). Such weak interactions can be ascribed to the Cu(I) ...pyrrole π -interaction and are better characterized by the NCI plots, where the nature of interactions are represented by the 3-dimensional gradient isosurface (Fig. 4 and S19†) and the plot of reduced density gradient versus $\text{sign}(\lambda_2)\rho$ (Fig. S20†). They show the presence of van der Waals interaction for −0.01

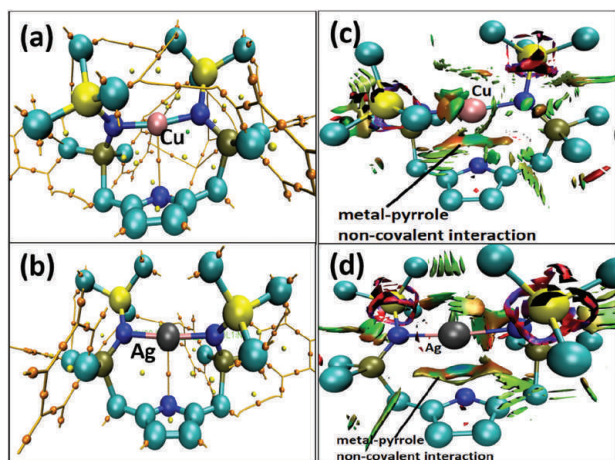


Fig. 4 The molecular graphs of copper(i) complex **3** (a) and silver(i) complex **5** (b) obtained from QTAIM. The non-covalent interaction in copper(i) complex **3** (c) and in silver(i) complex **5** (d). The phenyl rings and hydrogen atoms are not shown for clarity. C, N, P, Si, Cu, and Ag are shown in cyan, blue, tan, yellow, pink, and gray, respectively. The bond and ring critical points in (a) and (b) are shown in orange and yellow, respectively. A bond-critical point is found between the metal and the N atom of the pyrrole ring in (a) and (b). The isosurface between the metal ion and the pyrrole ring in (c) and (d) indicates the metal–pyrrole non-covalent interaction (the green surface for the attractive interaction and the brown surface for the van der Waals interaction).

$\langle \text{sign}(\lambda_2)\rho \rangle < 0.0$, attractive interaction for $\text{sign}(\lambda_2)\rho < -0.01$ and steric repulsion for $\text{sign}(\lambda_2)\rho > 0.005$.³⁷ Here, λ_2 is the second largest eigenvalue of the electron density Hessian matrix. In the NCI plots (Fig. 4), the greenish-blue shade between the pyrrole nitrogen and the metal ion reveals an attractive non-covalent interaction. The continuum of a greenish-brown isosurface between the C_α – C_β of pyrrole and the metal ion indicates a van der Waals interaction, which is more prominently congregated at one of the two α -carbons (C_{20}) of the pyrrole in the copper(i) complex (Fig. 4c). Hence, the interaction of the pyrrole ring with the copper atom is described as a weak η^2 (C_α –N) π -coordination.

The curvature of the electron density perpendicular to the ring plane at the ring critical point (RCP) is a good indicator of the aromaticity of the concerned ring.³⁸ It has been shown that the more negative the curvature of the electron density, the greater the ring aromaticity. In the case of the free ligand, the electron density curvature at the RCP of the pyrrole plane has large negative values, showing strong aromaticity. Upon complexation, these values turn positive indicating the loss of aromaticity, which is attributed to the presence of a metal–pyrrole nitrogen π -interaction. In addition, the Bird aromaticity index, which is used to assign the aromaticity of a ring depending on how close this index is to 100,³⁹ also shows the loss of aromaticity of the pyrrole ring upon metalation (Table S4†).

Similar to complex **3**, both silver(i) complexes **4** and **5** show the Ag– N_{imine} bonds that are characterized by a strong electron density at the corresponding bond critical points (Table 1 and

Fig. 4b). This coordination of the imine nitrogens results in an increase in the P– N_{imine} and Si– N_{imine} distances and a decrease in their bond orders as compared to their values in free ligand **2** (Table S3†). Both the optimized structures of complexes **4** and **5** showed the Ag– N_{pyrrole} , Ag– $C_{\alpha\text{pyrrole}}$ and Ag– $C_{\alpha'\text{pyrrole}}$ distances close to those found in their crystal structures. These distances indicate the presence of weak attractive non-covalent interactions and are represented as the η^3 -pyrrole interaction with the silver atom. This is supported by the electron density at the bond-critical point and the NCI plots. The Laplacian of the electron density between the silver and pyrrole ring nitrogen atoms is about 25% greater than that in complex **3**, indicating a stronger bond represented by the greenish-blue region between the centers (Fig. 4d). In addition, in the NCI plots (Fig. 4d), a broad greenish-brown isosurface between the pyrrole ring C_α and metal indicates a weak van der Waals interaction, representing the η^3 coordination mode of the pyrrole ring. Owing to this stronger Ag–pyrrole interaction, the aromaticity index of the pyrrole ring shows a significant loss of aromaticity (both in terms of the curvature of the electron density as well as the Bird aromaticity index) as compared to the copper(i) complex (Table S4†).

In all three structures, the chelating mode of the ligand brings the pyrrole ring plane to face the metal atom with the above-mentioned π -interactions, leading to a greater stabilization of their structures. This suggests that any deviation from planarity would point N–H towards the metal centre which would be a destabilising contribution. However, the optimized geometry of the copper(i) complex containing the deprotonated form of the ligand shows the three-coordinate copper(i) structure containing the bis-chelated ligand in which the pyrrole nitrogen is σ -bonded (see the ESI, Fig. S21†), replacing π -interactions.

The optimized geometry of the bis(phosphinimine) ligand **2** shows a marginally relaxed structure as compared to the crystal structure, which is expected since DFT calculations were carried out on a single molecule, unlike the crystal structure which is influenced by crystal packing. The optimized structure shows bond distances and angles close to those found in the crystal structure (Table S2†). Furthermore, in the crystal structure of ligand **2**, the two trimethylsilylated imine arms are pointing in opposite directions with respect to the pyrrole ring, whereas in the crystal structure of complex **3**, **4** or **5**, these arms are on the same side and chelating to the metal. The energy difference between these two conformations of the ligand will give an approximate strain energy of the ligand, as reported by Colbran and coworkers.⁴⁰ The ligand energy in the crystal structure conformation was obtained from a single-point DFT computation after excluding the metal atom in the crystal structure. The ligand strain energies in complexes **3**, **4**, and **5** were estimated from ω b97xd/def2svp as well as from B3LYP (with empirical dispersion)/def2svp levels of theory. Both the methods yielded similar values of ligand strain energy between 23 and 25 kcal mol^{−1} (Table S5†) for all three complexes. However, the energy of stabilization upon coordination outweighs these strain energies.

Conclusions

The new P(v) bis(phosphinimine) **2**, synthesized from P(III) bis(phosphine) **1** in high yield, gives unusual ionic two-coordinate copper(I) and silver(I) complexes containing unhydrolyzed P=N bonds. This is in contrast to the parent phosphine **1** which gave binuclear copper(I) and silver(I) complexes containing the bridging mode of coordination. Although the link between the donor atoms is increased in **2** relative to the parent phosphine **1**, the bis(phosphinimine) ligand adopts chelation rather than the bridging mode of coordination with these ions which require 180° for the two-coordinate linear geometry otherwise possible only with monodentate ligands. It could be attributed to the very interesting π -interactions found in the structure of copper(I) [η^2 -(C $_{\alpha}$ -N)] and silver(I) [η^3 -(C $_{\alpha}$ -N-C $_{\alpha}$)] complexes representing the new modes of non-covalent interactions of the pyrrole ring which usually adopts η^2 -(C $_{\alpha}$ -C $_{\beta}$), η^2 -(C $_{\beta}$ -C $_{\beta}$) or η^1 -C $_{\beta}$ π -interactions. Furthermore, these interactions were supported by DFT calculations in terms of their electron densities, NCI plots and the decrease in the aromaticity of the pyrrole ring. Given this variance, the pyrrole ring interactions with metal cations are flexible and vary with the nature of the electronic structure of the metal cation, as shown by the η^2 - mode in the copper(I) ion, while it is η^3 in the silver(I) ion. It then suggests that supramolecular architectures incorporating both aryl and heterocycle pyrrole rings would be better for trapping these ions, which would have better sorption properties. Work in this direction is underway and metal complexes of the bis(phosphinimine) derivative of multipyrrole ligands are under investigation in our laboratory.

Experimental section

General

All reactions and manipulations were carried out using standard Schlenk-line techniques under a nitrogen atmosphere or nitrogen filled glove box. Petroleum ether (bp 40–60 °C) and other solvents were distilled under an N₂ atmosphere according to the standard procedures. Other chemicals were obtained from commercial sources and used as received. Compound **1**⁴¹ and [CuCl(COD)]₂⁴² were prepared according to the reported procedures. ¹H NMR (400 and 600 MHz), ¹³C{¹H} NMR (100.6 and 150.9 MHz) and ³¹P NMR (161.9 MHz) spectra were recorded at room temperature. For ¹H NMR spectra, chemical shifts were referenced with respect to the chemical shifts of the residual protons present in deuterated solvents. H₃PO₄ (85%) was used as an external standard for ³¹P{¹H} NMR measurements. Coupling constants are given in Hz and chemical shifts are given in ppm. ATR spectra were recorded using a PerkinElmer Spectrum Rx system. High-resolution mass spectra (ESI) were recorded using a Xevo G2 TOF mass spectrometer (Waters). Elemental analyses were carried out using a PerkinElmer 2400 CHN analyzer.

Synthesis of 2,5-bis{diphenyl(trimethylsilylphosphino)methyl}pyrrole **2**

Trimethylsilylazide (2.5 mL, 18.9 mmol) was added to a Schlenk flask containing 2,5-bis(diphenylphosphinomethyl)pyrrole **1** (4.0 g, 8.6 mmol) at room temperature. The reaction mixture was heated at 160 °C for 13 h. The mixture was cooled to room temperature to give a sticky oily compound. Petroleum ether (30 mL) was added and the mixture was stirred to give a colorless powdery compound. The solvent was decanted, and the solid was washed again with petroleum ether (3 × 15 mL) and dried under vacuum to give **2** (4.4 g, 6.9 mmol, 80% yield). The suitable crystals were grown from a concentrated toluene solution at –18 °C over a period of two weeks. ¹H NMR (400 MHz, CDCl₃): δ = 9.52 (br s, 1 H, NH), 7.54–7.36 (m, 20 H, C₆H₅), 5.64 (s, 2 H, pyrrole β -CH), 3.48 (d, ²J(P,H) = 13.2, 4 H, CH₂), –0.08 (s, 18 H, CH₃). ¹³C{¹H} NMR (100.6 MHz, CDCl₃): δ = 4.1, 32.5 (d, ¹J(C,P) = 75.5, CH₂), 108.3, 122.3 (m, pyrrole α -CH), 128.1 (d, ²J(C,P) = 62.4, phenyl), 131.1, 131.4 (d, ³J(C,P) = 17.1, phenyl), 135.0 (d, ¹J(C,P) = 93.5). ³¹P{¹H} NMR (161.9 MHz, toluene, external D₂O): δ = –0.4 (s). ATR-IR (cm^{–1}): ν = 3416 (m), 3055 (m), 1575 (m), 1483 (m), 1444 (m), 1434 (m), 1411 (m), 1381 (w), 1319 (w), 1306 (w), 1270 (w), 1243 (w), 1201 (m), 1181 (m), 1155 (w), 1096 (m), 1086 (w), 1070 (m), 1043 (m), 1027 (m), 1001 (m), 984 (w), 899 (w), 876 (w), 843 (w), 827 (m), 774 (m), 761 (m), 738 (s), 695 (vs), 626 (m), 538 (m), 531 (m), 505 (m), 479 (m), 426 (m). HRMS (+ESI): calcd *m/z* for [M + H⁺] C₃₆H₄₆N₃P₂Si₂: 638.2700, found: 638.2720. Satisfactory CHN analysis could not be obtained owing to the air-sensitive nature of the compound.

Synthesis of [Cu{C₄H₃N-2,5-(CH₂PPh₂NSiMe₃)₂- κ^2 N,N}][CuCl₂] **3**

To a solution of **2** (0.175 g, 0.274 mmol) in THF (20 mL), [CuCl(COD)]₂ (0.113 g, 0.273 mmol) was added. The suspension was stirred for 15 h at room temperature to give a clear solution. The solvent was removed under vacuum and the residue was washed with petroleum ether (2 × 10 mL). The solid residue was redissolved in THF (15 mL) and the solution was layered with petroleum ether (35 mL). Prism shaped colorless crystals of **3** were formed over a period of 7 days. The crystals were separated and dried under vacuum (0.063 g, 0.075 mmol, 55% yield based on the metal precursor). ¹H NMR (600 MHz, CDCl₃): δ = 0.05 (s, 18H, CH₃), 3.88 (br s, 4H, CH₂), 5.56 (br s, 2H, pyrrole β -CH), 7.53 and 7.64 (br s 20 H, C₆H₅). ³¹P{¹H} NMR (161.9 MHz, CDCl₃): δ = 35.7 (s). FT-IR (KBr, cm^{–1}): ν = 3288 (m), 3052 (m), 2948 (s), 2915 (m), 1582 (m), 1483 (m), 1436 (s), 1331 (w), 1307 (w), 1248 (s), 1181 (m), 1118 (vs), 1084 (vs), 1032 (m), 994 (m), 858 (s), 837 (vs), 771 (s), 737 (s), 692 (s), 648 (m), 506 (m), 477 (m), 410 (m). Anal. calcd for C₃₆H₄₅Cl₂Cu₂N₃P₂Si₂: C, 51.73; H, 5.43; N, 5.03. Found: C, 52.04; H, 5.55; N, 5.15.

Synthesis of [Ag{C₄H₃N-2,5-(CH₂PPh₂NSiMe₃)₂- κ^2 N,N}][BF₄] **4**

To a solution of **2** (0.300 g, 0.470 mmol) in THF (20 mL) was added AgBF₄ (0.092, 0.473 mmol). The suspension was covered with aluminum foil and stirred for 15 h at room temperature

to a give clear solution. The solvent was removed under vacuum and the residue was washed with petroleum ether (2 × 10 mL). The solid residue was redissolved in THF (15 mL) and the solution was layered with petroleum ether (35 mL). Needle shaped colorless crystals of **4** appeared after 2 days. The crystals were separated and dried under vacuum (0.217 g, 0.240 mmol, 51% yield based on the metal precursor). ¹H NMR (600 MHz, CDCl₃): δ = −0.10 (s, 18 H, CH₃), 3.60 (br s, 2 H, CH₂), 4.17 (br s, 2 H, CH₂), 5.15 (s, 2 H, pyrrole β-CH), 7.53–7.71 (m, 20 H, C₆H₅), 9.88 (s, 1 H, NH). ¹³C NMR (150.9 MHz, CDCl₃): δ = 4.9 (CH₃), 31.4 (d, ¹J(C,P) = 70.5, CH₂), 110.5 (pyrrole β-CH), 120.8 (t, ²J(P,C) = 3, pyrrole α-C), 129.1, 129.5, 132.3, 132.8, 133.0. ³¹P{¹H} NMR (161.9 MHz, CDCl₃): δ = 23.7 (s). ATR-IR (cm^{−1}): ν = 3321 (w), 3061 (w), 2947 (w), 2890 (w), 1581 (w), 1485 (w), 1439 (m), 1417 (w), 1396 (w), 1336 (w), 1307 (w), 1282 (w), 1250 (m), 1218 (w), 1183 (w), 1133 (vs), 1112 (vs), 1090 (vs), 1076 (vs), 1040 (vs), 1030 (s), 998 (m), 991 (m), 859 (s), 834 (vs), 813 (m), 784 (m), 763 (s), 749 (s), 738 (s), 727 (s), 713 (m), 692 (vs), 667 (m), 513 (m), 514 (vs), 503 (vs), 478 (s), 450 (w), 436 (w), 414 (w). HRMS (+ESI): calcd *m/z* for [M-BF₄]⁺: 744.1673, found: 744.2656. Anal. calcd for C₃₆H₄₅AgBF₄N₃P₂Si₂: C, 51.93; H, 5.45; N, 5.05. Found: C, 52.05; H, 4.80; N, 5.54.

Synthesis of [Ag{C₄H₃N-2,5-(CH₂PPh₂NSiMe₃)₂-κ²N,N}][OTf] **5**

The above procedure was followed to synthesize this compound. **2** (0.337 g, 0.529 mmol) and AgOTf (0.135 g, 0.525 mmol) were used. Needle shaped colorless crystals of **5** were formed from a solution of **5** in THF layered with petroleum ether. After 2 days, the crystals were separated and dried under vacuum (0.271 g, 0.280 mmol, 53% yield based on the metal precursor). ¹H NMR (600 MHz, CDCl₃): δ = −0.10 (s, 18 H, CH₃), 3.60 (br s, 2 H, CH₂), 4.26 (br s, 2 H, CH₂), 5.13 (s, 2 H, pyrrole β-CH), 7.53–7.70 (m, 20 H, C₆H₅), 10.65 (s, 1 H, NH). ¹³C NMR (150.9 MHz, CDCl₃): δ = 4.9, 31.6 (d, ¹J(C,P) = 69.4, CH₂), 110.3 (pyrrole β-CH), 120.8 (t, ²J(P,C) = 3, pyrrole α-C), 120.8 (quartet, ¹J(C,F) = 166, CF₃), 128.9, 129.4, 132.4, 132.9. ³¹P{¹H} NMR (161.9 MHz, CDCl₃): δ = 23.8 (s). ATR-IR (cm^{−1}): ν = 3301 (w), 3055 (w), 2947 (w), 1588 (w), 1483 (w), 1434 (m), 1398 (w), 1335 (w), 1276 (s), 1250 (vs), 1224 (s), 1155 (s), 1135 (vs), 1115 (vs), 1099 (s), 1066 (m), 1027 (vs), 997 (m), 978 (w), 912 (w), 856 (s), 833 (vs), 810 (s), 800 (s), 754 (s), 738 (s), 725 (w), 705 (s), 692 (vs), 666 (m), 636 (vs), 617 (s), 574 (m), 508 (vs), 472 (s), 462 (m), 439 (w), 413 (w). Anal. calcd for C₃₇H₄₅F₃N₃O₃P₂SSi₂Ag(C₄H₈O): C, 50.93; H, 5.52; N, 4.35. Found: C, 50.37; H, 5.35; N, 4.60. HRMS (+ESI): calcd *m/z* for [M-OTf]⁺ C₃₆H₄₅N₃P₂Si₂Ag: 744.1673, found: 744.1733.

X-ray crystallography

Single crystal X-ray diffraction data collections for all compounds were performed using a Bruker-APEX-II CCD diffractometer with graphite monochromated Mo Kα radiation (λ = 0.71073 Å). The space group for every structure was obtained using the XPREP program. Using the OLEX2 program version 1.2.10,⁴³ the structures were solved using SHELXT,⁴⁴ which successfully located most of the nonhydrogen atoms.

Subsequently, least-squares refinements were carried out on *F*² using SHELXL Version 2018/3⁴⁵ to locate the remaining nonhydrogen atoms. Non-hydrogen atoms were refined with anisotropic displacement parameters. All NH protons were located from the difference Fourier map and refined. The disordered Me₃Si group in complex **3** was dealt with SADI and EADP restraints. The refinement data for all the structures are summarized in Table S1.†

Computational methods

The crystal structures of the phosphinimine ligand **2** and its copper(i) complex **3** and silver(i) complexes **4** and **5** were taken as the starting point for geometry optimization with density functional theory (DFT) by employing the ωb97xd functional⁴⁶ and def2SVP basis set.⁴⁷ Hessian calculations were performed at the optimized geometries using the same functional and basis set to ensure that the optimized structures are true minima as indicated by all real vibrational frequencies. All quantum chemical calculations were carried out using Gaussian 16.⁴⁸ The wave functions obtained from these calculations were further used to obtain bond-order parameters, and the structure and bonding in the complexes were analyzed using Bader's quantum theory of atoms in molecules (QTAIM) technique⁴⁹ as well as topological and non-covalent interactions (NCIs)³⁷ using the Multiwfn program.⁵⁰

Conflicts of interest

There are no conflicts to declare.

Acknowledgements

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References

- 1 H. Staudinger and J. Meyer, *Helv. Chim. Acta*, 1919, **2**, 635.
- 2 (a) E. W. Abel and S. A. Mucklejohn, *Phosphorus Sulfur*, 1981, **9**, 235; (b) K. K. Katti, A. A. Pinkerton and R. G. Cavell, *Inorg. Chem.*, 1991, **30**, 2631; (c) S.-Y. Pyun, Y.-H. Lee and T.-R. Kim, *Kinet. Catal.*, 2005, **46**, 21.
- 3 (a) H. Schmidbaur, G. A. Bowmaker, O. Kumberger, G. Müller and W. Wolfsberger, *Z. Naturforsch., B: J. Chem. Sci.*, 1990, **45b**, 476; (b) K. Dehnicke, M. Krieger and W. Massa, *Coord. Chem. Rev.*, 1999, **182**, 19; (c) M. Ganesan, P. E. Fanwick and R. A. Walton, *Inorg. Chim. Acta*, 2003, **346**, 181; (d) A. Hagenbacha, S. Athenstäda,

- H. E. Daróczia, U. Abrama and R. Albertob, *Z. Anorg. Allg. Chem.*, 2004, **630**, 2709.
- 4 (a) T. K. Panda and P. W. Roesky, *Chem. Soc. Rev.*, 2009, **38**, 2782; (b) H. Xie, Z. Mou, B. Liu, P. Li, W. Rong, S. Li and D. Cui, *Organometallics*, 2014, **33**, 722; (c) R. P. K. Babu, K. Aparna, R. McDonald and R. G. Cavell, *Organometallics*, 2001, **20**, 1451; (d) A. J. Wooles, M. Gregson, O. J. Cooper, A. Middleton-Gear, D. P. Mills, W. Lewis, A. J. Blake and S. T. Liddle, *Organometallics*, 2011, **30**, 5314; (e) G. C. Welch, W. E. Piers, M. Parvez and R. McDonald, *Organometallics*, 2004, **23**, 1811; (f) T. K. Panda, A. Zulys, M. T. Gamer and P. W. Roesky, *J. Organomet. Chem.*, 2005, **690**, 5078; (g) K. R. D. Johnson and P. G. Hayes, *Inorg. Chim. Acta*, 2014, **422**, 209.
- 5 (a) J. L. Brosmer and P. L. Diaconescu, *Organometallics*, 2015, **34**, 2567; (b) M. J. Sarsfield, M. Said, M. Thornton-Pett, L. A. Gerrard and M. Bochmann, *J. Chem. Soc., Dalton Trans.*, 2001, 822; (c) R. P. K. Babu, R. McDonald and R. G. Cavell, *J. Chem. Soc., Dalton Trans.*, 2001, 2210; (d) L. Morello, P. Yu, C. D. Carmichael, B. O. Patrick and M. D. Fryzuk, *J. Am. Chem. Soc.*, 2005, **127**, 12796; (e) E. Hollink, J. C. Stewart, P. Wei and D. W. Stephan, *Dalton Trans.*, 2003, 3968; (f) U. Siemeling, L. Kölling, A. Stammmler and H. Stammmler, *J. Chem. Soc., Dalton Trans.*, 2002, 3277; (g) G. Martinez and D. W. Stefan, *Can. J. Chem.*, 2006, **84**, 1180; (h) R. Cariou, F. Dahcheh, T. W. Graham and D. W. Stephan, *Dalton Trans.*, 2011, **40**, 4918; (i) X. Xing, S. Zhang, L. M. Thierer, M. R. Gau, P. J. Carroll and N. C. Tomson, *Dalton Trans.*, 2020, **49**, 7796; (j) R. Cariou, T. W. Graham, F. Dahcheh and D. W. Stephan, *Dalton Trans.*, 2011, **40**, 5419.
- 6 (a) K. R. D. Johnson, B. L. Kamenz and P. G. Hayes, *Can. J. Chem.*, 2016, **94**, 330; (b) Z.-Y. Chai and Z.-X. Wang, *Dalton Trans.*, 2009, 8005; (c) M. T. Zamora, K. R. D. Johnson, M. M. Hänninen and P. G. Hayes, *Dalton Trans.*, 2014, **43**, 10739; (d) J. P. Knott, M. M. Hänninen, J. M. Rautiainen, H. M. Tuononen and P. G. Hayes, *J. Organomet. Chem.*, 2017, **845**, 135; (e) W. Rong, D. Liu, H. Zuo, Y. Pan, Z. Jian, S. Li and D. Cui, *Organometallics*, 2013, **32**, 1166; (f) M. Wiecko and P. W. Roesky, *Organometallics*, 2009, **28**, 1266; (g) A. Buchard, R. H. Platel, A. Auffrant, X. F. Le Goff, P. Le Floch and C. K. Williams, *Organometallics*, 2010, **29**, 2892.
- 7 (a) T. K. K. Dickie, A. A. Aborawi and P. G. Hayes, *Organometallics*, 2020, **39**, 2047; (b) O. J. Cooper, J. McMaster, W. Lewis, A. J. Blake and S. T. Liddle, *Dalton Trans.*, 2010, **39**, 5074; (c) G. Ma, M. J. Ferguson, R. McDonald and R. G. Cavell, *Inorg. Chem.*, 2011, **50**, 6500.
- 8 (a) R. P. K. Babu, R. McDonald, S. A. Decker, M. Klobukowski and R. G. Cavell, *Organometallics*, 1999, **18**, 4226; (b) R. G. Cavell, R. P. K. Babu, A. Kasani and R. McDonald, *J. Am. Chem. Soc.*, 1999, **121**, 5805; (c) A. Kasani, R. P. K. Babu, R. McDonald and R. G. Cavell, *Angew. Chem., Int. Ed.*, 1999, **38**, 1483; (d) R. P. K. Babu, R. McDonald and R. G. Cavell, *Chem. Commun.*, 2000, 481.
- 9 (a) A. Zulys, T. K. Panda, M. T. Gamer and P. W. Roesky, *Chem. Commun.*, 2004, 2584; (b) T. K. Panda, A. Zulys, M. T. Gamer and P. W. Roesky, *Organometallics*, 2005, **24**, 2197; (c) M. Rastätter, A. Zulys and P. W. Roesky, *Chem. Commun.*, 2006, 874; (d) M. Rastätter, A. Zulys and P. W. Roesky, *Chem. – Eur. J.*, 2007, **13**, 3606.
- 10 (a) A. Ramos and D. W. Stephan, *Dalton Trans.*, 2010, **39**, 1328; (b) D. Li, S. Li, D. Cui, X. Zhang and A. A. Trifonov, *Dalton Trans.*, 2011, **40**, 2151.
- 11 (a) C. A. Wheaton and P. G. Hayes, *Dalton Trans.*, 2010, **39**, 3861; (b) C. A. Wheaton and P. G. Hayes, *Catal. Sci. Technol.*, 2012, **2**, 125; (c) C. A. Wheaton and P. G. Hayes, *Chem. Commun.*, 2010, **46**, 8404; (d) H. Sun, J. S. Ritch and P. G. Hayes, *Dalton Trans.*, 2012, **41**, 3701; (e) B. J. Ireland, C. A. Wheaton and P. G. Hayes, *Organometallics*, 2010, **29**, 1079; (f) M. T. Gamer, M. Rastätter, P. W. Roesky, A. Steffens and M. Glanz, *Chem. – Eur. J.*, 2005, **11**, 3165; (g) C. Bakewell, T.-P.-A. Cao, X. F. Le Goff, N. J. Long, A. Auffrant and C. K. Williams, *Organometallics*, 2013, **32**, 1475.
- 12 (a) K. R. D. Johnson and P. G. Hayes, *Organometallics*, 2013, **32**, 4046; (b) K. R. D. Johnson and P. G. Hayes, *Organometallics*, 2009, **28**, 6352; (c) K. R. D. Johnson and P. G. Hayes, *Organometallics*, 2011, **30**, 58.
- 13 (a) K. R. D. Johnson, M. A. Hannon, J. S. Ritch and P. G. Hayes, *Dalton Trans.*, 2012, **41**, 7873; (b) M. M. Hänninen, M. T. Zamora, C. S. MacNeil, J. P. Knott and P. G. Hayes, *Chem. Commun.*, 2016, **52**, 586; (c) C. S. MacNeil, K. E. Glynn and P. G. Hayes, *Organometallics*, 2018, **37**, 3248; (d) C. S. MacNeil, S.-J. Hsiang and P. G. Hayes, *Chem. Commun.*, 2020, **56**, 12323.
- 14 (a) C. V. Thompson and Z. J. Tonzetich, *Adv. Organometal. Chem.*, 2020, **74**, 153; (b) L. S. Merz, J. Ballmann and L. H. Gade, *Eur. J. Inorg. Chem.*, 2020, **21**, 2023; (c) H. Alawisi, H. D. Arman and Z. J. Tonzetich, *Organometallics*, 2021, DOI: DOI: 10.1021/acs.organomet.1c00053; (d) J. Sampson, G. Choi, M. N. Akhtar, E. A. Jaseer, R. Theravalappil, N. Garcia and T. Agapie, *ACS Omega*, 2019, **4**, 15879.
- 15 (a) L. Wang, D. Liu and D. Cui, *Organometallics*, 2012, **31**, 6014; (b) S. Kuriyama, K. Arashiba, K. Nakajima, H. Tanaka, K. Yoshizawa and Y. Nishibayashi, *Eur. J. Inorg. Chem.*, 2016, **2016**, 4856; (c) V. K. Jha, G. Mani, Y. R. Davuluri and A. Anoop, *Dalton Trans.*, 2017, **46**, 1840; (d) J. A. Kessler and V. M. Iluc, *Inorg. Chem.*, 2014, **53**, 12360; (e) M. O. Senge, *Angew. Chem., Int. Ed.*, 1996, **35**, 1923; (f) M. Ganesan, S. Gambarotta and G. P. A. Yap, *Angew. Chem., Int. Ed.*, 2001, **40**, 766; (g) A. Novak, A. J. Blake, C. Wilson and J. B. Love, *Chem. Commun.*, 2002, 2796; (h) J. B. Love, P. A. Salyer, A. S. Bailey, C. Wilson, A. J. Blake, E. S. Davies and D. J. Evans, *Chem. Commun.*, 2003, 1390; (i) D. L. Swartz II and A. L. Odom, *Dalton Trans.*, 2008, 4254; (j) D. L. Swartz II and A. L. Odom, *Organometallics*, 2006, **25**, 6125.
- 16 (a) S. Kumar, O. Jana, V. Subramaniam and G. Mani, *Inorg. Chim. Acta*, 2018, **480**, 113; (b) S. Kumar, G. Mani, D. Dutta and S. Mishra, *Inorg. Chem.*, 2014, **53**, 700.
- 17 O. Jana and G. Mani, *New J. Chem.*, 2017, **41**, 9361.

- 18 T. Guchhait, B. Barua, A. Biswas, B. Basak and G. Mani, *Dalton Trans.*, 2015, **44**, 9091.
- 19 S. A. Baudron, *Coord. Chem. Rev.*, 2019, **380**, 318.
- 20 (a) D. Salazar-Mendoza, S. A. Baudron and M. W. Hosseini, *Chem. Commun.*, 2007, 2252; (b) A. Béziau, S. A. Baudron and M. W. Hosseini, *Dalton Trans.*, 2012, **41**, 7227; (c) F. Zhang, S. A. Baudron and M. W. Hosseini, *CrystEngComm*, 2017, **19**, 4393; (d) H. Ruffin, S. A. Baudron, D. Salazar-Mendoza and M. W. Hosseini, *Chem. – Eur. J.*, 2014, **20**, 2449; (e) S. A. Baudron and M. W. Hosseini, *Chem. Commun.*, 2016, **52**, 13000; (f) S. A. Baudron and H. Chevreau, *CrystEngComm*, 2019, **21**, 1853.
- 21 (a) J. Wojaczynski, J. Maciolek and P. J. Chmielewski, *Chem. – Asian J.*, 2017, **12**, 643.
- 22 (a) R. E. Rundle and J. E. Goring, *J. Am. Chem. Soc.*, 1950, **72**, 5337; (b) E. A. H. Griffith and E. L. Amma, *J. Am. Chem. Soc.*, 1974, **96**, 743; (c) J. C. Ma and D. A. Dougherty, *Chem. Rev.*, 1997, **97**, 1303.
- 23 (a) J. Burgess and P. J. Steel, *Coord. Chem. Rev.*, 2011, **255**, 2094; (b) Z. Wang, M. Ashafaq, Y.-F. Lu, L. Feng, M. Kurmoo, H. Liu, Z.-Y. Gao, Y.-W. Li and D. Sun, *Inorg. Chem.*, 2021, **60**, 2899; (c) D. Sun, N. Zhang, Q.-J. Xu, R.-B. Huang and L.-S. Zheng, *J. Organomet. Chem.*, 2010, **695**, 1598; (d) M.-X. Liang, C.-Z. Ruan, D. Sun, X.-J. Kong, Y.-P. Ren, L.-S. Long, R.-B. Huang and L.-S. Zheng, *Inorg. Chem.*, 2014, **53**, 897.
- 24 B. Li, Y. Zhang, R. Krishna, K. Yao, Y. Han, Z. Wu, D. Ma, Z. Shi, T. Pham, B. Space, J. Liu, P. K. Thallapally, J. Liu, M. Chrzanowski and S. Ma, *J. Am. Chem. Soc.*, 2014, **136**, 8654.
- 25 Z.-X. Wang and C.-Y. Qi, *Dalton Trans.*, 2005, 996.
- 26 C.-C. Chou, H.-J. Liu and C.-C. Su, *Dalton Trans.*, 2008, 3358.
- 27 H.-C. Liang, E. Kim, C. D. Incarvito, A. L. Rheingold and K. D. Karlin, *Inorg. Chem.*, 2002, **41**, 2209.
- 28 Y. Tanaka, T. Yoneda, K. Furukawa, T. Koide, H. Mori, T. Tanaka, H. Shinokubo and A. Osuka, *Angew. Chem., Int. Ed.*, 2015, **54**, 10908.
- 29 T. N. Sorrell and D. L. Jameson, *J. Am. Chem. Soc.*, 1983, **105**, 6013.
- 30 Y. Liao, J. J. Novoa, A. Arif and J. S. Miller, *Chem. Commun.*, 2002, 3008.
- 31 C.-C. Chou, H.-J. Liu, L. H.-C. Chao, H.-B. Syu and T.-S. Kuo, *Polyhedron*, 2012, **37**, 60.
- 32 A. Bondi, *J. Phys. Chem.*, 1964, **68**, 441.
- 33 D. Ghorai and G. Mani, *Inorg. Chem.*, 2014, **53**, 4117.
- 34 K. Ohui, M. V. Babak, D. Darvasiova, A. Roller, D. Vegh, P. Rapta, G. R. S. Guan, Y. H. Ou, G. Pastorin and V. B. Arion, *Organometallics*, 2019, **38**, 2307.
- 35 S. Kitagawa, M. Kondo, S. Kawata, S. Wada, M. Maekawa and M. Munakata, *Inorg. Chem.*, 1995, **34**, 1455.
- 36 P. Woidy and F. Z. Kraus, *Anorg. Allg. Chem.*, 2013, **639**, 2643.
- 37 E. R. Johnson, S. Keinan, P. Mori-Sánchez, J. Contreras-García, A. J. Cohen and W. Yang, *J. Am. Chem. Soc.*, 2010, **132**, 6498.
- 38 S. T. Howard and T. M. Krygowski, *Can. J. Chem.*, 1997, **75**, 1174.
- 39 C. W. Bird, *Tetrahedron*, 1986, **42**, 89.
- 40 J. N. McPherson, T. E. Elton and S. B. Colbran, *Inorg. Chem.*, 2018, **57**, 12312.
- 41 S. Kumar, G. Mani, S. Mondal and P. K. Chattaraj, *Inorg. Chem.*, 2012, **51**, 12527.
- 42 K. M. Chi, H.-K. Shin, M. J. Hampden-Smith, E. N. Duesler and T. T. Kodas, *Polyhedron*, 1991, **10**, 2293.
- 43 O. V. Dolomanov, L. J. Bourhis, R. J. Gildea, J. A. K. Howard and H. Puschmann, *J. Appl. Crystallogr.*, 2009, **42**, 339.
- 44 G. M. Sheldrick, *Acta Crystallogr., Sect. A: Found. Crystallogr.*, 2015, **71**, 3.
- 45 G. M. Sheldrick, *Acta Crystallogr., Sect. C: Struct. Chem.*, 2015, **71**, 3.
- 46 J.-D. Chai and M. Head-Gordon, *Phys. Chem. Chem. Phys.*, 2008, **10**, 6615.
- 47 F. Weigend and R. Ahlrichs, *Phys. Chem. Chem. Phys.*, 2005, **7**, 3297.
- 48 M. J. Frisch, *et al.*, *Gaussian 16, Revision C.01*, Gaussian, Inc., Wallingford CT, 2016.
- 49 R. Bader, *Chem. Rev.*, 1991, **91**, 893.
- 50 T. Lu and F. Chen, *J. Comput. Chem.*, 2012, **33**, 580.



Evaluation of genoprotective and antioxidative potentiality of ethanolic extract of *N. sativa* seed in streptozotocin induced diabetic albino rats

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Abstract

In the present study oxidative stress, DNA damage in streptozotocin induced diabetic rats and its repair after treating with ethanolic extract of *Nigella sativa* seed were evaluated via comet assay and estimation of SOD and TBARS. Blood lymphocytes of Streptozotocin (60 mg/kg BW) induced diabetic rats showed significant increase ($p < 0.05$) in DNA damage as evidenced by comet tail length, due to the formation of reactive oxygen species (ROS) leading to genotoxicity. Feeding rats with ethanolic extract of *N. sativa* seed (500 mg/kg BW) significantly ($p < 0.05$) improved the level of SOD and TBARS and decreased the comet tail length and percentage of comet cells, indicating the antioxidative and genoprotective potentiality of *Nigella sativa* seed.

Keywords Comet assay · DNA damage · *Nigella sativa* · Antioxidant

Introduction

Diabetes mellitus is the most common endocrine disorder characterized by hyperglycemia resulting from defects either in insulin secretion or insulin action or both (David 1996; Kumar et al. 2006). Streptozotocin (STZ) induces diabetes mellitus by destroying pancreatic β -cells, possibly through generating excess reactive oxygen species (ROS) (Damesceno et al. 2014). The persistent and chronic hyperglycemia due to diabetes mellitus generates free radical and ROS which trigger an oxidative stress (Kedziora-Kornatowska et al. 2009; Pavana et al. 2007). The overproduction of free radical and ROS resulted in DNA damage, enhanced lipid peroxidation, protein degradation and exhaustion of antioxidant defense system (Lenzen 2008) which contributes to a large number of serious problems.

Though a large number of conventional drugs having antioxidant potential are available but they pose serious side effects. Therefore, an interest in herbal medicine has grown recently. The major advantage of herbal medicine is

its efficacy and less toxicity (Ali and Blunden 2003). Plant extracts have been used in traditional medicine since ancient time for various treatment including diabetes mellitus (El-Tantawy and Timraz 2018).

Nigella sativa L. (family Ranunculaceae), commonly known as black seed or black cumin, is an annual herb that has been traditionally used as a natural remedy for a number of illnesses (Fabricant and Farnsworth 2001). Notable pharmacological properties such as antioxidative (Houghton et al. 1995) immunomodulation (Salem 2005) anti-inflammatory, neuroprotective, anti-ischemic, antiepileptic and anxiolytic effects have been reported for *N. sativa* extract or its constituents (Gilhotra and Dhingra 2011; Hossein et al 2007; Ilhan et al. 2005; Kanter et al. 2006). Many of the pharmacological activities mentioned above have been attributed to quinone constituents in the seed, especially thymoquinone (TQ) (Badary 1999). TQ has been reported to exhibit antioxidant (Badary et al. 2003; Burits and Bucar 2000), anti-inflammatory, neuroprotective, anti-ischemic and chemopreventive effects (Rajkamal et al. 2010). Ethanolic extract of *Nigella sativa* seed extract has also shown to reduce chromosomal aberrations and micronuclei formation induced MNNG (Khader et al. 2010). Keeping the facts that diabetes is an emerging problem worldwide and is a major concern of developing countries; the present study was conducted to assess oxidative DNA damage and its amelioration

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by *N. sativa* seed extract in the blood of streptozotocin induced diabetic rats through Comet assay which is a very rapid and sensitive method to examine oxidative DNA damage and repair at individual cell level (Kassie et al. 2000).

Materials and methods

Preparation of ethanolic extract of *N. sativa* seed

Seeds of *N. sativa* seed were obtained locally and were authenticated by the pharmaceutical department, BIT Mesra. Seeds were crushed into powder and were used for physicochemical and phytochemical analysis. Crushed seeds (500 g) were extracted with petroleum ether to remove lipids. It was then extracted with 95% ethanol using soxhlet extractor. Ethanol was evaporated in a rotator evaporator at 40–45 °C under reduced pressure. The obtained extract was then used for the present study.

Induction of oxidative stress DNA damage

Diabetes was induced in overnight fasted adult Wistar albino rats weighing (160–190 g) by feeding 21% fructose with standard chow for four weeks before a single dose of intra peritoneal injection of 60 mg/kg of STZ dissolved in 0.1 M citrate phosphate buffer (pH 6.3) (Akbarzadeh et al. 2007). Hyperglycemia was confirmed by elevated glucose levels in plasma, determined at 72 h and then on day 7 after injection. The threshold value of fasting plasma glucose to diagnose diabetes was taken as > 126 mg/dl. Only rats found with permanent noninsulin dependent diabetes mellitus (NIDDM) (except for control and control treatment) were selected for the oxidative stress DNA damage study.

Experimental animals

Male albino rats (*Rattus norvegicus*) weighing 125–175 g and 12–14 weeks old were used for study. They were acclimatized in the laboratory condition at a constant temperature of $22^{\circ} \pm 3^{\circ}$ and 12:12 h. Light: dark for fifteen days. They were provided with pelleted rat feed (M/S Amrut Feed, Pranav Agro Industries Ltd. Sangli, India) and water ad libitum. All the animals receive humane care during the study and the protocol was approved by institutional animal ethics committee.

Experimental design

The animals were divided into 5 groups (5 rats in each group) as follows—Group-1 containing normal non-diabetic rats, Group-2: diabetic control rats (induction of diabetes already explained above in the “induction of oxidative stress

DNA damage” paragraph), Group-3: diabetic rats fed with ethanolic extract of *N. sativa* seed (250 mg/kg body wt.), Group-4: diabetic rats fed with 500 mg/kg body wt. ethanolic extract of *N. sativa* seed, and Group-5: Runner group (normal rats fed with ethanolic extract of *N. sativa* seed at 500 mg/kg body wt.). *N. sativa* seed extract was fed to rats of respective groups for eight weeks continuously. All rats were sacrificed at 8th weeks of experimental period and the obtained blood was assessed for DNA damage and repair.

Comet assay

The comet assay (SCGE) was conducted in blood following Singh et al (1988). One hundred microliters of normal melting point (NMP) agarose was quickly layered on conventional slides, the slides were covered with a cover slip, and then the slides were placed on ice to allow agarose to gel. 25 μ l of whole blood was mixed with 75 μ l low melting point (LMP) agarose, and the mixture was quickly layered over the NMP agarose layer after removal of the cover slip. Finally, another layer of LMP agarose was added on top. The slides were immersed immediately in a chilled lysing solution (pH = 10) made up of 2.5 M NaCl, 100 mM EDTA, 10 mM Trizma, 1% sarkosyl, 10% DMSO, and 1% Triton X-100, and kept at 0 °C in the dark overnight. Then, the slides were placed on a horizontal gel electrophoresis platform and covered with a prechilled alkaline solution made up of 300 mM NaOH and 1 mM EDTA (pH = 10). They were left in the solution in the dark at 0 °C for 40 min, and then electrophoresed at 0 °C in the dark for 30 min at 25 V and approximately 300 mA. The slides were rinsed gently three times with 400 mM Trizma solution (adjusted to pH 7.5 by HCl) to neutralize the excess alkali, stained with 50 ml of 20 μ g/ml ethidium bromide, and covered with a cover slip.

Comet analysis

The slides were examined and photographed using fluorescence microscope (BX, Olympus Singapore PTE Ltd. Singapore) at 1000 \times magnification equipped with an excitation filter of 520–550 nm and a barrier filter of 580 nm. Undamaged cells resemble an intact nucleus without a tail, and damaged cells have the appearance of a comet. The amount of DNA in the comet tail (% tail DNA), which is an estimate of DNA damage, was measured using a computerized image analysis software (CASP software).

Estimation of antioxidative property

Lipid peroxidation (TBARS) and Superoxide Dismutase (SOD) activity was estimated in liver and kidney homogenate, prepared in Tris–HCl buffer (0.025 M, pH7.8) to study

antioxidative potentiality of the ethanolic extract of *Nigella sativa* seed. Lipid peroxidation was estimated by the method of Nichans and Samuelson (1968) in which malondialdehyde and other thiobarbituric acid reactive substances (TBARS) were measured by their reactivity with thiobarbituric acid (TBA) in acidic conditions to generate a pink coloured chromophore, which was read at 535 nm.

The activity of SOD was estimated by adding 1 mM diethylene triamine penta-acetic acid and 2 mM pyrogallol to tissue homogenate prepared in Tris–HCl buffer (Marklund and Marklund 1974). A blank was prepared without addition of sample. The rate of auto oxidation of pyrogallol was calculated using an increase in absorbance at 420 nm against a reference cuvette containing Tris–HCl buffer with the help of Specord 200 double beam UV/visible Spectrophotometer (Analytikjena, Germany). The inhibition of pyrogallol auto-oxidation was brought about by superoxide dismutase, which was employed for the determination of enzyme activity. A unit of enzyme was defined as the amount of enzyme that inhibits the reaction by 50%. The results were expressed in terms of U/mg tissue.

Statistical analysis

All results were expressed as mean \pm SEM. Statistical differences between groups were analyzed by one way analysis of variance (ANOVA). A probability level of $p < 0.05$ was considered statistically significant.

Results

In the present study, comet area, percent DNA damage, DNA percent in head of comet and DNA percent in tail of comet, were measured (Figs. 1, 2, 3, 4; Plates A, B, C, D). In the control group (group 1), total comet area, percent DNA damage, percent DNA in the tail region were found to be minimum ($p < 0.05$) and percent DNA in the head region was maximum ($p < 0.05$) as compared to diabetic control group (group II) where percent DNA damage and percent DNA in tail were found to be maximum thus indicating streptozotocin induced DNA damage. Feeding rats with 500 mg/kg BW ethanolic extract of *N. sativa* seed (group IV) significantly ($p < 0.05$) reduced DNA damage and the decrease was non-significant ($p > 0.05$) in rats of group III who were fed with 250 mg/kg BW of ethanolic extract of *N. sativa* seed extract. In rats of runner group (group V) no adverse effect of extract was observed and DNA damage was found to be non-significant ($p > 0.05$).

TBARS were estimated in the kidney and liver of rats of all groups at 8th week of treatment (Figs. 5, 6). In the kidney of control rats (group-II) lipid peroxidation (nmol/g protein) was found to be 21.41 ± 3.03 nmol/g protein which

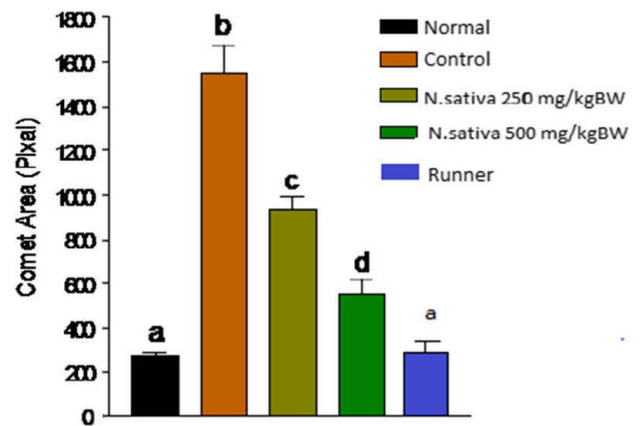


Fig. 1 Effect of ethanolic extract of *N. sativa* seed on Comet area of comet assay in blood at last day (8th week) of treatment. (Values are Mean \pm S.E.M. of three experiments, Means with different letters are significantly different at ($p < 0.05$))

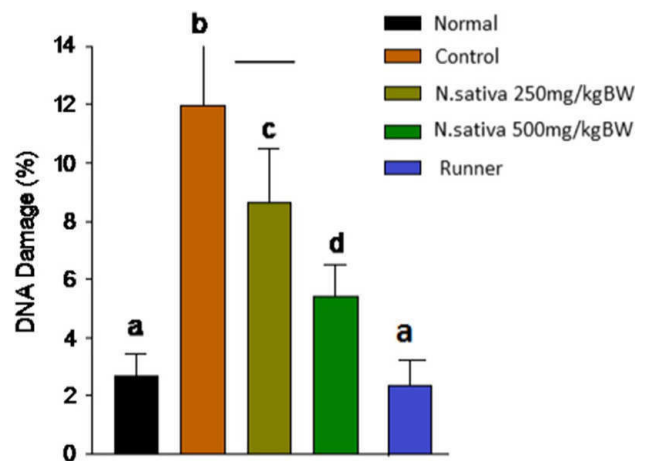


Fig. 2 Effect of ethanolic extract of *N. sativa* seed on percent DNA damage in comet assay of blood at last day (8th week) of treatment. (Values are Mean \pm S.E.M. of three experiments, Means with different letters are significantly different at ($p < 0.05$))

was significantly ($p < 0.05$) higher than rats of normal group (group-I, 7.49 ± 1.49). Feeding *N. sativa* seed extract to diabetic rats at a concentration of 250 mg/Kg BW (group-III) or 500 mg/Kg BW (group-IV) significantly ($p < 0.05$) decreased lipid peroxidation in kidney (Fig. 5). Feeding *N. sativa* seed extract at a concentration of 500 mg/Kg BW (10.11 ± 2.66) showed significantly ($p < 0.05$) lower lipid peroxidation as compared to feeding 250 mg *N. sativa* seed extract/Kg BW (16.55 ± 3.88) for 8 weeks.

In liver of diabetic rat control group (group-II), significantly ($p < 0.05$) high level of lipid peroxidation (35.58 ± 3.57) was observed (Fig. 6) as compared to normal group (group-I, 12.89 ± 2.62). Feeding *N. sativa* seed extract at a concentration of 250 mg/Kg BW (group-III,

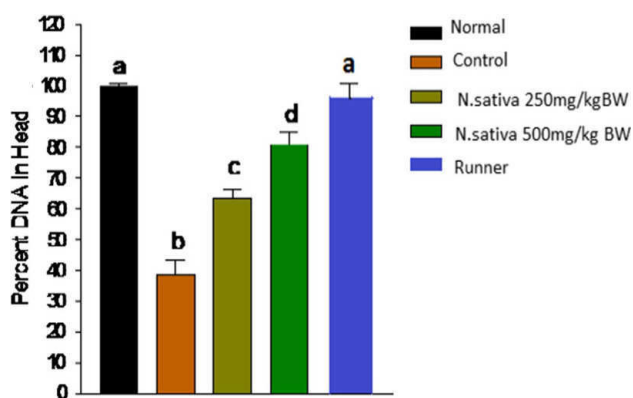


Fig. 3 Effect of ethanolic extract of *N. sativa* seed on DNA percent in head of comet in comet assay at last day (8th week) of treatment. (Values are Mean \pm S.E.M. of three experiments, Means with different letters are significantly different at ($p < 0.05$))

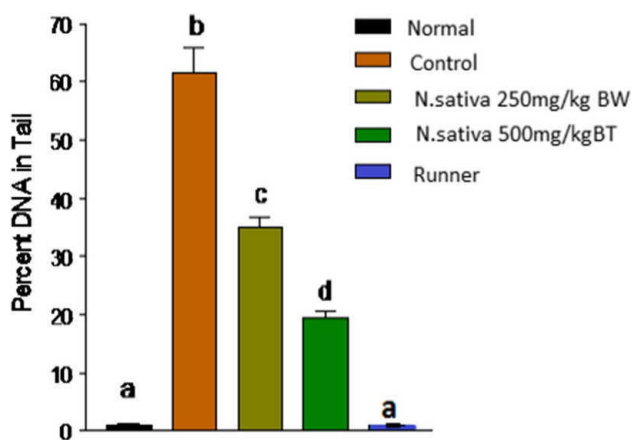


Fig. 4 Effect of ethanolic extract of *N. sativa* seed on DNA percent in tail of comet in comet assay at last day (8th week) of treatment. (Values are Mean \pm S.E.M. of three experiments, Means with different letters are significantly different at ($p < 0.05$))

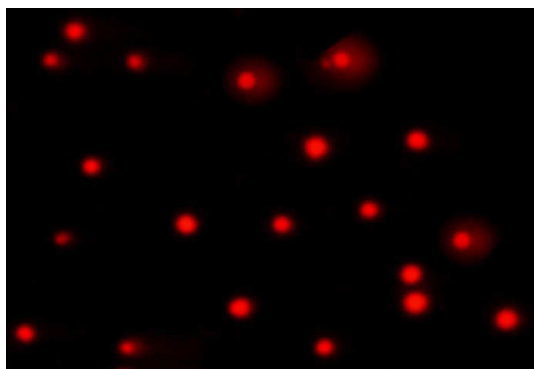


Plate A DNA damage in blood cells of rats in normal and runner group as assessed by alkaline comet assay (1000 \times magnification)

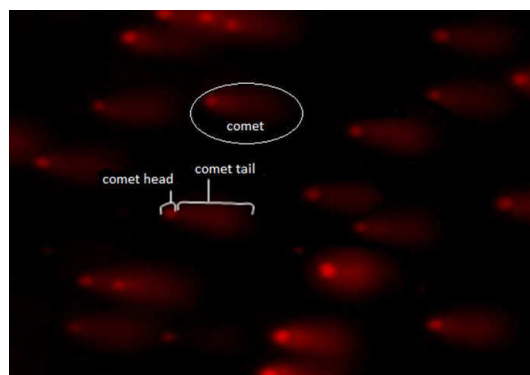


Plate B DNA damage in blood cells of rats in Control group assessed by alkaline comet assay (1000 \times magnification)

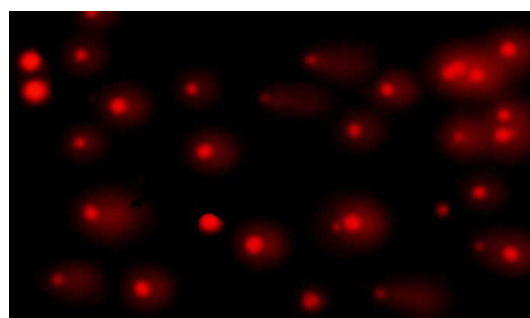


Plate C DNA damage in blood cells of 250 mg/kg BW *N. sativa* fed rats assessed by comet assay (1000 \times magnification)

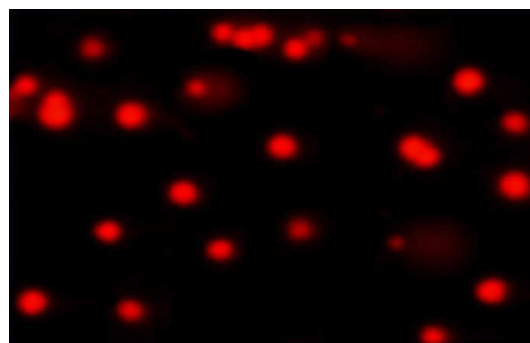


Plate D DNA damage in blood cells of 500 mg/kg BW *N. sativa* fed rats assessed by comet assay (1000 \times magnification)

25.85 \pm 3.01) or 500 mg/Kg BW (group-IV, 16.14 \pm 2.30) to diabetic rats significantly ($p < 0.05$) decreased lipid peroxidation in liver as compared to non-fed rat groups. This improvement in lipid peroxidation was found to be statistically non-significant ($p > 0.05$) with rats of normal (group-I, 12.89 \pm 2.62) and runner group (group-V, 12.12 \pm 1.43). Feeding *N. sativa* seed extract at a concentration of 500 mg/

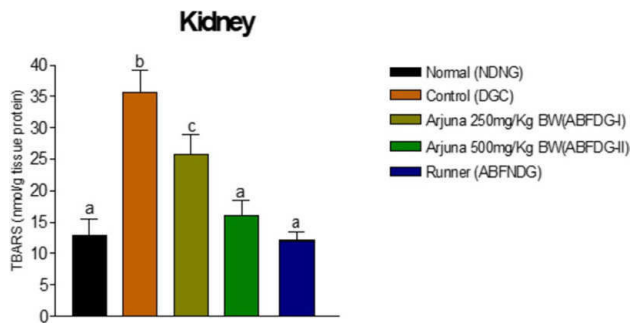


Fig. 5 Antioxidative effect of acetone extract of *N. sativa* seed on Kidney TBARS (Thioarbiruric acid reactive substances) at last day (8th week) of treatment by the method of Nichans and Samuelson (1968) (Values are Mean \pm S.E.M. of three experiments, Means with different letters are significantly different at ($p < 0.05$))

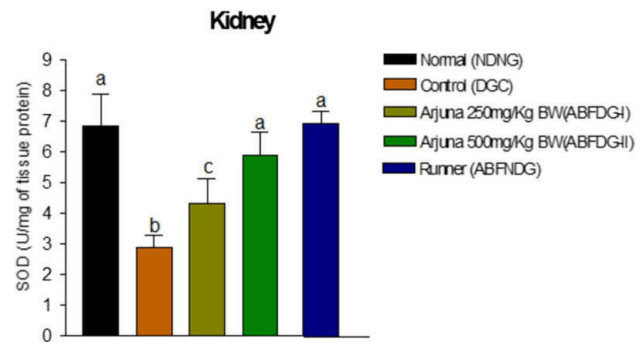


Fig. 7 Antioxidative effect of acetone extract of *N. sativa* on Kidney SOD (Super-oxide dismutase) at last day (8th week) of treatment by the method of Marklund and Marklund (1974) (Values are Mean \pm S.E.M. of three experiments, Means with different letters are significantly different at ($p < 0.05$))

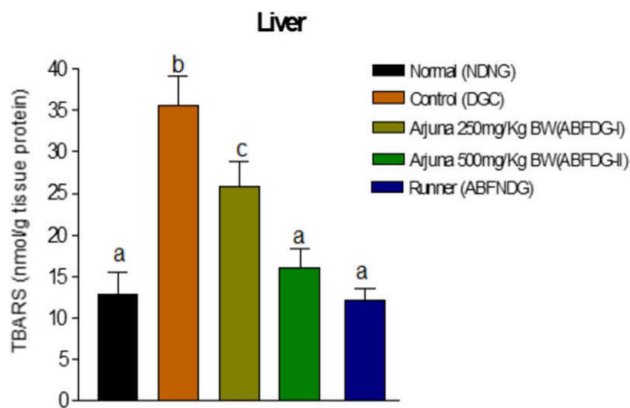


Fig. 6 Antioxidative effect of acetone extract of *N. sativa* seed on Kidney TBARS (Thio-barbiruric acid reactive substances) at last day (8th week) of treatment by the method of Nichans and Samuelson (1968) (Values are Mean \pm S.E.M. of three experiments, Means with different letters are significantly different at ($p < 0.05$))

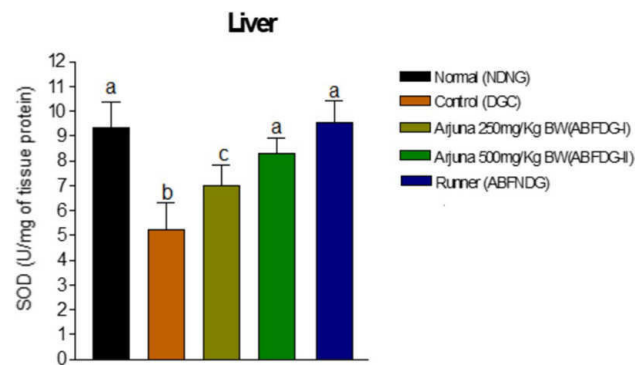


Fig. 8 Antioxidative effect of acetone extract of *N. sativa* on Liver SOD (Super-oxide dismutase) at last day (8th week) of treatment by the method of Marklund and Marklund (1974) (Values are Mean \pm S.E.M. of three experiments, Means with different letters are significantly different at ($p < 0.05$))

Kg BW showed significantly ($p < 0.05$) better result as compared to 250 mg/Kg BW.

Superoxide dismutase (SOD), were estimated in kidney and liver of rats of all groups at 8th week of treatment. SOD activity (U/mg protein) in kidney of normal rats (group-I) was found to be 6.82 ± 1.05 which significantly ($p < 0.5$) decreased to 2.89 ± 0.40 U/mg protein in rats of diabetic control group (group-II). Feeding *N. sativa* seed extract to diabetic rats significantly ($p < 0.05$) increased SOD activity. Feeding 500 mg/Kg BW extract to diabetic rats showed significantly ($p < 0.05$) better result (5.91 ± 0.72) as compared to that of 250 mg/Kg BW extract (4.35 ± 0.80) (Fig. 7).

In the liver of normal rat, higher SOD activity (U/mg protein) was found (9.35 ± 1.01) as compared to kidney. Diabetic rats showed significantly ($p < 0.05$) lower SOD activity (5.21 ± 1.08) in liver which were improved by feeding *N. sativa* seed extract at a concentration of 250 mg/Kg

BW (group-III, 7.02 ± 0.82) or 500 mg/Kg BW (group-IV, 8.29 ± 0.62) to diabetic rats. Similarly, the feeding extract at a concentration of 500 mg/Kg BW for 8 weeks showed significantly ($p < 0.05$) better improvement in SOD activity in liver and value was found comparable with rats of normal (group-I, 9.35 ± 1.01) and runner (group-V, 9.56 ± 0.87) group (Fig. 8).

Discussion

Oxidative stress, including oxidative damage to DNA as a result of interaction of DNA with ROS has been thought to contribute to the pathological conditions that are associated to diabetes, in particular. Persistent and chronic hyperglycemia in diabetes, generate free radicals and ROS. ROS formation results in damage to an array of biomolecules found in cells, including membrane lipids, proteins and nucleic acids

(Datta and Namasivayam 2003). In diabetes, generation of ROS due to oxidative stress, contributes to impairment of β cell function, insulin resistance, macrovascular and microvascular disease. (Kaneto et al. 2006; Fiorentino et al. 2013).

In the present study, STZ induced diabetes model was used to evaluate DNA damage in blood cells via comet assay and also to estimate the level of SOD and TBARS in kidney and liver cells. The relationship between oxidative DNA damage and diabetes has been shown by Pan et al. (2007) while working on oxidative DNA damage in diabetic individuals. Authors showed that greater oxidative stress leads to DNA damage in diabetic patient and percentage of comet cells and length of DNA migration (comet tail) of peripheral blood lymphocyte significantly ($p < 0.05$) increased in patients with diabetes. Yaduvanshi et al. (2012) reported that ROS leads to genotoxicity in diabetic rats and showed significant increase in DNA strand breaks. Janusz et al. (2004) reported that type-2 diabetes mellitus is not only associated with the elevated level of oxidative DNA damage but also with the increased susceptibility to mutagens and the decreased efficacy of DNA repair. Biswas et al. (2011) found significantly low activity of SOD, in liver and kidney of diabetic rats which resulted in significantly high lipid peroxidation as indicated by high level of MDA.

In our study, greater proportion of DNA damage, low level of SOD and high concentration of MDA were reported in rats of diabetic control groups, indicating higher level of oxidative stress in diabetic rats. Our results are in line with Erejuwa et al (2010) who reported low level of SOD, and high TBARS in pancreatic tissue of streptozotocin—induced diabetic rats.

The antioxidants are among the most promising therapeutic class for the treatment of diabetes, due to the fact that their therapeutic effect remain for longer period of time than that of the other strategies (Isabelle et al 2005). Therefore, the discovery and development of potent antioxidant agent has been one of the interesting and promising approaches in the field of diabetic treatment.

The results of the present study show that diabetic rats fed with 500 mg/kgBW ethanolic extract of *N. sativa* seed showed significantly ($p < 0.05$) lower DNA damage, decreased lipid peroxidation and increased SOD concentration. This may be due to the strong radical scavenging potentiality of ethanolic extract of *N. sativa* seed which prevent the interaction of DNA with free radical and subsequent DNA damage. *N. sativa* seed extract contain about 32 compounds, out of which thymoquinone forms the most abundant compound (Nehar and Rani 2011; Alam et al 2013) and the antioxidative property of *N. sativa* is attributed to this compound (Burits and Bucar 2000) Our observations are in strong agreement with Babazadeh et al. (2012) who demonstrated that *N. sativa* protect pc12 cells against serum glucose deprivation (SGD) induced cell death through antioxidant

mechanism. Our results are consistent with the studies of Al Wafai (2013) on streptozotocin-induced diabetic rats that reported lowered lipid peroxidation products and elevated levels of antioxidant enzymes; superoxide dismutase, catalase, and glutathione peroxidase in liver and kidney, after feeding with *Nigella sativa* ethanol extract. Huda Kaatabi et al (2015) also demonstrated the similar effect of *Nigella sativa* in ameliorating the oxidative stress in patients with Type 2 Diabetes mellitus.

Another study on neuroprotective action of *N. sativa* oil on pentylentetrazole (PTZ) induced seizures in mice correlates with its ability to inhibit excessive ROS formation (Gilhotra and Dhingra 2011). Kanter (2008) also demonstrated neuroprotective activity of *N. sativa* on STZ induced diabetic rats. Recently, a study conducted by Nehar and Kumari (2013) on hepatoprotective effect of *N. sativa* seed oil on thioacetamide-induced liver cirrhosis in albino rat showed decrease in malondialdehyde (MDA), increase in catalase (CAT), superoxide dismutase (SOD) and glutathione peroxidase (GP_x), following treatment with *N. sativa* seed oil which indicates its antioxidative property.

It is therefore concluded that *N. sativa* seed extract has the potential to reduce DNA damage in STZ induced diabetic rats which is due to its antioxidative and genoprotective property (Mousavi et al. 2010).

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

- Akbarzadeh A, Norouzian D, Mehrabi MR, Jamshidi Sh, Farhangi A, Allah Verdi A, Mofidian SMA, Lame Rad B (2007) Induction of diabetes by Streptozotocin in rats. *Indian J Clin Biochem* 22(2):60–64
- Al Wafai RJ (2013) *Nigella sativa* and thymoquinone suppress cyclooxygenase-2 and oxidative stress in pancreatic tissue of streptozotocin-induced diabetic rats. *Pancreas* 42(5):841–849
- Alam P, Yusufoglu H, Alam A (2013) HPTLC densitometric method for analysis of thymoquinone in *Nigella sativa* extracts and marketed formulations. *Asian Pac J Trop Dis* 3(6):467–471
- Ali BH, Blunden G (2003) Pharmacological and toxicological properties of *Nigella sativa*. *Phytother Res* 17:299–305
- Babazadeh B, Sadeghnia HR, Kapurchal ES, Nasri S, Najaran ZT (2012) Protective effect of *Nigella sativa* and thymoquinone on serum/glucose deprivation-induced DNA damage in PC12 cells. *Avicenna J Phytomed* 2(3):125–132
- Badary OA (1999) Thymoquinone attenuates ifosfamide-induced Fanconis syndrome in rats and enhances its antitumor activity in mice. *J Ethnopharmacol* 67:135–142

- Badary OA, Taha RA, Gamal el-Din AM, Abdel-Wahab MH (2003) Thymoquinone Is a potent superoxide anion scavenger. *Drug Chemical Toxicol* 26:87–98
- Biswas M, Kar B, Bhattacharya S, Kumar RB, Ghosh AK, Haldar PK (2011) Antihyperglycemic activity and antioxidant role of *Terminalia arjuna* leaf in streptozotocin-induced diabetic rats. *Pharm Biol* 49(4):335–340
- Burits M, Bucar F (2000) Antioxidant activity of *Nigella sativa* essential oil. *Phytother Res* 14:323–328
- Damasceno DC, Netto AO, Iessi IL, Gallego FQ, Corvino SB, Dallaqua B, Sinzato YK, Bueno A, Calderon IPM, Rudge MVC (2014) Streptozotocin-induced diabetes models: pathophysiological mechanisms and fetal outcomes. *Biomed Res Int* 2014(2014):819065
- Datta NJ, Namasivayam A (2003) In vitro effect of methanol on folate-deficient rat hepatocytes. *Drug Alcohol Depend* 71:87–91
- David MN (1996) The pathophysiology of diabetic complications. *Ann Intern Med* 124:86–89
- El-Tantawy WH, Temraz A (2018) Management of diabetes using herbal extracts: review. *Arch Physiol Biochem* 124(5):383–389
- Erejuwa OO, Sulaiman SA, Wahab MSA, Sirajudeen KNS, Salzihan M, Salleh M, Gurtu S (2010) Antioxidant protective effect of Glibenclamide and Metformin in combination with honey in pancreas of streptozotocin-induced diabetic Rats. *Int J Mol Sci* 11(5):2056–2066
- Fabricant DS, Farnsworth NR (2001) The value of the plants used in traditional medicine for drug discovery. *Environ Health Perspect* 109:69–75
- Fiorentino TV, Priolella A, Zuo P, Folli F (2013) Hyperglycemia-induced oxidative stress and its role in diabetes mellitus related cardiovascular diseases. *Curr Pharm Des* 19(32):5695–5703
- Gilhotra N, Dhingra D (2011) Thymoquinone produced antianxiety-like effects in mice through modulation of GABA and NO levels. *Pharmacol Rep* 63:660–669
- Hossein H, Siavash P, Marjan NA, Sadeghnia Hamid R, Toktam Z (2007) Effect of thymoquinone and *Nigella sativa* seeds oil on lipid peroxidation level during global cerebral ischemia-reperfusion injury in rat hippocampus. *Phytomedicine* 14:621–627
- Houghton PJ, Zarka R, De las Heras B, Hoult JR (1995) Fixed oil of *Nigella sativa* and derived thymoquinone inhibit eicosanoid generation in leukocytes and membrane lipid peroxidation. *Planta Med* 61:33–36
- Ilhan A, Gurel A, Armutcu F, Kamisli S, Iraz M (2005) Antiepileptogenic and antioxidant effects of *Nigella sativa* oil against pentylentetrazol-induced kindling in mice. *Neuropharmacology* 49:456–464
- Isabelle M, Michel P, Dominique L (2005) Antioxidant strategies in the treatment of stroke. *Free Radical Biol Med* 39:429–443
- Janusz B, Michal A, Renata K, Katarzyna W, Marek Z et al (2004) DNA damage and repair in type 2 diabetes mellitus. *Mutat Res* 554:297–304
- Kaatabi H, Bamosa AO, Badar A, Al-Elq A, Abou-Hozaiifa B, Lebda F, Al-Khadra A, Al-Almaie S (2015) *Nigella sativa* improves glycaemic control and ameliorates oxidative stress in patients with type 2 Diabetes Mellitus: placebo controlled participant blinded clinical trial. *PLoS ONE* 10(2):e0113486
- Kaneto NY, Kawamori D, Miyatsuka T, Matsuo TA, Matsuhisa M, Yamasaki Y (2006) Role of oxidative stress, endoplasmic reticulum stress, and c-Jun N-terminal kinase in pancreatic beta-cell dysfunction and insulin resistance. *Int J Biochem Cell Biol* 38(5–6):782–793
- Kanter M (2008) Effects of *Nigella sativa* and its major constituent, Thymoquinone on sciatic nerves in experimental diabetic neuropathy. *Neurochem Res* 33:87–96
- Kanter M, Coskun O, Kalayci M, Buyukbas S, Cagavi F (2006) Neuroprotective effects of *Nigella sativa* on experimental spinal cord injury in rats. *Hum Exp Toxicol* 25:127–133
- Kassie F, Parzefall W, Knasmüller S (2000) Single cell gel electrophoresis assay: a new technique for human biomonitoring studies. *Mutat Res* 463:13–31
- Kedziora-Kornatowska K, Szewczyk-Golec K, Kozakiewicz M, Pawluk H, Czuczejko J, Kornatowski T et al (2009) Melatonin improves oxidative stress parameters measured in the blood of elderly type 2 diabetic patients. *J Pineal Res* 46:333–337
- Khader M, Bresgen N, Eckl PM (2010) Antimutagenic effects of ethanolic extracts from selected Palestinian medicinal plants. *Journal of Ethnopharmacology* 127(2):319–324
- Kumar GPS, Arulselvan P, Kumar SD, Subramaniam PS (2006) Antidiabetic activity of fruits of *Terminalia chebula* STZ induced diabetic rats. *J Health Sci* 52:283–291
- Lenzen S (2008) The mechanisms of alloxan- and streptozotocin-induced diabetes. *Diabetologia* 51:216–226
- Marklund S, Marklund G (1974) Involvement of the superoxide anion radical in the autoxidation of pyrogallol and a convenient assay for superoxide dismutase. *Eur J Biochem* 47(3):469–474
- Mousavi SH, Tayarani-Najaran Z, Asghari M, Sadeghnia HR (2010) Protective effect of *Nigella sativa* extract and Thymoquinone on serum/glucose deprivation-induced PC12 cells death. *Cell Mol Neurobiol* 30:591–598
- Nehar S, Kumari M (2013) Ameliorating Effect of *Nigella sativa* oil in thioacetamide-induced liver cirrhosis in albino rats. *Indian J Pharm Educ Res* 47(2):135–139
- Nehar S, Rani P (2011) HPTLC studies on ethanolic extract of *Nigella sativa* Linn. seeds and its phytochemical standardization. *Ecoscan* 1:105–108
- Nichans WG, Samuelson B (1968) Formation of malondialdehyde from phospholipid arachidonate during microsomal lipid peroxidation. *Eur J Biochem* 6:126–130
- Pan HZ, Chang D, Feng LG, Xu FJ, Kuang HY, Lu MJ (2007) Oxidative damage to DNA and its relationship with diabetic complications. *Biomedical and Environmental Sciences*. *Biomed Environ Sci* 20(2):160–163
- Pavana P, Sethupathy S, Manoharan S (2007) Antihyperglycemic and antilipidperoxidative effects of *Tephrosia purpurea* seed extract in streptozotocin induced diabetic rats. *Indian J Clin Biochem* 22:77–83
- Rajkamal G, Suresh K, Sugunadevi G, Vijayaanand MA, Rajalingam K (2010) Evaluation of chemopreventive effects of Thymoquinone on cell surface glycoconjugates and cytokeratin expression during DMBA induced hamster buccal pouch carcinogenesis. *BMB Rep* 43(10):664–669
- Salem ML (2005) Immunomodulatory and therapeutic properties of the *Nigella sativa* L seed. *Int Immunopharmacol* 5:1749–1770
- Singh NP, McCoy MT, Tice RR, Schneider EL (1988) A simple technique for quantitation of low levels of DNA damage in individual cells. *Exp Cell Res* 175:184–191
- Yaduvanshi SK, Srivastav N, Prasad GB, Yadav M, Jain S, Yadav H (2012). Genotoxic potential of reactive oxygen species (ROS) Lipid peroxidation and DNA repair, enzymes (FPG and ENDO iii) in alloxan injected diabetic rats. *Endocr Metab Immuno Disord Target* 28 PMID: 23210730.

शासकीय रेवती रमण मिश्र स्नातकोत्तर महाविद्यालय सूरजपुर
जिला-सूरजपुर

समाजशास्त्र शोध केन्द्र में उपलब्ध पुस्तकें

1	अपराधशास्त्र	डॉ. धर्मवीर महाजन
2	भारतीय सामाजिक परिवर्तन	डॉ. रवीन्द्रनाथ
3	आधुनिक भारत का आ. सा. एवं इति.	गिरीश कुमार सिंह
4	राजनीतिक समाजशास्त्र	डॉ. एम. एस. लवानिया
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6	नई सहर प्राप्ती का पर्यावरण	डॉ. विरेन्द्र सिंह यादव
7	उत्कृष्ट समाजशास्त्री परम्पराएँ	डॉ. रवीन्द्रनाथ
8	सामाजिक मानवशास्त्र की रूप-रेखा	डॉ. रवीन्द्रनाथ
9	विकास का समाजशास्त्र	डॉ. जी.आर. मदन
10	जनांकिकी	डॉ. किरण बघेल
11	नगरीय समाजशास्त्र	डॉ. बी.एम. सिंह
12	सामाजिक शोध एवं सांख्यिकीय	डॉ. रवीन्द्रनाथ
13	सामाजिक अनुसंधान का प्रणाली विज्ञान	डॉ. धर्मवीर महाजन
14	सामाजिक संरचना एवं परिवर्तन	डॉ. रवीन्द्रनाथ
15	ग्रामीण समाजशास्त्र	डॉ. बी.एम. सिंह
16	पंचायती राज्य एवं ग्रामीण विकास	डॉ. श्रीनाथ शर्मा
17	खैरवार जनजाति	डॉ. महेश शुक्ला

विभागाध्यक्ष

सुश्री प्रतिभा कश्यप
सामाजशास्त्र विभाग

(डॉ. एन.एस. अग्रवाल)

प्राचार्य

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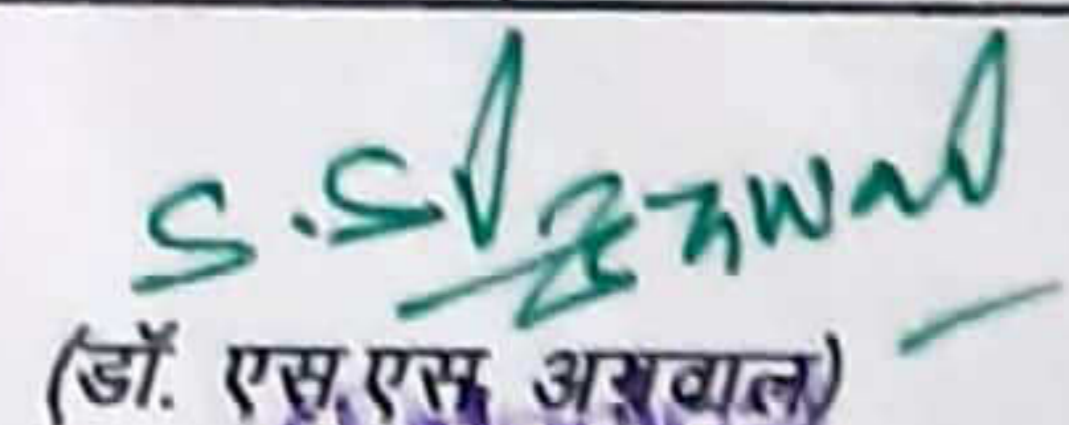
शासकीय रेवती रमण मिश्र स्नातकोत्तर महाविद्यालय सूरजपुर
जिला-सूरजपुर

अर्थशास्त्र
व्यक्तिगत शोध केन्द्र में उपलब्ध पुस्तकें

1	व्यष्टि अर्थशास्त्र	डॉ. वी.सी. सिन्हा	10 प्रति
2	व्यष्टि अर्थशास्त्र	डॉ. अनुपम अग्रवाल	4 प्रति
3	उच्च आर्थिक सिद्धांत	डॉ. अनुपम अग्रवाल	5 प्रति
4	व्यष्टि आर्थिक विश्लेषण	डॉ. अनुपम अग्रवाल	5 प्रति
5	व्यष्टि अर्थशास्त्र	डॉ. वी. सी. सिन्हा	5 प्रति
6	समष्टि अर्थशास्त्र	डॉ. एस. के. सिंह डॉ. ज.पी. मिश्रा	2 प्रति
7	समष्टि अर्थशास्त्र	डॉ. वी.सी. सिन्हा	7 प्रति
8	समष्टि अर्थशास्त्र	डॉ. वी.सी. सिन्हा	7 प्रति
9	कृषि अर्थशास्त्र	डॉ. शिवभूषण गुप्ता	5 प्रति
10	कृषि अर्थशास्त्र	डॉ. ज.पी. मिश्रा	10 प्रति
11	अन्तर्राष्ट्रीय अर्थशास्त्र	डॉ. वी.सी. सिन्हा	14 प्रति
12	पर्यावरण अर्थशास्त्र	डॉ. वी.सी. सिन्हा	5 प्रति
13	लोकवित्त	डॉ. जे.सी. वाष्णेय	13 प्रति
14	भारतीय अर्थशास्त्र	डॉ. चर्तुभुज ममोरिया	3 प्रति
15	शोध प्रविधि	हरीश कुमार खत्री	3 प्रति
16	सामाजिक अनुसंधान	डॉ. डी.एस. बघेल	2 प्रति
17	अर्थशास्त्र प्रथम	रामप्रसाद एण्ड संस	2 प्रति
18	अर्थशास्त्र प्रथम	वी.सी. सिन्हा	1 प्रति
19	अर्थशास्त्र प्रथम	पो. पी. एल. वर्मा	1 प्रति
20	अर्थशास्त्र द्वितीय	रामप्रसाद एण्ड संस	4 प्रति
21	अर्थशास्त्र तृतीय	रामप्रसाद एण्ड संस	5 प्रति
22	समष्टि अर्थशास्त्र	डॉ. वी.सी. सिन्हा	1 प्रति
23	समष्टि अर्थशास्त्र	डॉ. एस. के. सिंह	1 प्रति
24	औद्योगिक अर्थशास्त्र	डॉ. रमेश चन्द्र शर्मा	3 प्रति
25	औद्योगिक अर्थशास्त्र	आर. एस. कुलक्षेण्ड	1 प्रति
26	अर्थशास्त्र	डॉ. सी.एस. मिश्रा	1 प्रति
27	सामाजिक अनुसंधान प्रद्धतियाँ	डॉ. वुजेश कुमार सिंह	1 प्रति



विभागाध्यक्ष
श्री आनंद कुमार पैकरा
अर्थशास्त्र विभाग

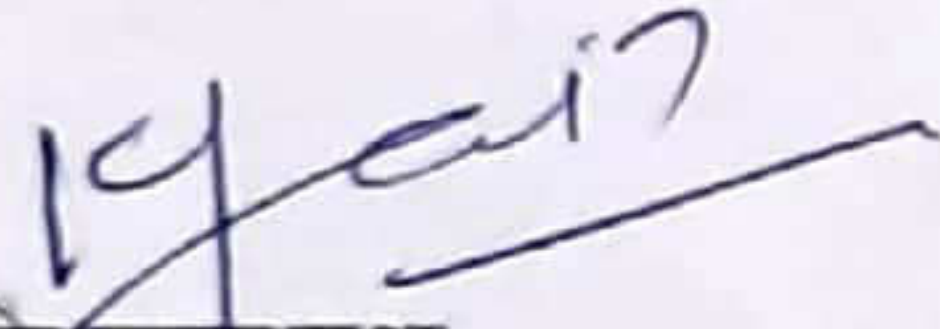


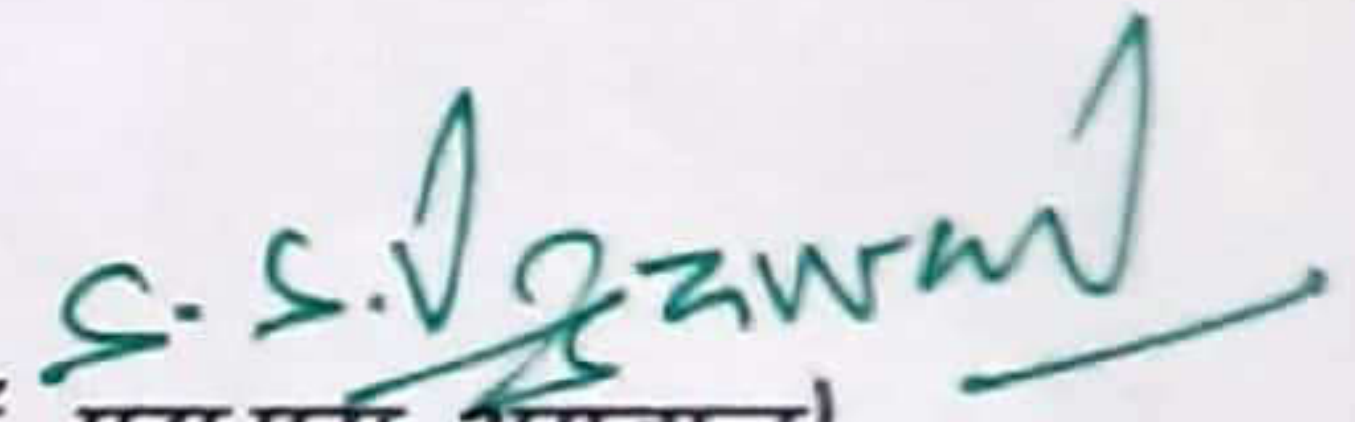
(डॉ. एस.एस. अग्रवाल)
प्राचार्य
शास. रे. 301 प्र. स्नात. महा. सूरजपुर
Surajpur

शासकीय रेवती रमण मिश्र स्नातकोत्तर महाविद्यालय सूरजपुर,
जिला-सूरजपुर (छ0ग0)

हिंदी शोध केंद्र में उपलब्ध पुस्तकें-

1. प्राचीन एवं मध्यकालीन काव्य-	उपयोगी प्रकाशन रायपुर	25 प्रति
2. हिंदी साहित्य का इतिहास	डॉ. नगेन्द्र	5 प्रति
3. हिंदी साहित्य का इतिहास	आचार्य रामचन्द्र शुक्ल	2 प्रति
4. चिंतामणी भाग तीन	आचार्य रामचन्द्र शुक्ल	10 प्रति
5. चिंतामणी भाग एक	आचार्य रामचन्द्र शुक्ल	1 प्रति
6. चिंतामणी भाग दो	आचार्य रामचन्द्र शुक्ल	2 प्रति
7. हिंदी पत्रकारिता	डॉ. धीरेन्द्र	1 प्रति
8. आधुनिक पत्रकारिता	डॉ. अर्जुन तिवारी	1 प्रति
9. लोक साहित्य	डॉ. अनिरुद्ध कुमार	5 प्रति
10. लोक साहित्य	डॉ. राजेश श्रीवास्तव	1 प्रति
11. जायसी ग्रंथावली भाग-1	आचार्य रामचन्द्र शुक्ल	1 प्रति
12. सूरदास	पं. ज्वाला प्रसाद	1 प्रति
13. कबीर	हजारी प्रसाद द्विवेदी	10 प्रति
14. हिंदी साहित्य का उदभव और विकास	हजारी प्रसाद द्विवेदी	1 प्रति
15. आधुनिक काव्य संग्रह	रामवीर सिंह	1 प्रति
16. भारतीय साहित्य	डॉ. नगेन्द्र	5 प्रति
17. आधुनिक हिंदी काव्य	उपयोगी प्रकाशन रायपुर	5 प्रति
18. जयशंकर प्रसाद	नंद दुलारे वाजपेयी	5 प्रति


विभागाध्यक्ष
डॉ. कल्याणी जैन
हिंदी विभाग


(डॉ. एस.एस. अग्रवाल)
Principal
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Govt R.R.M. College
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Govt. Rewati Raman Mishra P.G. College Surajpur

Chemistry Departments (Research Centre)

List of Reference Books

s.n.	Books Name	writer's name
1	Medicinal Chemistry 6th ed.	Ashutosh kar
2	Stereo Chemistry	P. S. Kalsi
3	Elementary Organic spectroscopy	Y. R. sharma
4	Fundamentals of Biochemistry	Dr. J. L. Jain
5	(Vogel's) Text book Quantitative Chemical Analysis	J. Mendham
6	A guide book to Mechanism in organic Chemistry	Peter Sykes
7	Organic Chemistry (Fifth ed.)	I. L. Finer
8	Inorganic Chemistry (III ed.)	Gary L. Miessler.
9	Stereo Chemistry of Organic Compounds.	Ernest L. Eliel
10	Analytical Chemistry	Gary D. Christian
11	March's Advanced organic Chemistry (Reactions and structure) (7th ed.)	Michael B. Smith
12	Spectroscopy of organic Compounds.	P. S. Kalsi
13	Organic Chemistry (11 ed.)	T.W.Graham Solomons
14	Organic Reaction Mechanisms. (IV ed.)	Raj K Bansal
15	Inorganic Chemistry 6th ed.	Mark weller
16	Concise Inorganic Chemistry	J. D. Lee
17	Bio chemistry	U. Satyanarayana
18	Organic Chemistry II ed	Jonathan Clayden
19	Organic Chemistry Vol. I	I. L. Finar
20	Organic Synthesis	Dr. Jagdamba Singh
21	Materials Science and Engineering (6th ed.)	V. Raghavan
22	Solid State Chemistry and its Applications.	Anthony R. West
23	Elementary Organic spectroscopy	Y. R. sharma
24	Spectroscopy of organic Compounds. (7th ed.)	P. S. Kalsi
25	Cosmetics Science and Technology (Second ed.) Vol.1	Marvin S. Balsam
26	Organic chemistry	Graham Solomons
27	Inorganic Chemistry (6th - ed.)	Weller Overton
28	Inorganic Chemistry	James Huheey
29	Inorganic Chemistry	Gary L. Miessler.
30	Inorganic Chemistry	Dr. Wahid U. Malik
31	Material Science & Engg. A first Course.	V. Raghavan
32	Vogel's. Text Book of practical Organic Chemistry	B.S.Furniss

33	Organic Chemistry (Vol.2)	Finar
34	Inorganic Chemistry : Principal of structure&Reactivity	Huheey
35	Chemical Kinetics	Laidler
36	Vogel's Text Book of Quantitative Chemical Analysis	Mendham
37	Organic Chemistry	Smith
38	Fundamentals Of Molecular Spectroscopy	Banwell
39	Spectroscopic Method in Organic Chemistry	Williams
40	Environmental chemistry	Anil k DE
41	Laboratory Manual of Organic chemistry	Raj k Bansal
42	Symmetry and spectroscopy molecules.	K. Veera Reddy
43	Photo chemistry and Pericyclic Reaction	Jagdamba singh
44	Fundamentals Of Photo Chemistry	K.K. Rohatgi Mukharjee
45	Stereo chemistry of organic compounds	D. Nasrpuri
46	Ess. Of Nuclear Chemistry	H.J. Arnikar
47	Concise Inorganic chemistry	J D Lee.
48	Organic chemistry	Jonathan clayden
49	An Introduction to Medicinal Chemistry	Patrick
50	Nano chemistry	Nishit Mathur
51	A Hand Book of Nano Chemistry	Patric Saloman
52	Organic chemistry Vol-II	I.L. Finer.
53	Vogel's Text Book of Qualitative Inorganic Analysis	G.Svehla
54	Engineering Chemistry	Jain
55	Fund. Of Analytical Chemistry (Skoog)	F. James
56	Practical Organic Chemistry	Bravins Furruiiss
57	Ad. Inorganic Chemistry	f. Albert Cotton
58	Organic chemistry (7th.ed)	paula, Bruice
59	Intrduction to Organic chemistry	john memurry
60	Principles of Bio Inorganic chemistry	stephen j. Lippard
61	Inorganic chemitry	Keith F Purcell c kotz
62	Basic Organometallic Chemistry	B.D Gupta ,A J Elias
63	Introduction to Spectroscopy	Pavia
64	Hetrocyclic Chemistry	R K Bansal
65	Organic Chemistry	T.W.Solomonas
66	Analytical Chemistry	G Christian
67	Stereo Chemistry of Organic Compounds	E.L.Eliel

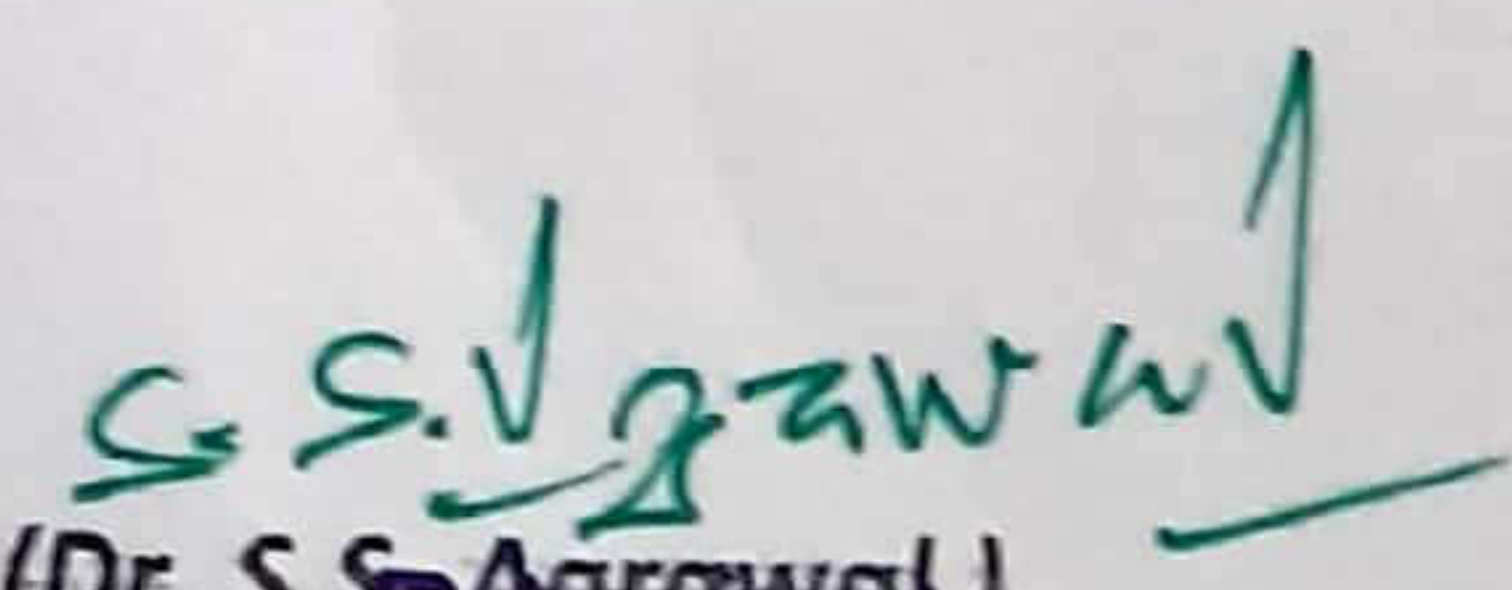
Principal
 Govt R.R.M. College
 Surajpur (C.G.)

Govt. R. R. M. PG College Surajpur
Chemistry Department
List of Instruments

SR.NO.	NAME OF INSTRUMENTS
1	Microprocessor Nephelo/Turbidity Meter
2	Digital Potentometer
3	Digital pH Meter
4	Heating Mantle
5	Chemical Balance
6	Digital Photo Colorimeter
7	Digital Conductometer
8	Centrifuge Machine
9	Melting/Boiling Point Apparatus
10	Magnetic Stirrer With Hot Plate
11	Micro Incubator
12	Rectangular Water Bath 6 Chamber
13	Rectangular Water Bath 8 Chamber
14	Digital Weighing Machine
15	Digital Flame Photometer
16	Hot Air Oven
17	Vacuum Pump
18	Ultra Violet Cabinet
19	Digital TDS Meter
20	Muffle Furnace
21	Rotary Vacuum Evaporator
22	Digital Melting Point Apparatus
23	Vacuum Oven
24	Digital Polarimeter
25	Rotary Flask Shaker
26	Rectangular Water Bath
27	Water Distillation Apparatus
28	Double beam UV-Vis Spectrophotometer (Lab India)
29	Digital Refractometer

Journals Subscription	
1	N- List
2	American Chemical Society Membership
3	SciFinder


Department of HOD
Dr. Vikesh Kumar Jha


(Dr. S. S. Agrawal)
Principal
Govt R R.M. College
Surajpur (C G.)

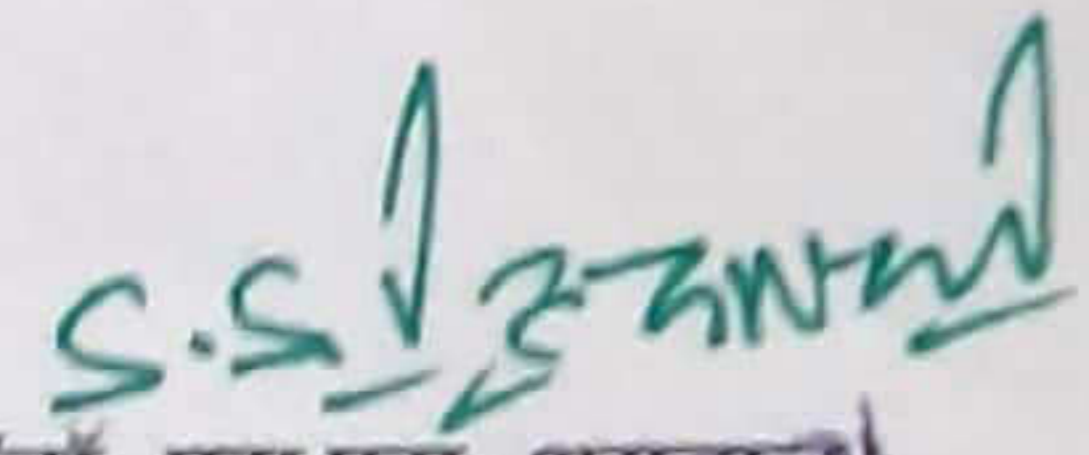
शासकीय रेवती रमण मिश्र स्नातकोत्तर महाविद्यालय सूरजपुर
जिला-सूरजपुर

वाणिज्य शोध केन्द्र में उपलब्ध पुस्तकें

1	Advertising and Sales promotion	Paukhuri Bhagat
2	विनियोग प्रबंध	डॉ. वी.सी. सिन्हा
3	विपणन प्रबंध	आर. पी. अग्रवाल
4	प्रबंध की अवधारणा	आर. पी. अग्रवाल
5	प्रबंधकीय निर्णयों हेतु लेखाकंन	डॉ. के. एल. गुप्ता
6	व्यावसायिक सनियम	आर.पी. अग्रवाल
7	प्रबंधकीय अर्थशास्त्र	डॉ. वी.सी. सिन्हा
8	विपणन प्रबंध	डॉ. एस.सी. जैन
9	संगणनात्मक व्यवहार	आर. सी. अग्रवाल
10	सामाजिक अनुसंधान पद्धतियाँ	डॉ. ब्रिजेश कुमार सिंह
11	अंतर्राष्ट्रीय अर्थशास्त्र	डॉ. वी.सी. सिन्हा
12	उच्चतर सांख्यिकीय विश्लेषण	डॉ. वास्तोपति शास्त्री
13	सांख्यिकीय विश्लेषण	डॉ. वी.एन. गुप्ता
14	शोध पद्धतियाँ	डॉ. बी. एल. फडिया
15	शोध पद्धतियाँ	हरीश खत्री
16	शोध पद्धतियाँ	डॉ. एल.एस. गजपाल
17	सामाजिक अनुसंधान की पद्धतियाँ	डॉ. एल.एस. गजपाल
18	शोध प्रविधि	डॉ. गणेश पाण्डेय
19	सामाजिक अनुसंधान	डॉ. डी.एस. बघेल
20	वित्तीय प्रबंध	आर. एस. कुलश्रेष्ठ



विनागाध्यदा
श्री सी.बी. मिश्र
वाणिज्य विभाग



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R.R.M. College
शास. रे. सूरजपुर स्नात. महा. सूरजपुर


शासकीय रेवती रमण मिश्र स्नातकोत्तर महाविद्यालय सूरजपुर
जिला-सूरजपुर (छ0ग0)

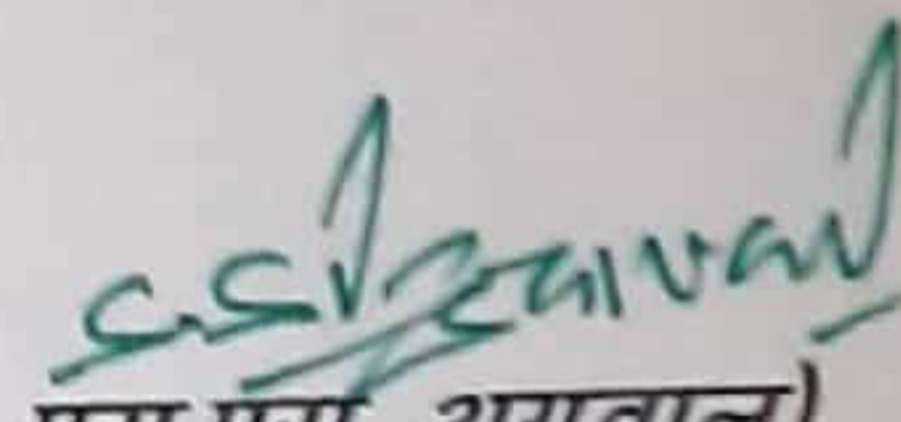
राजनीतिशास्त्र शोध केन्द्र में उपलब्ध पुस्तकें

1	लोक प्रशासन एवं शोध प्रविधि	सी.पी. शर्मा	31 प्रति
2	अंतर्राष्ट्रीय संगठन एवं अंतर्राष्ट्रीय कानून	डॉ. बी.एल. फड़िया	08 प्रति
3	अंतर्राष्ट्रीय संबंध	डॉ. बी.एल. फड़िया	11 प्रति
4	राजनीतिक चिंतन भारतीय एवं पाश्चात्य	डॉ. बी.एल. फड़िया	4 प्रति
5	राजनीतिक चिंतन भारतीय एवं पाश्चात्य	पी.डी. पाठक	18 प्रति
6	'शोध प्रविधि	द्वारका कुमार	5 प्रति
7	'शोध प्रविधि	वंदना वोहरा	2 प्रति
8	'शोध प्रद्धतियाँ	डॉ. बी.एल. फड़िया	6 प्रति
9	भारतीय शासन एवं राजनीति	शरद भटनागर	20 प्रति
10	अंतर्राष्ट्रीय राजनीति के सिद्धांत	शरद भटनागर	21 प्रति
11	तुलनात्मक राजनीति	डॉ. विनिता कुल श्रेष्ठ	20 प्रति
12	तुलनात्मक सरकारें	सी.पी. शर्मा	01 प्रति
13	आधुनिक राजनीति विज्ञान	डॉ. हरीश चन्द्र	01 प्रति
14	एकाधिकार	डॉ. ए. जी. रॉबिन्सन	01 प्रति
15	दार्शनिक निबंध संचमन	प्रो. शशिभूषण सिन्हा	01 प्रति
16	जिला सरकार अवधारणा स्वरूप	बी. एम. शर्मा	01 प्रति
17	अंतर्राष्ट्रीय संबंध	भूपेन्द्र शंकर	01 प्रति
18	राजनीति विज्ञान सिविल सेवा	अरुण दत्त शर्मा	01 प्रति
19	राजनीतिक समाजशास्त्र	डॉ. गणेश पाण्डेय	02 प्रति
20	भारतीय विदेश नीति	डॉ. एस. वाधवा	01 प्रति
21	भारतीय राजनीति और प्रशासन	डॉ. एस. वाधवा	01 प्रति
22	राजनैय सिद्धांत एवं व्यवहार	श्रीवास्तव	01 प्रति
23	भारत में स्वतंत्रता आंदोलन	सी.के. सक्सेना	01 प्रति
24	अंतर्राष्ट्रीय राजनीति	हरिदत्त वेदालकर	01 प्रति
25	लोक प्रशासन	वामेश्वर	03 प्रति
26	भारतीय राजनीतिक सिद्धांत समस्या सुधार	डॉ. सुभाष कश्यप	01 प्रति
27	संविधान	पी.के. शर्मा	01 प्रति
28	विदेश नीतियाँ सिद्धांत एवं व्यवहार	डॉ. प्रभु दत्त शर्मा	01 प्रति
29	मध्यप्रदेश राजनीति विविध आयाम	महेश महेश्वरी	01 प्रति
30	आधुनिक भारत का सामाजिक एवं आर्थिक इतिहास	प्रताप सिंह	01 प्रति
31	आधुनिक सरकारें	डॉ. प्रभु दत्त शर्मा	01 प्रति
32	अंतर्राष्ट्रीय संगठन	प्रो. रामानंद गैरोला	01 प्रति
33	प्रमुख राजनीति विचारक एवं विचारधाराएँ	डॉ. ओम नाग पाल	01 प्रति

34	विश्व राजनीति में भारत	डॉ. जे. श्याम सुन्दरम	01 प्रति
35	राजनीति विज्ञान के मूल सिद्धांत	डॉ. बी.एल. फडिया	01 प्रति
36	प्रशासनिक विधियाँ	जे. एन. मालयानी	01 प्रति
37	सेवी वर्ग प्रबंध	डॉ. एस.सी. सक्सेना	01 प्रति
38	प्रमुख राजनीति विचारक	डॉ. राजकुमार	01 प्रति
39	भारत की विदेश नीति	आर. एस. यादव	01 प्रति
40	भारतीय राष्ट्रीय आंदोलन	सी.पी. शर्मा	01 प्रति
41	भारत व विश्व आंदोलन	डॉ. ओम नाथ पाल	01 प्रति
42	आधुनिक राजनीतिक विचारों का इतिहास	प्रभुदत्त शर्मा	01 प्रति
43	स्विटजरलैंड जापान एवं चीन का संविधान	डॉ. पी.डी. शर्मा	01 प्रति
44	संसद का इतिहास	डॉ. सुभाष कश्यप	01 प्रति
45	राजनीतिक दल एवं जनप्रतिनिधि	डॉ. एस.आर.पाल	01 प्रति

इसके अतिरिक्त अन्य सदर्थ ग्रंथ मुख्य ग्रंथालय में उपलब्ध हैं तथा महाविद्यालय में INFLIBNET तथा N-LIST की भी सुविधा है।


विभागाध्यक्ष
डॉ. एच.एन. दुबे
राजनीति विज्ञान विभाग


(डॉ. एस.एस. अग्रवाल)
प्राचार्य
Principal
शास. रे. र. मिश्र स्नात. महा. सुरजपुर
Govt R.K.M. College
Surajpur (C.G.)

Govt. Rewati Raman Mishra P.G. College Surajpur, Dist-Surajpur

Research Center , Department of Botany

List of Reference Books

S.N.	Title of Crop Plants in India	Writer's/ Authar's Name
1	Disease of crop Plants in India	H. Ranga Swami
2	Cell Biology Genetics, Molecular Biology, Evolation and Ecology	Dr. P.S. Verma
3	The Embryology of Angiosperms	S.S. Bhojwani
4	Concepts of Genticis	William S. King
5	Biochemistry and molecular Biology	B. Bhuchnan
6	Genetics : Analysis of gane and genomes	Daniel L. Harti & E.W. Jones
7	Encyclopedia of Fungicides	Chris Frost
8	Biology of Micro organisms	Michael T. Madigen
9	Cell and Molecular Biology	De. Roddy
10	Bios Instant Microbiology	Siman Baver
11	Fundamentals of Agricultural Microbiology	K.K. Aneja
12	Practical Microbiology	S.C. Parija
13	Microbiology and Plant Panthology	P.D. Sharma

HOD OF BOTANY

Mr. T.S. Rahangdale

S.S. Agrawal
Dr. S.S. Agrawal

PRINCIPAL
Govt. Rewati Raman Mishra P.G. College
Surajpur (C.A.)
Surajpur

Govt. Rewati Raman Mishra P.G. College Surajpur, Dist-Surajpur

Research Center , Department of Botany

Lab Equipments/Apparatus List 2020-21

S.No.	Name of the Articl	Nos.
1	Laminar air flow (Stanless Steel)	
2	Phase contrast Microscope	
3	Digital pH Meter	
4	Hot air Oven	
5	Autoclave	
6	Water Bath	
7	Binocular Microscope	
8	Compound Microscope	
9	Dissecting Microscope	
10	Micrometer	
11	Photolorimeter	
12	Chrometographic Chamber (For paper chrometography)	
13	BOD Inculcator	
14	Refrigeretor	
15	Humidity Chamber	
16	Distilatiion Unit	
17	Mini rotator Flask Shaker	
18	TDS meter	
19	UV Cabinete	
20	Centrifngation	
21	Bacteriological Incubator	
22	Magnatic Stiror with hot Plate	
23	Camera Lucida	

HOD OF BOTANY
Mr. I.R. Rahangdale

S.S. Agrawal
Dr. S.S. Agrawal
Principal
Govt. R. R. M. PG College
Surajpur


Govt. Rewati Raman Mishra P.G. College Surajpur, Dist-Surajpur

Research Center , Department of Botany

List of Journals


S.No.	Name of Journals	Remark
1	All Journals available in N-List	Online
2	Plant Impact Factor - 3.935 (200) ISSN : 2223-7747	MDPI Open Access Online
3	Cells Impact Factor 6.600 (2020) ISSN : 2073-4409	MDPI Open Access Online


HOD OF BOTANY
Mr. T.R. Rahangdale


Dr. S.S. Agrawal
Principal
Govt. R. R. M. PG College
Surajpur (U.G.)

आज दिनांक - 28.06.2021 को महाविद्यालय के रसायन विभाग के रीर राइडिंग विभाग एवं संगोष्ठी विभाग द्वारा संयुक्त रूप से एक दिवसीय ^{ऑनलाइन} संगोष्ठी सह कार्यक्रमा का आयोजन सम्पन्न हुआ। जिसका थीम "रसायन शास्त्र के क्षेत्र" है। के रीर के अक्सर महत्व व उपयोगिता रहा। इस कार्यक्रमा के मुख्य वक्ता डॉ. वीरज सुक्सा शासकीय विभाग महाविद्यालय राजनोदगांव (दुंगु) एवं डॉ. अतल मिश्रा इस शासकीय विभाग विज्ञान महाविद्यालय राजनोदगांव (दुंगु) है।

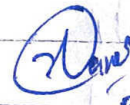
महाविद्यालय के छात्र डॉ. एस. एस. अग्रवाल ने विद्यार्थियों को के रीर का अनुभव करते समय सतर्क रहने पर जोर दिया। इस कार्यक्रम का सफल बनने के महाविद्यालय के प्राचार्य एवं डॉ. सहयोग रहा।


28/6/21



Principal
Govt. R.R.B. College
Surajpur (C.G.)

आज दिनांक 22/07/2021 को शालकीय शैली समन
सिद्ध महाविद्यालय, खुरजपुर (द्व.ग.) में प्राचार्य की
अध्यक्षता में प्राचार्य के समुख CIPET, कोरबा के
प्रभारी निदेशक श्री मनोज कुमार राजपूत एवं लक्ष्मीको
उपाध्याय श्री अश्विनेश भांजा ने विद्यार्थियों को
शैजगार से संबंधित जानकारियाँ दी। इस बैंक में
विद्यार्थियों को Plastic Waste Management तथा Plastic
उपकरण के निर्माण संबंधी स्वरोजगार की जानकारी तथा
CIPET, Korba के माध्यम से किचे जाने वाले विकल्प
पाठ्यक्रमों की सहायता से मिचते एवं शालकीय क्षेत्र में
शैजगार की सम्भावनाओं को विस्तार पूर्वक बताया गया।

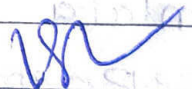
① श्री मनोज कुमार राजपूत
प्रभारी निदेशक CIPET कोरबा (द्व.ग.)


22/07/2021


② श्री अश्विनेश भांजा (उपाध्याय)
CIPET कोरबा (द्व.ग.)


22/7/2021

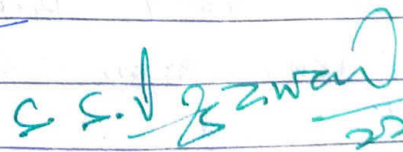
③ डॉ० बिलेश कुमार डॉ०
सहा० प्रा० (रसायनशास्त्र)



④ श्री टी० आर० राहेंगडाले
सहा० प्रा० (वनस्पतिशास्त्र)


22/7/2021

⑤ डॉ० न्यन्दन कुमार
सहा० प्रा० (प्राणीशास्त्र)


22/7/21

प्राचार्य
शासकीय रे.र.मि. महाविद्यालय
खुरजपुर (द्व.ग.)

① Anun Rajwade



② Ram satan



③ Anuj yadar



4) Sumeshwar Singh

Singh

5) Preeti Kushwaha

Preeti

6) Nisha patra

Patra

7) Sushma Sahu

Sushma

8) Kajal sonwani

Kajal

9) VITAM SAHU

Vitam

10) Babales

Babales

11) Susti Upadhyay

12) Anchal Kushwaha

Anchal Kushwaha

13) Leela Singh

Leela Singh

14) Kapil dev Singh

Kapil dev Singh

15) Kusum

Kusum

16) Shirmangli

Shirmangli

17) Dev kumari

Dev

18) Priyanka Yadav

Priyanka

19) Deepanjali Dwivedi

Deepanjali

20) Hemlata

Hemlata

21) Dileep Kumar

Dileep

22) Kamlesh Kumar Sahu

Kamlesh

23) Jugal

Jugal

24) Dev Prasad Patankar

Dev Prasad

25) SHRAVAN kumar RAJWADE

Shravan

26) Ramchand

Ramchand

27) Anjulata

Anjulata

28) Vinod Kumar

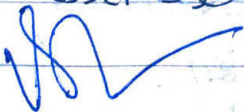
Vinod Kumar

29) Laxmi kindo

Laxmi

30) Usmila Debnayan

Usmila



आज दिनांक 26/11/2021 को अडानी ग्रुप उदयपुर छा.ग. से महाविद्यालय के स्नातक एवं स्नातकोत्तर कक्षाओं के विद्यार्थियों को लिफ्टिंग मशीन ऑपरेटर एवं माइनिंग से बंधी संबंधित ट्रेनिंग के बारे में जानकारी दी गई। रिलेस पर्सन के रूप में श्री विनीत श्रीवास्तव एवं श्रीमती प्रियंका सिंह उपस्थित हुए। आपन छात्र/छात्राओं को ट्रेनिंग के बाद रोजगार के संबंध में जानकारी दी गई। इसके अतिरिक्त इंग्लिश व पर्सनलिवी डेवलपमेंट की जानकारी दी गई।

जोब प्लेसमेंट के बारे में जानकारी दी गई।

श्री विनीत श्रीवास्तव (माइनिंग मेकेनिक) ट्रेनर
श्रीमती प्रियंका सिंह SMO ट्रेनर

26/11/2021

Singh

उपस्थित विद्यार्थियों के नाम व हस्ताक्षर

सं.क्र.	नाम	हस्ताक्षर
1.	आकांक्षा कुशावाहा	Akanksha
2.	अभय कुशावाहा	Abhay
3.	खुशबू साहू	Khushbu
4.	बिन्दूवती राजवाड़े	Binduswari
5.	प्रेमकुमारी राजवाड़े	Prem
6.	रेहाना रासमीन	Rehana
7.	तृपति कुशावाहा	Tripti
8.	शीतल साहू	Sheetal
9.	लक्ष्मी सिंह	Laxmi
10.	प्रतिमा	Pratima
(11)	प्रेमलता	Premalata
12.	उमा पैकरा	Uma

CK

- | | | |
|----|---------------------|--------------------|
| 13 | कामेश्वरी | <u>Rameshwari</u> |
| 14 | निलेश कुमार | _____ |
| 15 | समिक्षा | Samiksha |
| 16 | हेमा सारथी | Hema Sarthi |
| 17 | प्रियंका विश्वकर्मा | <u>Priyanka</u> |
| 18 | परमेश्वरी कुशावाहा | Parameshwari |
| 19 | सोने लाल | <u>Soney</u> |
| 20 | धर्मपाल | धर्मपाल |
| 21 | संध्या | <u>Sandhya</u> |
| 22 | रानू | Ranu |
| 23 | हृत्तीसिंह | <u>Hriti</u> |
| 24 | कविता सिंह मरकाम | <u>Kavita</u> |
| 25 | सुनिहा | सुनिहा |
| 26 | गायत्री सिंह | <u>Gayatri</u> |
| 27 | कर्वा बाबू | <u>Karwa</u> |
| 28 | पूजेश्वरी राजवाडे | <u>Poojeshwari</u> |
| 29 | सीता कुमारी | <u>Sita</u> |
| 30 | तारा साहू | <u>Tara</u> |
| 31 | शीला सिंह | <u>Sheela</u> |
| 32 | उज्जैनी कुशौर | Ujjaini kushor |
| 33 | मनिषा राजवाडे | Manisha Rajwade |
| 34 | प्रिया हेवांगन | <u>Priya</u> |
| 35 | Kalpna Rajwade | <u>Kalpna</u> |
| 36 | Shivangi | <u>Shivangi</u> |
| 37 | Shehina Perveen | Shehina |
| 38 | Ramkumari Singh | <u>Ramkumari</u> |
| 39 | Neha Singh | <u>Neha Singh</u> |

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40	सुरभेन सिंह	सुरभेन
41	Shruti Yadav	Shruti
42	Neha Rajwade	Neha
43	उमिला	Umilga
44	पार्वती	Parvati
45	देविका साहू	Devika Sahu
46	प्रिया साहू	Priya Sahu
47	संध्या सिंह	Sandhya
48	शिल्पा कुरे	Shilpa Kure
49	प्रीति साहू	Preeti Sahu
50	सुधा	Sudha
51	Sohanti	Sohanti
52	Jalita	Jalita Singh
53	महमा सिंह	Mahanti
54	महन्ती	Mahanti
55	रूपणा साहू	Rupna
56	चंदा साहू	Chanda
57	अंजू प्रजापती	Anju
58	आरती साहू	Arati
59	आरती साहू	Arati
60	रुपा	Rupa
61	sandhya	sandhya
62	sakshi das	sakshi
63	shivlochni	shivlochni
64	Devati	Devati
65	विन्देश्वरी	Bindevshwari
66	Dipti	Dipti
67	Tara	Tara

cks

प्रगति

- | | | |
|------|------------------|--------------------|
| 68 | रीना सिंह | Pragati |
| 69 | अरुण कुमार | Rina Singh |
| 70 | गोपेश्वर कुमार | Arun Kumar |
| (71) | शंकर सिंह | Gopeshwar |
| (72) | पितृन्द्र जयि | Shankar Singh |
| (73) | राजकुमार | Pitrandra Jai |
| (74) | पुरुषोत्तम सिंह | Raj Kumar |
| (75) | राधा साहू | Purushottam Singh |
| (76) | अशोका | Radha Sahu |
| (77) | दसमनिपा | Ashoka |
| (78) | ममता सिंह | Dasmaniya |
| (79) | देविका सिंह | Mamta Singh |
| (80) | चन्द्रशम | Devika Singh |
| (81) | अशोक सिंह | Chandrasam |
| (82) | Beelal Singh | Ashok Singh |
| (83) | विजय प्रताप सिंह | Beelal Singh |
| (84) | विक्रम सिंह | Vijay Pratap Singh |
| (85) | रोषनी दास | Vikram Singh |
| (86) | पिन्डू राम | Roshni Das |
| (87) | आहिल सिंह | Pinduram |
| (88) | रत्नरा | Aahil Singh |
| (89) | रामेश कुमार यादव | Ratnara |
| (90) | जागेन्द्र कुमार | Ramesh Kumar Yadav |
| (91) | पिला सिंह | Jagendra Kumar |
| (92) | | Pila Singh |

26/11/2021

Che 26/11/2021

Seen S.S. 26/11/2021

आज दिनांक 6-12-2021 को

जिला प्रशासन सुरजपुर के तत्वाधान में शासकीय रेवती रमण मिश्र स्नातकोत्तर महाविद्यालय सुरजपुर में "अविकल्प इक्ति सुवा स्मृति" कार्यक्रम के तहत विद्यार्थियों को कैरियर मार्गदर्शन जिला कलेक्टर डॉ. गौरव कुमार सिंह के द्वारा दिया गया। इस अवसर पर जिलाधीश महोदय ने महाविद्यालयी छात्र-छात्राओं से सनकरन होकर कैरियर गाइडेंस और उलियोगिता परीक्षाओं की तैयारी के सम्बन्ध में विस्तार से जानकारी दिया। इस कार्यक्रम में महाविद्यालय के छात्रों डॉ. रमण रमण अग्रवाल, महाविद्यालय जनभागीदारी के अध्यक्ष श्री सुनील अग्रवाल, जिला प्रशासन के विभिन्न अधिकारियों व महाविद्यालय के छात्रापदाधिकारी डॉ. अक्षयमनरत छात्र-छात्राएं उपस्थित रहे।

- | | |
|------------------|---------------------|
| 1 chanda | 9 ... |
| 2 Suman Singh | 10 Anita Singh |
| 3 Anil | 11 Dewanti Singh |
| 4 Rohani Sahu | 12 Ancha Singh |
| 5 Anand | 13 Prityankha Yadav |
| 6 ... | 14 Anita |
| 7 Gayatri | 15 Kavita Sahu |
| 8 ... | 16 ... |

- (17) Sneha
- (18) Laxmi
- (19) Jagyapurnasinh
- (20) Anu
- (21) Anu
- (22) Seema

(23) शिवानी झावही Shabang.

(24) विमल रिवी Shirav

(25) Mary Prabha

(26) Manju Manju

(27) Sunita

(28) Ankumar

(28) Yashvi

(29) DivyaBharti

30 Bobby

31 Hemanti Rajwade

32 Durgawati

(33) Bhanu Pratap Singh

(34) Bijeshwar Baghel

(34) Greeta Singh Engish

(35) Karishma

(36) Sakuntla

(37) Kiran

(38) Siddhi

39) Mahesh Kur. Singh

40) Ravina DeWangam.

(41) Sunita Singh

(42) ANKASH SAHU

Handwritten signature

43)	Amel kumar - patel	Amel
44)	Sunil kumar Rajwade	sunil
45)	Yashwada	Yashwada
46)	Priya	Priya
47)	Pooja Kushwaha	Pooja
48)	Sanjay kumar	संजय कुमार
49)	Krishna Kumar	krishna
50)	Saral Kumar	Saral Kumar
51)	Shivshankar Singh	Shivshankar
52)	Pushpa Rajwade	Pushpa
53)	Kasmeriya Singh	Kasmeriya
54)	Chandani	Chandani
55)	Tinku Raswade	Tinku
56)	UMA Rajwade (Uma
57)	G. Yamuna	Gyamin
58)	chanelawati	Chanelawati
59)	Safiyano	Safiyano
60)	Bhanumati	Bhanumati
61)	Sonam kumar	Sonam kumar
62)	Aarti Singh (09)	Aarti Singh
63)	shyambai Singh (144)	Shyambai
64)	Karavada	Karavada
65)	Garima Vishwakarma	Garima
66)	Kalawati	Kalawati
67)	Abimata Singh	Abimata
68)	Somee Singh	Somee
69)	Archal	Archal
70)	pappi singh	pappi singh
71)		Pappi

(67)	Sunita Singh	Sunita Singh
(68)	Joshi Gupta	जोशी गुप्ता
(68)	Ankita Sahu	अंकिता साहू
(69)	Sunida	Sunida
(70)	सिनीटा	Santoshi
71	Susheela	Susheela
72	Dimpal	Dimpal
73	Dileswary	Dileswary
74	Suman	Suman
75	sonce Singh	sonce Singh
76	Prema Singh	prema singh
77	lishal Thakur	lishal
78	Mahendra pratap	महंत
79	Khushbu Sahu	Khushbu
80	Pritya Sahu	Pritya
81	Diksha Tiwari	Diksha
82	Shakh Rubee	Rubee
83	Santosh Kumar	Santosh
(84)	Bhagwat Diwakar	Bhagwat
(85)	Dhimeshwo Kumar	Dhimeshwo
(86)	Sudha Dewangan	Sudha
(87)	Geetanjali Rajwade	गीतानजली
88	Katyani Singh	KATYANI
(89)	Basanti Singh	Basanti
(90)	VIVEK Sahu	Vivek
100	Kakhaty	Kakhaty
101	Aniket Sahu	Aniket

28

Principal
Govt. P.M. College,
G.O. (G.G.)

102	Amit kumar Singh	Amit
103	Shivkumar Singh	Shivkumar
104	Ravishankar	Ravishankar
105	Deep Singh Marabi	Deep Singh
106	Manisha Soni	Mani
107	Shahida Parveen	Shahida
108	Pinky Agrawal	Pinky
109	Bhagwat Dixit	Bhagwat
120	Jishan Ahmed	Jishan
121	Swati Singh	Swati
122	ASHA RANI BARMIA	Asha
123	Priyanshu	Priyanshu
124	Reena Sahu	Reena
125	NETDDHI GUPTA	Netddhi
126	Suraj Sahu	Suraj
127	Ashish	Ashish
128	Anamika Sahu	Anamika
129	Devraj Decongan	Devraj
130	Gayima	Gayima
131	Nishant Singh	Nishant
132	Sahdev Singh	Sahdev
133	Raja babu	Raja Babu
134	Devlal	Devalal
135	Abhay	Abhay
136	Banita	Banita
137	Fulmatiya	Fulmatiya
138	Bhupendra pratap	Bhupendra
140	Arun Gupta	Arun

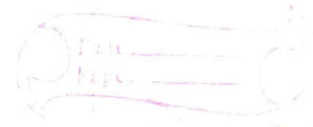
KS

S.S. Principal
P.M. College

- | | | |
|-------|------------------|------------------|
| (141) | शकेश कुमार | Rakesh |
| (142) | मिर्गव कुमार | Abdusal Kumer |
| (143) | उवा सिंह | Binth |
| (144) | उमिना यादव | U. Singh |
| (145) | पुनवर्ष | कुनवर्ष |
| (146) | Shivani | Shivani Keshwari |
| (147) | सुमन | सुमन देवांगन |
| (148) | जगेश्वर सिंह | जगेश्वर सिंह |
| (149) | उमेश कुमार | U. Singh |
| (150) | डिम्पल | डिम्पल |
| (151) | Dr. Chandan Kr | |
| (152) | C. B. Mishra | |
| (153) | T. R. Rahangdale | |

[Signature]

[Signature]
Principal
Govt. R.R.M. College
Surajpur (C.G.)



आज दिनांक 20.12.2021 को B.Sc. (अंतिम वर्ष) के विद्यार्थियों के लिए Career Cancellling and Placement cell के द्वारा विभिन्न कोर्स एवं रोजगार हेतु प्रकाश डाला गया। मुख्य वक्ता के रूप में डॉ. चन्दन कुमार एवं डॉ. शिवानी गुप्ता (जीव विज्ञान) व डॉ. एच.एन. साहू एवं डॉ. विवेका कुमाल झा (रसायन शास्त्र) के रूप में विभिन्न Career क्षेत्र एवं रोजगार के बारे में जानकारी दी। डॉ. एच.एन. साहू, सहायक प्राध्यापक (रसायन शास्त्र), शासकीय महाविद्यालय, बलरामपुर (द.ग.) ने अतिथि व्याख्यान के रूप में विद्यार्थियों की प्रतिक्रिया सुन ली एवं रसायन शास्त्र के साथ-साथ अन्य कोर्स की उपयोगिताओं की इसके रोजगार संबंधी जानकारी दी।

Name

Signature

- 1. Dr. S.N. Sahu —
- 2. Dr. Chandan Kumar —
- 3. Dr. V.K. Jha —
- 4. Dr. Shivani Gupta —
- 5. Mr. A.K. Paikra —
- 6. Miss. Pratibha Kashyap —
- 7. Mrs. Kalyani Jain —
- 8. Mrs. B. Mishra —
- 9. Dr. H.N. Dubey —

- 10. Anita Singh — Anita Singh
- 11. Sonita Rani — Sonita Rani
- (12) Anchal — Anchal
- (13) Yamuna — Yamuna
- (14) Durgawati — Durgawati

- (15) Rajni
- (16) Sonee Singh
- (17) Nikita
- (18) Greeta Singh
- (19) Sunita Singh
- (20) Shyambai Singh
- (21) Aarti Singh
- (22) Chandani
- (23) Aseemlatq
- (24) Kalawati
- (25) Khushbu Sahu
- (26) Shekh Rubee
- (27) AAKASH SAHU
- (28) Premlata Singh
- (29) Mankunwar
- (30) UMA RAJWADE
- (31) Ankita Sahu
- (32) Sunita Sahu
- (33) Joshi Gupta
- (34) Sakiyano
- (35) psijyanka Rani
- (36) Neha minj
- (37) Nishu
- (38) Hemardi Rajwade
- (39) Bobby
- (40) Sunita Singh
- (41) Karishma baxla
- (42) Shakuntala



- Rajni
- Sonee Singh
- Nikita
- Singh
- Sunita Singh
- S
- Aarti Singh
- Chandani
- Reemlatq
- Kalawati
- Khushbu
- Rubee
- आकाश
- Premlata
- Mankunwar
- Uma
- अंकिता साहू
- Sunita
- जोशी गुप्ता
- S
- Rani
- Nishu
- Aishu
- Hem
- Bobby
- Sunita Singh
- करिमा बखला
- Shakuntala

2/4

- (43) Kamla Yadav
- (44) Parvati Rajwade
- (45) Shrikumari
- (46) Ishika Ojha
- (47) Jasmida Sahu
- (48) Khushboo Kerketta
- (49) Kasimariya Singh
- 50) Hemamati Ekka
- (51) Pshpa Rajwade
- (52) Shivshankar Singh
- (53) Santosh kumar
- (54) Krishna kumar
- (55) Mahendra pratap
- (56) Bhagwat Diwakar
- (57) Anilkumar
- (58) Santosh kumar Singh
- (59) Sumesh kumar
- (60) Sunil kumar rajwade
- (61) Prakash paikra
- (62) Gautam Singh
- (63) Sumil Kumar (136)
- (64) Bhanu parlap Singh

- Kamla Yadav
- yadav
- शिवकुमारी
- Pshis
- Sahu
- Khushboo
- Singh
- Hikka
- Pshpa
- Shankar
- Santosh
- Krishi
- Pratap
- Anilkumar
- Singh
- Sumesh
- Sunil
- Prakash
- Singh
- Sumil Kumar (136)
- Bhanu

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