



**TEZPUR UNIVERSITY**  
(A Central University established by an Act of Parliament)  
**Department of Molecular Biology and Biotechnology**  
NAPAAM, TEZPUR-784028  
ASSAM, INDIA

*Pankaj Barah, Ph.D.*

Assistant Professor & DBT-Ramalingaswamy Fellow  
Member of Indian National Young Academy of Sciences

Tel: +91 3712-27-5415 (O)

Skype: pankaj.barah

Email: barah@tezu.ernet.in

To  
NER-BPMC  
Department of Biotechnology (DBT), GOI  
New Delhi – 110003

Date: 09.03.2023

**Subject:** Submission of documents for Final Settlement of Project Account

**Project Reference:** (BT/PR24757/NER/95/843/2017) “*Integrative system biology approach to identify the molecular response signatures in Rice during concurrent biotic (Rhizoctonia solani) and abiotic (heat) stresses*”

Dear NER-BPMC office,

With reference to your mail dated 23.12.2022 suggesting submission of the required documents for settlement of account of the project ‘*Integrative system biology approach to identify the molecular response signatures in Rice during concurrent biotic (Rhizoctonia solani) and abiotic (heat) stresses*’, bearing DBT sanction order -BT/PR24757/NER/95/843/2017, I submit the same with this letter.

**Enclosed documents checklist:**

1. UC and SoE for the period April 1, 2021 to March 31, 2022
2. Consolidated SoE for the project.
3. Manpower Certificates and Due Drawn statement for the period April 1, 2021 to March 31, 2022.
4. Asset acquired certificate for the project.
5. Declaration from the storekeeper of the institute.
6. Outcome/Achievement of the completed project
7. Final completion report
8. Bharatkosh receipts.

Thanking you,  
Sincerely,

(PANAKJ BARAH)

## Utilisation Certificate

(for the financial year ending 31<sup>st</sup> March 2022)

(Rs. in Lakhs)


1. Title of the Project/Scheme: *Integrative system biology approach to identify the molecular response signatures in Rice during concurrent biotic (Rhizoctonia solani) and abiotic (heat) stresses*
2. Name of the Organisation: Tezpur University
3. Principal Investigator: Dr. Pankaj Barah
4. Deptt. of Biotechnology sanction order No. & date of sanctioning the project: BT/PR24757/NER/95/843/2017 Dated: 26/07/2018
5. Amount brought forward from the previous financial year quoting DBT letter No. & date in which the authority to carry forward the said amount was given: Rs 1.99632 Lakhs
6. Amount received from DBT during the financial year (*please give No. and dates of sanction orders showing the amounts paid*): Rs 0.00
7. Other receipts/interest earned, if any, on the DBT grants: Rs 0.00730 Lakhs
8. Total amount that was available for expenditure during the financial year: Rs 2.00362 Lakhs
9. Actual expenditure (excluding commitments) incurred during the financial year (statement of expenditure is enclosed): Rs 1.70450 Lakhs
10. Unspent balance refunded, if any (*Please give details of cheque No. etc.*): 0.00
11. Balance amount available at the end of the financial year: Rs: 0.29912 Lakhs
12. Amount allowed to be carried forward to the next financial year vide letter No. & date: Rs: 0.29912 Lakhs


1. Certified that the amount of **Rs. 1.70450** mentioned against col. 9 has been utilised on the project/scheme for the purpose for which it was sanctioned and that the balance of **Rs 0.29912** remaining unutilized at the end of the year has been surrendered to Govt. (vide No. \_\_\_\_\_ dated \_\_\_\_\_)/will be adjusted towards the grants-in-aid payable during the next year.
2. Certified that I have satisfied myself that the conditions on which the grants-in-aid was sanctioned have been duly fulfilled/are being fulfilled and that I have exercised the following checks to see that the money was actually utilised for the purpose for which it was sanctioned.

Kinds of checks exercised:

1. (Cash Book)
2. (Ledgers)
3. (Vouchers)
4. (Bank Statements)
- 5.

  
(PROJECT INVESTIGATOR)  
**Dr. Pankaj Barah**  
Assistant Professor  
Dept. of Molecular Biology & Biotechnology  
Tezpur University  
Tezpur- 784028

  
(FINANCE OFFICER)  
**Finance Officer**  
Tezpur University

  
(HEAD OF THE INSTITUTE)  
**Registrar**  
Tezpur University

(To be countersigned by the DBT Officer-in-charge)



**Statement of Expenditure referred to in para 9 of the  
Utilisation Certificate**


Showing grants received the Department of Biotechnology and the expenditure incurred during the period from 1st April 2021 to 31st March 2022.  
(Rs. in lakhs)

Item	Unspent balance Carried forward from previous year (2020-2021)	Grants received from DBT during the year (2021-2022)	Interest earned amount	Total of Col. (2+3+4)	Expenditure (excluding commitments) incurred during in year	Balance (5-6)	Remarks
1	2	3	4	5	6	7	8
<b>1. Non-Recurring</b>							
(i) Equipment	0	0	----	0	0	0	
<b>2. Recurring</b>							
(i) Human Resource	-0.39292	0	----	-0.39292	1.67400	-2.06692	
(ii) Consumables	1.51256	0	----	1.51256	0	1.51256	
(iii) Travel	0.50000	0	----	0.50000	0.03050	0.46950	
(iv) Contingency	0.37668	0	----	0.37668	0	0.37668	
(v) Overheads (if applicable)	0.00	0	----	0.00	0.00	0.00	
(vi) Interest earned	0.00	0	0.00730	0.00730	0.00	0.00730	
<b>Total</b>	1.99632	0	0.00730	2.00362	1.70450	0.29912	


**Total:** Rs 1.70450/- (One lakh seventy thousand four hundred and fifty rupees only)

\*NOTE: An interest of Rs 499/- only was earned on the remaining funds after project completion (FY: 2022-23)

  
(PROJECT INVESTIGATOR)  
Signature & Stamp  
**Dr. Pankaj Barah**  
Assistant Professor  
Dept. of Molecular Biology & Biotechnology  
Tezpur University  
Tezpur- 784028

  
(HEAD OF THE INSTITUTE)  
Signature & Stamp

**Registrar**  
Tezpur University

  
(FINANCE OFFICER)  
Signature & Stamp  
**Finance Officer**  
Tezpur University






## Assets Acquired Format

Assets acquired wholly or substantially out of Govt. grants Register to be maintained by Grantee Institution

Name of the Sanctioning Authority:	Department of Biotechnology (DBT)
1. Sl. No	135-136 in the Register of grants
2. Name of the Grantee Institution	Tezpur University
3. No. & Date of sanction order	BT/PR24757/NER/95/843/2017 Dated:26/07/2018
4. Amount of the sanctioned grant	30,00,000.00
5. Brief purpose of the grant	To identify the molecular response signatures in Rice during concurrent biotic and abiotic stresses
6. Whether any condition regarding the Right of ownership of Govt. in the property or other assets acquired out of the grant was incorporated in the grant-in-aid sanction order.	_____
*7. Particulars of assets actually credited or acquired.	Attached in a separate enclosure
8. Value of the assets as on	06/11/2019 (Total: Rs. 25,16,272.00)
9. Purpose for which utilized at present	To analyze OMICS-scale data for various biological samples generated in-house and collaborator labs.
10. Encumbered or not	No
11. Reasons, if encumbered	
12. Disposed of or not	No
13. Reasons and authority, if any, for Disposal	N/A _____
14. Amount realized on disposal	N/A _____
15. Remarks	_____

  
(PROJECT INVESTIGATOR)  
Signature & Stamp

  
(HEAD OF THE INSTITUTE)  
Signature & Stamp

**Registrar**  
**Tezpur University**

  
(FINANCE OFFICER)  
Signature & Stamp

**Finance Officer**  
**Tezpur University**

## Completion Report for R&D Projects [Year 3]\*

### Section-A: Project Details

**A1. Project Title:** *Integrative system biology approach to identify the molecular response signatures in Rice during concurrent biotic (*Rhizoctonia solani*) and abiotic (heat) stresses*

**A2. DBT Sanction Order No. & Date:** BT/PR24757/NER/95/843/2017 Dated: 26/07/2018, 3 years project

**A3. Name of Principal Investigator:** Dr. Pankaj Barah, and Prof. P.B. Kirti

**Name of Co-PI/Co-Investigator:**

**A4. Institute:** Tezpur University, Dept. of Molecular Biology and Biotechnology

**A5. Address with Contact Nos. (Landline & Mobile) & Email:** Dept. of Molecular Biology and Biotechnology, Tezpur University, Napaam, Sonitpur, Assam -784028, INDIA, Phone: +91 3712-27-5415(O), Ph No +91-8638587915 and E. mail: barah@tezu.ernet.in

**A6. Total Cost:** Rs. 82,96,988/-

**A7. Duration:** 3 Years

**A8. Approved Objectives of the Project:**

A8.1. Integrative systems biology approach to identify the molecular stress response signatures, stress regulatory networks and signaling crosstalk events in Rice, during concurrent exposure to combination of temperature and pathogen stress.

A8.2. To use activation tagged rice population for screening novel tagged mutants which are resistance against *R. solani* pathogen.

**A9. Specific Recommendations made by the Task Force (if any):**

A9.1 To improve KRiSHI portal by incorporating data and information that can be directly be beneficial for the farmers.

A9.2 To conduct combined stress experiments on a tolerant and susceptible rice varieties.

## Section-B: Scientific and Technical Progress

### B1. Progress made against the Approved Objectives, Targets & Timelines during the Reporting Period

#### B1.1 Tezpur University (Specific Objectives)

**Objective 1:** Transcriptomics analysis of the single and concurrent exposure of heat and pathogen (*R. solani*) stresses on the widely cultivated rice varieties in India, BPT-5204.

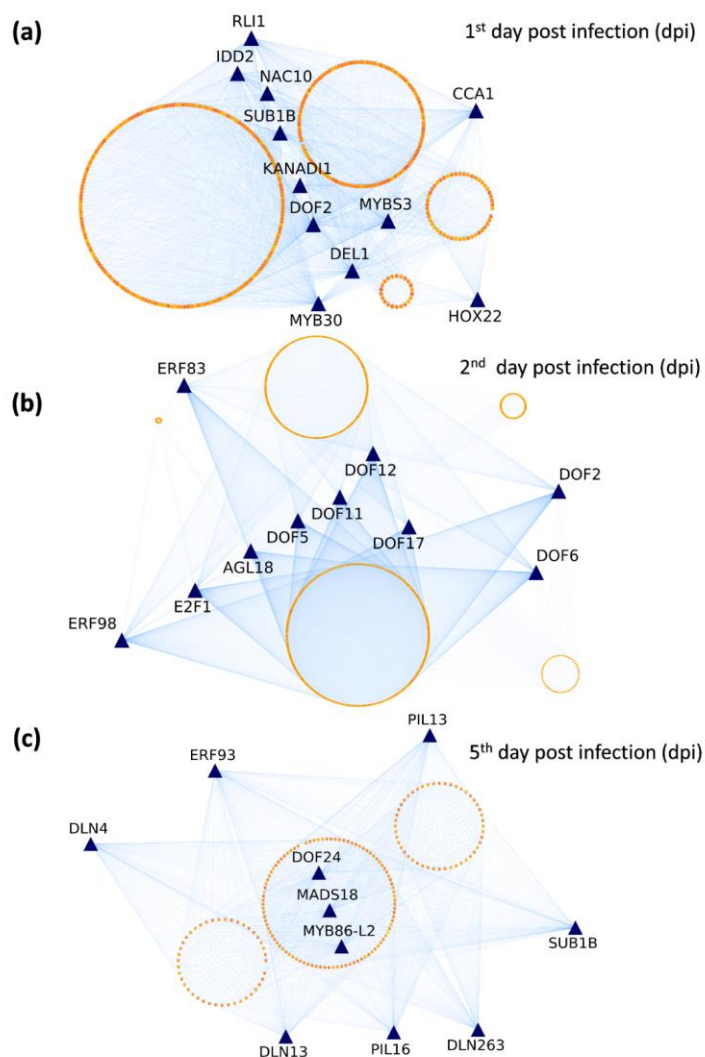
**Timeline:** 1-36 months.

**Status:** Completed and manuscript published.

Time-Series RNA-Seq analysis on a widely cultivated rice variety BPT-5204 was performed for identifying transcriptome level response signatures during *R. solani* infection at 1<sup>st</sup>, 2<sup>nd</sup> and 5<sup>th</sup> day post infection (dpi). This study identified 428, 3225 and 1225 Differentially expressed genes (DEGs) in rice plant during infection at three time points (TPs). Transcriptional Regulatory Networks (TRNs) for the three time points also identified *SUB1B*, *MYB30* and *CCA1* as important regulatory hub transcription factors in rice during *R. solani* infection. Jasmonic acid, salicylic acid, ethylene biogenesis and signaling were induced on infection. *SAR* was up regulated, while photosynthesis and carbon fixation processes were significantly down regulated. Involvement of MAPK, CYPs, peroxidase, PAL, chitinase genes were also observed in response to the fungal infection.

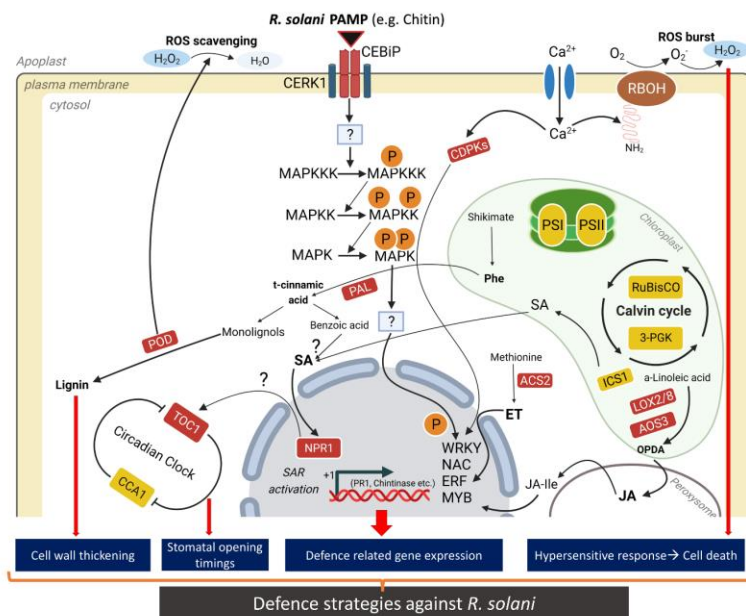
**Manuscript Published:** Das, A., Moin, M., Sahu, A., Kshatry, M., Kirti, P. B., & Barah, P. (2022). Time-course transcriptome analysis identifies rewiring patterns of transcriptional regulatory networks in rice under *Rhizoctonia solani* infection. *Gene*, 828, 146468.

LINK: <https://www.sciencedirect.com/science/article/abs/pii/S0378111922002876>



**Fig 1:** Transcriptional Regulatory Networks (TRNs) of BPT-5204 rice plants in 1<sup>st</sup>, 2<sup>nd</sup> and 5<sup>th</sup> day post infection (dpi) samples during *R. solani* infection





**Fig 2:** A hypothetical model showing molecular level orchestration in BPT-5204 rice plants in response to *R. solani* infection.

**Objective 2:** To develop a public knowledgebase, and a modular cum scalable meta-analysis workbench for studying the combined stress responses patterns in rice.

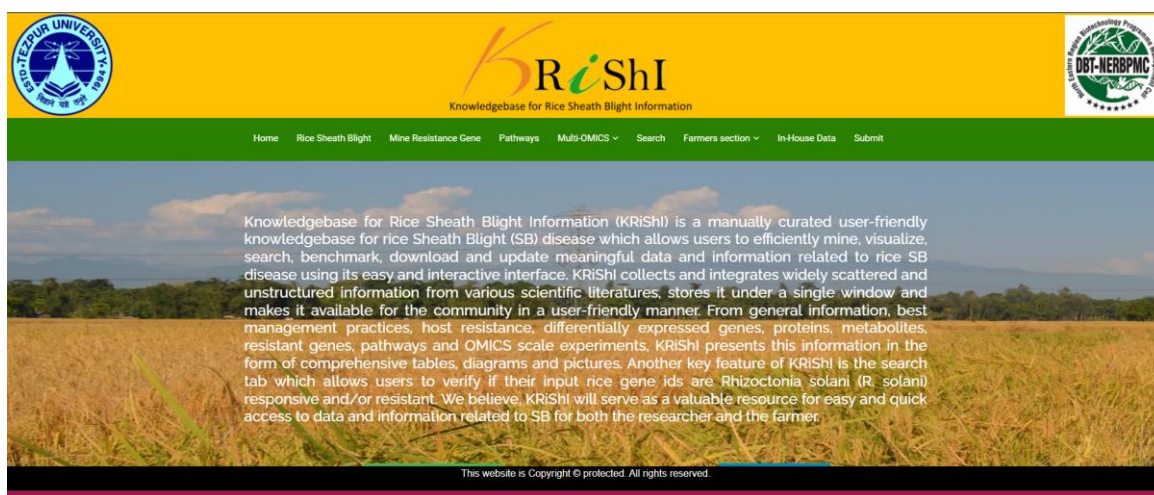
**Timeline:** 1-36 months

**Status:** Completed and hosted at Tezpur University server. Manuscript published.

Knowledgebase for Rice Sheath Blight Information (KRiShI) is a manually curated user-friendly knowledgebase for rice Sheath Blight (SB) disease that allows users to efficiently mine, visualize, search, benchmark, download, and update meaningful data and information related to SB using its easy and interactive interface. KRiShI collects and integrates widely scattered and unstructured information from various scientific literatures, stores it under a single window, and makes it available for the community in a user-friendly manner. KRiShI can be found at: [www.tezu.ernet.in/krish/](http://www.tezu.ernet.in/krish/)

**Manuscript Published:** Das, A., Mishra, A., Kashyap, A., Naika, M. B., & Barah, P. (2022). "KRiShI": a manually curated knowledgebase on rice sheath blight disease. *Functional & Integrative Genomics*, 22(6), 1403-1410.

LINK: <https://doi.org/10.1007/s10142-022-00899-9>



**Fig 3:** Snapshot of Knowledgebase for Rice Sheath Blight Information (KRiShI) homepage

Category	Organism	Sum total
Number of resistant genes	Rice	16
Number of genes in the knowledge base	Rice	24022
Number of pathways	Rice	10
Number of pathway molecule annotated	Rice	76
Number of genomic studies	Rice	2
	<i>R. solani</i>	2
Number of transcriptomic studies	Rice	5
	<i>R. solani</i>	9
Number of proteomic studies	Rice	3
	<i>R. solani</i>	3
Number of metabolomic studies	Rice	2
	<i>R. solani</i>	-
Number of DEGs	Rice	23762
	<i>R. solani</i>	8631
Number of DEPs	Rice	798
	<i>R. solani</i>	751
Number of DEMs	Rice	95
	<i>R. solani</i>	-
Tolerant varieties	Moderate	7
	Wild	9
	Transgenic	13

**Table 1:** A summary of overall data present in KRiShI knowledgebase

**Objective 3:** To develop a mechanistic understanding of temperature modulated pathogenic behavior of *R. solani* on rice plant through integration of heterogeneous omics data.

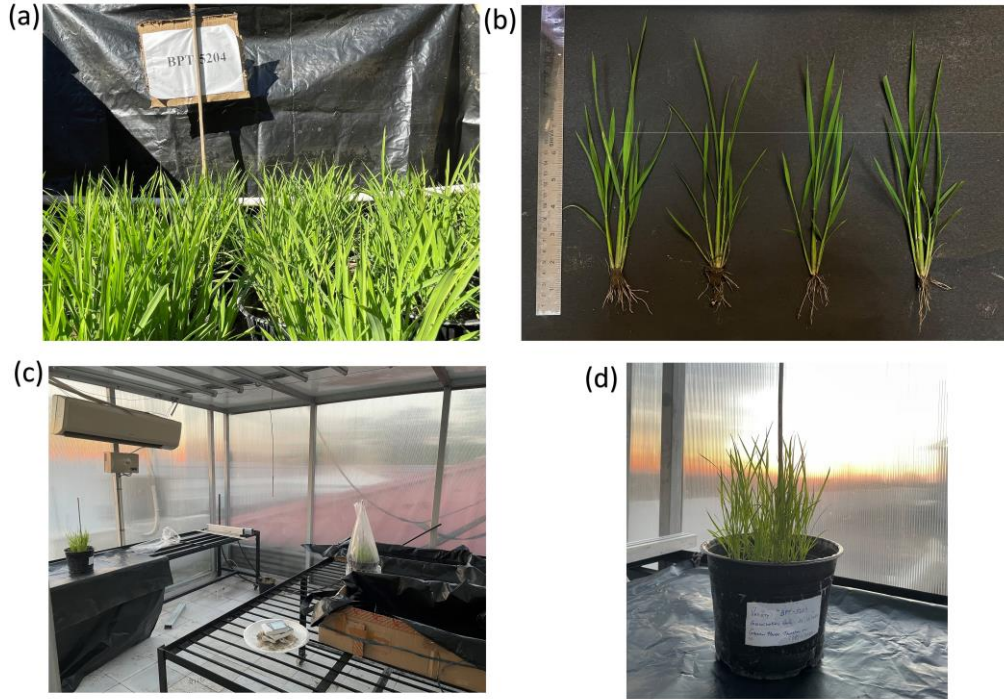
**Timeline:** 18-32 months

**Status:** Under progress

The experiments for combined *R. solani* and High Temperature combined stresses is complete. After 5 times of repeated failures, the experiments were again revived and finally completed. Samples have been collected and sent for sequencing. The total samples collected is represented in **Table 2**.

	High Temperature (A)	R. solani (B)	High Temperature + R. solani (C)
1 <sup>st</sup> dpi	3	3	3
2 <sup>nd</sup> dpi	3	3	3
5 <sup>th</sup> dpi	3	3	3
<b>Total</b>	<b>9</b>	<b>9</b>	<b>9</b>

**Table 2:** Total stress samples collected from the combined High Temperature and *Rhizoctonia solani* (R. solani) experiments performed at Tezpur University.



**Fig 4:** Combined *Rhizoctonia solani* and High Temperature (HT) stress experiment setup and progress at Tezpur University. (a) Growth of BPT-5204 rice plants in open field like conditions. (b) 45 days old BPT-5204 rice plants. (c) Air Conditioned green house setup for combined stress induction (d) Plants growth monitoring inside the Air Conditioned green house.



**Fig 5:** Response of BPT-5204 plants to single *Rhizoctonia solani* (*R. solani*) infection [B1:RS] and combined High Temperature and *R. solani* stress [B1:HT+RS]



**Websserver developed:**

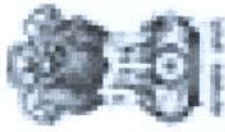
Knowledgebase for rice Sheath Blight disease 'KRiShI' was developed and is currently hosted under Tezpur University (<http://www.tezu.ernet.in/krishi/>)

**Computational Pipelines [Open-Access]**

In-house benchmarked RNA-Seq data analysis pipeline developed and can be obtained freely from <https://github.com/EvoLOMICS-TU/-rna-seq-pipeline-Public>

**B5. Benefits gained:**

- Scientific & Technical expertise gained:  
Conduct Rice stress experiments in control and open field like setup, analyze RNA-seq data, interpret results, write manuscripts for publications.
- No. of NER manpower (including PI & staffs) trained in the Non-NER Institute: 2
- No. of visits by Non-NER Researchers to NER Institutes and vice-versa: 2
- Training in any new techniques, if any: Next Generation Sequencing (NGS) data analysis



**bharatkosh.gov.in**  
Government of India Receipt Portal

## RECEIPT

Transaction Ref.No. 1602230010725

Dated: Feb 17 2023 11:02PM

Received from M/S. TEZPURUNIVERSITY with Transaction Ref.No. 1602230010725

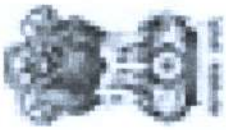
Dated Feb 17 2023 11:02PM the sum of INR 29912 (Twenty-Nine Thousand Nine Hundred Twelve Only) through Internet based Online payment in the account of

Refund of unspent Grants-in-Aids(DBT), , DBT PANKAJ BARAH.

**Disclaimer:- This is a system generated electronic receipt, hence no physical signature is required for the purpose of authentication**

Printed On: 22-02-2023 03:55:15

Courtesy :- Controller General of Accounts



**bharatkosh.gov.in**

Government of India Receipt Portal

## RECEIPT

Transaction Ref.No. 1602230011037

Dated: Feb 17 2023 11:02PM

Received from MR. TEZPURUNIVERSITY with Transaction Ref.No. 1602230011037

Dated Feb 17 2023 11:02PM the sum of INR 499 (Four Hundred Ninety-Nine Only) through Internet based Online payment in the account of

Refund of earned interest on Grant(PAO DBT), , DBT- PANKAJ BARAH.

**Disclaimer:- This is a system generated electronic receipt, hence no physical signature is required for the purpose of authentication**

Printed On: 22-02-2023 03:54:21

Courtesy :- Controller General of Accounts