Dr. Vijai K. Rai

Assistant Professor
Department of Chemistry
Guru Ghasidas Vishwavidyalaya
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Education

Ph. D. from *University of Allahabad, Allahabad*, U. P. INDIA (**2006**).
UGC-CSIR-NET (Chemical Sciences) qualified.
M. Sc. (72 %) From *D. D. U. Gorakhpur University*, U. P. India.
B. Sc. (72 %) From *D. D. U. Gorakhpur University*, U. P. India.

Experience (*09 Years as Assistant Professor*)

- **07 Years** as Assistant Professor, GG Central University, Bilaspur, C. G. (From 12. 08. 2011 to Continued).
- **02 Years** as Assistant Professor, SMVD University, Jammu, J & K, (From 20. 08. 2009 to 09. 08. 2011).
- Postdoctoral Research Work (From 01. 04. 2007 to 19. 04. 2009).

Awards Received

1.	Fast Track Young Scientist Award	4th March, 2011	**DST, Government of India**, New Delhi, INDIA
2.	Young Scientist Award	10th Feb., 2010	5th J K Science Congress, Jammu, India
3.	Golden Jubilee Award (INSA)	21st Nov., 2008	**National Academy of Sciences**, India
4.	D. S. Bhakuni Award	26th Dec., 2007	**Indian Chemical Society**, India
5.	Young Scientist Award	5th Feb., 2007	International Academy of Physical Sciences, India

Research Projects (Completed) – 03

1. Funding Agency: **University Grants Commission (UGC), New Delhi, India**
   Ref No.: F. No. 39-764/2010 (SR)
   Title: *Access to potentially antiviral novel nucleosides using microwave methodology*

2. Funding Agency: **Council of Scientific & Industrial Research (CSIR), New Delhi, India**
   Ref No.: No. 01 (2442)/10/(EMR-II)
   Title: *Access to novel imino-/thiosugar scaffolds from renewable bioresources*

3. Funding Agency: **Department of Science & Technology (DST), New Delhi, India**
Ref No.: No. SR/FT/CS-99/2010
Title: *NHC-/enamine-iminium catalysis in stereocontrolled construction of bioactive scaffolds*

Research Interest

Broad area of research is ***Synthetic Organic Chemistry***, giving emphasis on design and development of new catalytic organic transformations using ***Green Chemistry Protocols***. Specific area of research program:

- Heterogeneous Catalysis using nano-materials
- Visible-Light Induced Organic Reactions
- Stereo-controlled Construction of C-C and C-Hetero Bond
- Small & Medium Ring Heterocyclic Syntheses
- Homogeneous Catalysis, Ionic Liquids, Organocatalysis

Ph. D. Students

S. No.	Name of Students	Enrollment No.	Current Status
1	Fooleswar Varma	GC/07/3761	Ph. D. Thesis Submitted on 21.02.2019
2	Suhasini Mahata	GC/11/656	Ph. D. Thesis Submitted on 17.02.2019

Summary of Research Papers Published [70]

S. No.	Published Papers	Impact Factor
1.	***Advanced Synthesis & Catalysis* 2019**, *361*, 1247-1252	**5.123**
2.	*New J. Chem.* **2019**, DOI: 10.1039/c9nj00837c	3.277
3.	*Tetrahedron Lett.*, **2019**, *60*, 524-529	2.660
4.	***Sensors & Actuators: B. Chemical*, 2019**, (Accepted)	**5.670**
5.	*Chemistry Select*, **2019**, *4*, 1240-1243.	1.500
6.	*Catalysis Commun.* **2019**, *119*, 76-81.	3.460
7.	*Sensors & Actuators: B. Chemical*, **2019**, *281*, 1045-1053.	5.670
8.	***Green Chem*. 2018**, 20, 3783-3789.	**9.125**
9.	*New J. Chem.* **2018**, *42*, 19945.	3.277
10.	*Tetrahedron Lett.*, **2018**, *59*, 1783.	2.660
11.	*Competes Rendus Chimie*, **2018**, *21*, 71-79.	1.798
12.	*Lett. Org. Chem.* **2018**, *15*, 665-672.	1.200
13.	***Eur. J. Org. Chem*. 2018**, 537.	**3.192**
14.	*New J. Chem.* **2018**, *42*, 2067.	3.277
15.	*RSC Advances*, **2017**, 7, 48723.	3.289
16.	***New J. Chem. 2017, 41, 4937.***	**3.277**
17.	*Res Chem. Intermed*. **2017**, *43*, 7319-7329	1.000
18.	*New J. Chem.* **2017**, *41*, 6489.	3.277
19.	*C. R. Chimie*, **2017**, *20*, 140.	1.798
20.	*Phosphorus, Sulfur, And Silicon and The Related Elements* **2017**, *192*, 381.	0.561
21.	*J. Heterocyclic Chem.*, **2017**, *54*, 1178.	0.813
22.	***RSC Advances*, 2016**, *6*, 104868.	**3.289**
23.	*Tetrahedron Lett.* **2016,** *57*, 3260.	2.660
24.	*Can. J. Chem.* **2016**, *94*, 827.	1.061
25.	***Tetrahedron Lett.* 2016**, *57*, 5084.	**2.660**
26.	*Lett. Org. Chem.*, **2016**, *13*, 000-000	1.200
27.	*Tetrahedron Lett*. **2015**, *56*, 2664.	2.660
28.	*Tetrahedron Lett*. **2013**, *54*, 1071.	2.660
29.	*Synlett* **2013**, *24*, 97.	2.838
30.	*Nucleosides, nucleotides & Nucleic acids*, **2013**, *32*, 247.	0.723
31.	*Tetrahedron Lett.* **2013**, *54*, 6469.	2.660
32.	*Synthetic Commun.* **2012**, *42*, 1489.	1.200
33.	***Green Chem.* 2011**, *13*, 1217.	**9.125**
34.	*Eur. J. Org Chem.* **2011**, 4302.	3.192

35.	*Tetrahedron Lett.* **2011**, *52*, 125.	2.660
36.	*Synthesis* **2010** 4051.	2.572
37.	*Synlett* **2010,** 2649.	2.838
38.	*Synthesis* **2010**, 2957.	2.572
39.	*Tetrahedron Lett.* **2010**, *51*, 1657.	2.660
40.	*Synlett* **2010**, 240.	2.838
41.	*J. Chem. Res.* **2009**, 520.	0.444
42.	***Green Chem.* 2009**, *11*, 878	**9.125**
43.	*Synlett*, **2009**, 1423.	2.838
44.	*Tetrahedron Lett.*, **2009**, *50*, 2414.	2.660
45.	*Tetrahedron Lett.*, **2009**, *50*, 2208.	2.660
46.	*Tetrahedron*, **2009**, *65*, 1306.	3.269
47.	*Nucleosides, nucleotides & Nucleic acids*, **2008**, *27*, 1227.	0.723
48.	*Tetrahedron Lett.*, **2008**, *49*, 5553.	2.660
49.	*Synlett*, **2008**, 2257.	2.838
50.	*J. Heterocyclic Chem.*, **2008**, *45*, 1315.	0.813
51.	***Tetrahedron*, 2008,** *64*, 4246.	**3.269**
52.	*Tetrahedron Lett.*, **2008**, *49*, 2377.	2.660
53.	*Tetrahedron*, **2008,** *64*, 1420.	2.838
54.	*Synlett*, **2008**, 0529.	2.838
55.	*Tetrahedron Lett.*, **2008**, *49*, 687.	2.660
56.	***Synthesis*, 2007**, 3831.	**2.570**
57.	*Synlett*, **2007**, 1905.	2.838
58.	*Tetrahedron Lett.*, **2007**, *48*, 8037.	2.660
59.	*Tetrahedron Lett.*, **2007**, *48*, 7793.	2.660
60.	*Tetrahedron*, **2007,** *63*, 6924.	3.269
61.	*Tetrahedron Lett.*, **2007**, *48*, 4899.	2.660
62.	*Lett. Org. Chem.*, **2007,** *4*, 47.	1.200
63.	***Synlett,* 2007**, 1227.	**2.838**
64.	*Tetrahedron Lett.*, **2006**, *47*, 395.	2.660
65.	*Synthesis*, **2006**, 1868.	2.572
66.	***Green Chem.*, 2006**, *8*, 455.	**9.125**
67.	*Tetrahedron*, **2006**, *62*, 5464.	3.269
68.	*Tetrahedron*, **2006**, *62*, 8029.	3.269
69.	*Tetrahedron*, **2005,** *61*, 10013.	3.269
70.	*Tetrahedron Lett.*, **2004**, *45*, 5351.	2.660
	Aggregate Impact Factor	**207.786**
	Average Impact Factor	**2.968**

Details of Research Papers Published [70]

Year 2019:

1. *Photocatalytic C(sp^3)–H activation towards α-methylenation of ketones using MeOH as 1C source steering reagent*
F. Verma, P. Shukla, S. R. Bhardiya, M. Singh, A. Rai, **Vijai K. Rai**
Advanced Synthesis & Catalysis **2019**, *361*, 1247-1252.

2. *Efficient electrocatalytic oxidation of p-phenylenediamine using a novel PANI/ZnO anchored bio-reduced graphene oxide nanocomposite*
M. Singh, A. Sahu, S. Mahata, P. Shukla, A. Rai, **Vijai K. Rai**
New J. Chem. **2019**, DOI: 10.1039/c9nj00837c.

3. *A novel carbocatalytic hydride transfer strategy for efficient reduction of structurally different aldehydes and ketones in water*
Vijai K. Rai, S. Mahata, S. R. Bhardiya, P. Shukla, A. Rai, M. Singh
Tetrahedron Lett., **2019**, *60*, 524-529.

4. *AuNPs/Neutral red-biofunctionalized graphene nanocomposite for nonenzymatic electrochemical detection of organophosphate via NO_2 reduction*
M. Singh, H. Kashyap, P. K. Singh, S. Mahata, **Vijai K. Rai**, A. Rai
Sensors & Actuators: B. Chemical, **2019**, (Accepted).

5. *Visible Light-Induced Direct Conversion of Aldehydes into Nitriles in Aqueous Medium Using Co@g-C_3N_4 as Photocatalyst*
F. Verma, P. Shukla, S. R. Bhardiya, M. Singh, A. Rai, **Vijai K. Rai**
Catalysis Commun. **2019**, *119*, 76-81.

6. *A Facile Iodine-Promoted N-Ts Insertion into Enals: cis-Selective Construction of Aziridin-2-aldehyde in Water*
P. K. Singh, F. Verma, S. R. Bhardiya, M Singh, **Vijai K. Rai**, A. Rai
Chemistry Select, **2019**, *4*, 1240-1243.

7. *First bio-covalent functionalization of graphene with threonine towards drug sensing via electrocatalytic transfer hydrogenation*
A. Sahu, P. Shukla, S. Mahata, **Vijai. K. Rai**, A. Rai, M. Singh
Sensors & Actuators: B. Chemical, **2019**, *281*, 1045-1053.

Year 2018:

8. *A novel and efficient reduction of graphene oxide using Ocimum sanctum L. leaf extract as an alternative renewable bio-resource*
S. Mahata, A. Sahu, P. Shukla, A. Rai, M. Singh, **Vijai K. Rai**
New J. Chem. **2018**, *42*, 19945-19952.

9. *Visible-light driven regioselective synthesis of 1H-tetrazoles from aldehydes through isocyanide-based [3+2] cycloaddition*
F. Verma, A. Sahu, P. K. Singh, A. Rai, M. Singh, **Vijai K. Rai**
Green Chem. **2018**, *20*, 3783-3789.

10. *One-Pot Allan–Robinson/Friedländer Route to Chromen-/Quinolin-4-ones through the Domino Acetylative Cyclisation of 2-Hydroxy-/2-Aminobenzaldehyde*
Vijai K. Rai, F. Verma, G. P. Sahu, M. Singh, A. Rai
Eur. J. Org. Chem. **2018**, 537–544.

11. Morita-*Baylis-Hillman enal-based triple cascade strategy for anti-selective synthesis of highly functionalized tetrahydropyridines using iminium-enamine catalysis*
Vijai K. Rai, F. Verma, M. Satnami, M. Singh, A. Rai
Tetrahedron Lett., **2018**, *59*, 1783–1786.

12. *Aqueous mortar-pestle grinding: An efficient, attractive, and viable technique for the regioselective synthesis of β-amino alcohols*
N. Singh, **Vijai K. Rai**, A. Kumar
Competes Rendus Chimie, **2018**, *21*, 71-79.

13. *Bio-inspired unprecedented synthesis of reduced graphene oxide: a catalytic probe for electro-/chemical reduction of nitro groups in an aqueous medium*
S. Mahata, A. Sahu, P. Shukla, A. Rai, M. Singh, **Vijai K. Rai**
New J. Chem., **2018**, *42*, 2067-2073.

14. *Graphene oxide catalyzed C-N/C-S/[3+2] cyclization cascade for green synthesis of thiazolidinone in water*
S. Mahata, A. Sahu, P. Shukla, A. Rai, M. Singh, **Vijai K. Rai**
Lett. Org. Chem. **2018**, *15*, 665-672.

Year 2017:

15. *A co-operative effect of visible light photo-catalysis and $CoFe_2O_4$ nanoparticles for green synthesis of furans in water*
F. Verma, P. K. Singh, S. R. Bhardiya, M. Singh, A. Rai, **Vijai K. Rai**
New J. Chem. **2017**, *41*, 4937-4942.

16. *Facile construction of AuNPs modulated SDS wrapped G-TC tailored electrode for sensitive detection of ascorbic acid*
H. Kashyap, P. K. Singh, F. Verma, **Vijai K. Rai**, A. Rai, M. Singh
New J. Chem. **2017**, *41*, 6489-6496.

17. *First graphene oxide promoted metal-free nitrene insertion into olefins in water: towards facile synthesis of activated aziridines*
P. Shukla, S. Mahata, A. Sahu, M. Singh, **Vijai K. Rai**, A. Rai
RSC Advances, **2017**, 7, 48723–48729.

18. *Synthesis of 2-amino-4H-chromen-4-ylphosphonates and β-phosphonomalonates via tandem Knoevenagel–Phospha-Michael reaction and antimicrobial evaluation of newly synthesized β-phosphonomalonates*.
P. Kour, A. Kumar, R. Sharma, R, Chib, I. A. Khan, **Vijai K. Rai**
Res Chem. Intermed. **2017**, *43*, 7319-7329.

19. *$Bi(NO_3)_3.5H_2O$ catalyzed phosphorylation of aldehydes: an efficient route to α-hydroxyphosphonates*
A. Kumar, S. Jamwal, S. Khan, N. Singh, **Vijai K. Rai**
Phosphorus, Sulfur, Silicon and The Related Elements **2017**, 192, 381-385.

20. *Aqueous microwave-assisted DMAP catalyzed synthesis of β-phosphonomalonates and 2-amino-4H-chromen-4-ylphosphonates via a domino Knoevenagel-phospha-Michael reaction*
P. Kour, A. Kumar, **Vijai K. Rai**
C. R. Chimie, **2017**, *20*, 140-145.

21. *One-pot synthesis of highly functionalized pyrido-1,3-thiazin-4-ones using unprotected sugars in a Task-specific Ionic Liquid, [Bmim]SCN*
Vijai K. Rai & V. R. Sharrof
J. Heterocyclic Chem., **2017**, *54*, 1178–1185.

Year 2016:

22. *First iodine/IL-catalyzed carbohydrate activation as aldehyde equivalent for [C+2C+N] construction of β-lactam ring*
Vijai K. Rai, B. Sharma, V. R. Sharoff, A. Rai,
Tetrahedron Lett. **2016,** *57*, 3260-3263.

23. *One-pot cis-selective route to sugar-fused thiazines via a masking–unmasking strategy in basic ionic liquid*
Vijai K. Rai, Rahul K. Kosta,
Can. J. Chem. **2016**, *94*, 827–832.

24. *Carbocation catalyzed carboxylic acid activation in Staudinger reaction for stereoselective synthesis of β-lactams,*
A. Rai, P. K. Singh, P. Shukla, **Vijai K. Rai,**
Tetrahedron Lett. **2016,** *57*, 5084-5088.

25. *Decoration of GO with Fe spinel-Naf/DMAP: an electrochemical probe for sensing H_2O_2 reduction,*
M. Singh, S. R. Bhardiya, H. Kashyap, F. Verma, **Vijai K. Rai** & I. Tiwari,
RSC Advances, **2016**, *6*, 104868-104874.

26. *A facile anti-selective synthesis of 3-nitropyridin-2-ones using Morita-Baylis Hillman adduct of nitroalkene*
Vijai K. Rai, G. P. Sahu, M. Singh & A. Rai
Lett. Org. Chem., **2016**, *13*, 547-553.

Year 2015-14:

27. *The first NHC-induced regioselective introduction of C- and N-nucleophiles in to Baylis–Hillman enals,*
Vijai K. Rai, G. P. Sahu, A. Rai
Tetrahedron Lett. **2015,** *55*, 2664-2668.

Year 2013:

28. *Masked amino acid: a new C-nucleophile for I_2–catalyzed stereoselective ring opening of epoxides in ionic liquid*
Vijai K. Rai, R. Sharma, A. Kumar
Tetrahedron Lett. **2013,** *54*, 1071-1075.

29. *The First I_2 Promoted Efficient Aminoacetylation of Activated Aziridines in Ionic liquids,*
Vijai K. Rai, N. Sharma & A. Kumar
Synlett **2013,** *24*, 097-101.

30. *$CeCl_3.7H_2O$/NaI-Promoted Direct Synthesis of 1,3-Benzoxazine-2-Thione N-Nucleosides under Microwave Irradiation*
Vijai K. Rai, N. Singh
Nucleosides, Nucleotides & Nucleic Acids **2013**, *32*, 247-255.

31. *Masked mecapto acid-driven MCR in task-specific ionic liquid: a new stereocontrolled entry into bicyclic 1,3-thiazines*
Vijai K. Rai, P. K. Rai, Y. Thakur
Tetrahedron Lett. **2013,** *54*, 6469-6473.

Year 2012:

32. *Efficient Ce(III)-Catalyzed Cis-Selective Synthetic Approach to γ-Lactones in Aqueous Media,*
Vijai K. Rai, P. Tiku, A. Kumar;
Synth. Commun. **2012,** *42*, 1489-1499.

Year 2011:

33. *An unprecedented synthesis of γ-lactams via mercaptoacetylation of aziridines in water,*
Vijai K. Rai, P.K. Rai, S. Bajaj, A. Kumar
Green Chem. **2011**, *13*, 1217-1223.

34. *[2 + 2] Annulation of aldimines with sulfonic acids: a novel one-pot cis-selective route to β-sultams*
A. Rai, **Vijai K. Rai**, A. Singh, L.D.S. Yadav
Eur. J. Org. Chem. **2011**, 4302-4306.

35. *Nucleophilic acylation of α-haloketones with aldehydes: an umpolung strategy for the synthesis of 1,3-diketones*
S. Singh, P. Singh, **Vijai K. Rai**, R. Kapoor, L.D.S. Yadav
Tetrahedron Lett. **2011**, *52*, 125-128.

Year 2010:

36. *Carbohydrate Building Block in Ugi 3-Component Coupling Reaction: Convenient Annulation of Iminosugars on Imidazoles,*
Vijai K. Rai, S. Singh, P. Singh, L.D.S. Yadav,
Synthesis **2010** 4051-4056.

37. *N-Heterocyclic Carbene Catalyzed Cross Coupling of Aromatic Aldehydes with Baylis-Hillman Bromides: An Easy Access to α-Arylidene-γ–keto Esters*,
P. Singh, S. Singh, **Vijai K. Rai**, L.D.S. Yadav,
Synlett **2010,** 2649-2653.

38. *Expeditious synthesis of functionalized piperidines via NHC-catalyzed regioselective aziridine ring-opening with enals,*
S. Singh, **Vijai K. Rai**, P. Singh, L.D.S. Yadav,
Synthesis **2010**, 2957-2964.

39. *NHC-catalyzed efficient synthesis of β′-amino enones via carbonyl umpolung reaction of enals with aziridines,*
L.D.S. Yadav, **Vijai K. Rai**, S. Singh, P. Singh,
Tetrahedron Lett. **2010**, *51*, 1657-1662.

40. *Carbonyl umpolung reactivity of enals: NHC-catalyzed synthesis of Aldol products via epoxide ring-opening,*
L.D.S. Yadav, S. Singh, **Vijai K. Rai**, P. Singh;
Synlett **2010**, 240-246.

Year 2009:

41. *A one pot [Bmim]OH mediated synthesis of 3-benzamidocoumarins*
L.D.S. Yadav, S. Singh & **Vijai K. Rai**;
Tetrahedron Lett. **2009**, *50*, 2208-2212.

42. *Novel catalyst-free, step and pot economic efficient mercaptoacetylative cyclisation in H_2O: synthesis of 3-mercaptocoumarins;*
L.D.S. Yadav, S. Singh & **Vijai K. Rai**;
Green Chem. **2009**, *11*, 878-882.

43. *The First $Cu(OTf)_2$-catalyzed synthesis of structurally novel bicyclic 1,3-oxazines via condensation-dehydrazinative ring transformation cascades;*
L.D.S. Yadav, A. Rai, **Vijai K. Rai** & C. Awasthi;

J. Chem. Res. **2009**, 520-526.

44. *A novel one-pot stereoselective synthesis of N-protected α-amino acids from Morita-Baylis-Hillman acetates;*
L.D.S. Yadav, **Vijai K. Rai** & S. Singh;
Synlett **2009**, 1423-1428.

45. *The first regio- and diastereoselective direct introduction of α-mercaptoacetic acid/amide units into Morita-Baylis-Hillman acetates*
L.D.S. Yadav & **Vijai K. Rai**;
Tetrahedron Lett. **2009**, *50*, 2414-2419.

46. *The first ionic liquid-promoted one-pot diastereoselective synthesis of 2,5-diamino-/2-amino-5-mercapto-1,3-thiazin-4-ones using masked amino/mercapto acids;*
L.D.S. Yadav, **Vijai K. Rai** & B. S. Yadav;
Tetrahedron **2009**, *65*, 1306-1315.

Year 2008:

47. *A convenient $CeCl_3.7H_2O$/NaI-promoted synthesis of structurally novel and strained tricyclic β-lactams from hydrazines,*
L.D.S. Yadav, **Vijai K. Rai**;
Tetrahedron Lett. **2008**, *49*, 5553-5556.

48. *K-10 clay-catalyzed enol-driven decarboxylative ring transformation approach to dihydro- and tetrahydroquinolines from carbohydrates,*
L.D.S. Yadav, C. Awasthi, **Vijai K. Rai**, A. Rai;
Synlett **2008**, 2257-2262.

49. *Diversity oriented synthesis of fused-ring 1,3-oxazines from carbohydrates as biorenewable feedstocks*
L.D.S. Yadav, V.P. Srivastava, **Vijai K. Rai**, R. Patel;
Tetrahedron **2008**, *64*, 4246-4253.

50. *A route to functionalized pyrimidines from carbohydrates via amine-driven dehydrative ring transformations,*
L.D.S. Yadav, C. Awasthi, **Vijai K. Rai**, A. Rai;
Tetrahedron Lett. **2008**, *49*, 2377-2380.

51. *Multicomponent reactions in chiral ionic liquids: a stereocontrolled route to mercaptopyranothiazoles,*
L.D.S. Yadav, B.S. Yadav, **Vijai K. Rai,**
J. Heterocyclic Chem. **2008**, *45*, 1315-1319.

52. *Carbohydrates to functionalized pyridines: a new synthetic approach via enol-driven ring transformations,*
L.D.S. Yadav, A. Rai, **Vijai K. Rai**, C. Awasthi;
Synlett **2008**, 529-534.

53. *An expeditious synthesis of benzoxazine-2-thione C-nucleosides via $Cu(OTf)_2$-mediated dehydrazinative β-glycosylation;*
L.D.S. Yadav, **Vijai K. Rai**;
Nucleosides, Nucleotides & Nucleic Acids **2008**, *27*, 1227-1237.

54. *Novel aziridination of α-halo ketones: an efficient nucleophile-induced cyclization of phosphoramidates to functionalized aziridines;*
L.D.S. Yadav, A. Rai, **Vijai K. Rai**, C. Awasthi;
Tetrahedron Lett. **2008**, *49*, 687-690.

55. *Chiral ionic liquid-catalyzed Biginelli reaction: stereoselective synthesis of polyfunctionalized perhydropyrimidines;*
L.D.S. Yadav, A. Rai, **Vijai K. Rai**, C. Awasthi;
Tetrahedron **2008**, *64*, 1420-1429.

Year 2007:

56. *A convenient synthesis of 1,2,4-trisubstituted azetidines by reductive cyclization of aza-Michael adducts of chalcones*.
L.D.S. Yadav, C. Awasthi, **Vijai K. Rai,** A. Rai;
Tetrahedron Lett. **2007**, *48*, 8037-8039.

57. *Multicomponent solvent-free cyclocondensation/glycosylation strategy for thiazolo-s-triazine N-nucleosides*;
L.D.S. Yadav, **Vijai K. Rai**, S. Yadav,
Lett. Org. Chem. **2007,** *4*, 47-50.

58. *Thiourea to dithiazolopyrimidines: highly regio- and stereoselective synthetic routes via mercaptoacetylative cyclization*;
L.D.S. Yadav, S. Yadav, **Vijai K. Rai**;
Synthesis **2007**, 3831-3838.

59. *An efficient conjugate hydrothiocyanation of chalcones with a task-specific ionic liquid*;
L.D.S. Yadav, R. Patel, **Vijai K. Rai**, V.P. Srivastava;
Tetrahedron Lett. **2007**, *48*, 7793-7795.

60. *Biorenewable resources in the Biginelli reaction: Ce(III)-catalyzed synthesis of novel iminosugar-annulated perhydropyridines*;
L.D.S. Yadav, A. Rai**, Vijai K. Rai**, C. Awasthi;
Synlett **2007**, 1905-1908.

61. *Biorenewable and mercaptoacetylating building blocks in the Biginelli reaction: synthesis of thiosugar-annulated dihydropyrimidines*;
L.D.S. Yadav, C. Awasthi, **Vijai K. Rai**, A. Rai;
Tetrahedron Lett. **2007**, *48*, 4899-4902.

62. *Thiourea to bicyclic scaffolds: highly regio/- and stereoselective routes to dithiazolopyrimidines;*
L.D.S. Yadav, **Vijai K. Rai**;
Tetrahedron **2007**, *63*, 6924-6931.

63. *One-pot dehydrazinative β-glycosylation in aqueous media: synthesis of benzoxazine C-nucleosides;*
L.D.S. Yadav & **Vijai K. Rai,**
Synlett **2007**, 1227-1230.

Year 2006:

64. *Chemoselective annulation of 1,3-dithiin/thiazine/oxathiin rings on thiazoles using green protocol*;
L.D.S. Yadav & **Vijai K. Rai**,
Tetrahedron **2006,** *62*, 8029-8034.

65. *A green protocol for annulation of s-triazine ring on thiazoles using three-component coupling strategy*;
L.D.S. Yadav, S. Yadav & **Vijai K. Rai**,
Green Chem. **2006**, *8*, 455-458.

66. *Novel mercaptoacetylative expeditious annulation of 5-mercaptopyrimidine ring on azoles using 1,3-oxathiolan-5-one*;
L.D.S. Yadav, **Vijai K. Rai** & S. Yadav,
Tetrahedron **2006**, *62*, 5464-5468.

67. *Active copper-promoted expeditious N-arylations in aqueous media under microwave irradiation,*
L.D.S. Yadav, B. S. Yadav, **Vijai K. Rai,**
Synthesis **2006,** 1868-1872.

68. *Three-component coupling strategy for the expeditious synthesis of novel 4-aminobenzoxazinone N-nucleoside*;
L.D.S. Yadav, **Vijai K. Rai**,
Tetrahedron Lett. **2006**, *47*, 395-397.

Year 2005:

69. *Mercaptoacetic acid based expeditious synthesis of polyfunctionalized 1,3-thiazines*
L.D.S. Yadav & S. Yadav & **Vijai K. Rai**,
Tetrahedron **2005**, *61*, 10013-10017.

Year 2004:

70. *A novel salicylaldehyde based mineral supported expedient synthesis of benzoxazinone nucleosides*,
L.D.S. Yadav & B.S. Yadav, **Vijai K. Rai**,
Tetrahedron Lett. **2004**, *45*, 5351-5353.

Invited Lectures/Papers presented in Conferences/Symposia

1. **Vijai K. Rai,** Organocatalytic C-C and C-N Bond Forming Reactions Using Baylis-Hillman Adduct; oral presentation in 103rd Indian Science Congress, 03-07 Jan., 2016, University of Mysore, Mysore.

2. **Vijai K. Rai**, Ion Implantation: A Green Chemistry Perspective; In National workshop at Guru Ghasidas Vishwavidyalaya, 18-19 Feb, 2014, Bilaspur, C. G.

3. **Vijai K. Rai**, Green Chemistry: Why & How in Laboratory, In National Seminar on Chemistry in Our Lives, held on 1-2 Feb. **2013** at Science College, Bilaspur, Chhattisgarh.

4. **Vijai K. Rai**, Green Synthetic Approaches in Drug Discovery Process, in Indian Chemical Society Conference held on Dec. 12-15, **2012** at NITTTR, Shamla Hills, Bhopal, M. P.

5. **Vijai K. Rai**, Stringent and growing environmental regulation in Green Chemistry, In 12th CONIAPS, on 22-25 Dec, **2010** at University of Rajasthan, Jaipur.

6. **Vijai K. Rai**, A.K. Yadav, S. Singh, P. Singh, L.D.S. Yadav, N-Heterocyclic Carbene-Catalyzed Efficient Synthesis of Functionalized Enones, In 5th JK Science Congress, on 8-10 Feb, **2010,** at University of Jammu, J&K.

7. L.D.S. Yadav & **Vijai K. Rai**; A Convenient β-Gycosylation of 1,3-Benzoxazine-2-thiones, organized by National Academy of Sciences (NASI), India, on 21-23rd Nov., **2008**, held at Punjab University Chandigarh.

8. L.D.S. Yadav & **Vijai K. Rai**; Chiral ionic liquid-catalyzed Biginelli reaction: stereoselective synthesis of polyfunctionalized perhydropyrimidines, presented in Proc. of 44th annual convention of chemist on 23-27 Dec. **2007** at Jaipur, p. C-3, ORG (AP)-9.

9. L.D.S. Yadav & **Vijai K. Rai**; Chemoselective annulation of 1,3,4-thiadi- and dithiazine rings on imidazoles, presented in the 9th session of CONIAPS held at **Agra, India**, 3-5 Feb. **2007**; Proc. 9th CONIAPS, p. C-104 to C-105.

10. L.D.S. Yadav & **Vijai K. Rai**; Green synthetic approach to thiazolo-*s*-triazine *N*-nucleosides, presented in the 76th annual session of NASI held at IIT Bombay, India, 6-8 Oct., **2006**; p. 37.

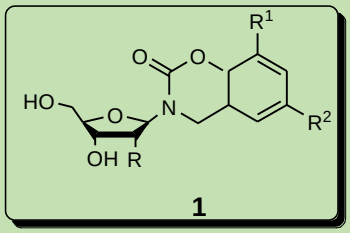
11. L.D.S. Yadav, S. Yadav & **Vijai K. Rai**; Multicomponent annulation of *s*-triazine ring on thiazoles under solvent-free microwave irradiation, presented in the 93rd session of the Indian Science Congress held at Hyderabad, India, 3-7 Jan, **2006**; Proc. 93rd Ind. Sci. Cong. p. 93-94.

Research-Summary

In my *over ten years of research experience in the Synthetic Organic Chemistry*, I have been working mainly on synthesis and application in the following areas:

[A]. Synthesis of Benzoxazinone *C*- and *N*-nucleosides:

Efavirenz (Sustiva), a benzoxazinone derivative, is a non-nucleoside reverse transcriptase inhibitor that has been approved by the FDA (September 17, 1998) and is presently in clinical use for the treatment of AIDS. In this respect, I have synthesized benzoxazinone *N*-nucleosides **1** (*Tetrahedron Lett.* **2004**, *45*, 5351) and **2** (*Tetrahedron Lett.* **2006**, *47*, 395) and their *C*-nucleosides **3** (*Synlett* **2007**, 1227). Compounds **1** were prepared by K-10 clay catalyzed cycloisomerization of salicylaldehyde 4-(β-D-ribo- or β-D-2'-deoxribofuranosyl) semicarbazones followed by reductive dehydrazination of their 4-hydrazinoderivatives. Compounds **2** were synthesized by K-10 clay supported three- component coupling reactions of substituted salicylaldehydes, ribosyl/deoxyribosylureas and ammonium acetate via cycloisomerisation of a aldimine intermediate. For benzoxazinone *C*-nucleosides **3,** a novel one-pot expeditious synthetic protocol has been developed via dehydrazinative β-glycosylation in aqueous media from the unprotected sugar and a compound containing an activated methylene group (Ref. 3). Recently, we have also reported 1,3-benzoxazine-2-thione C-nucleosides (*Nucleosides, Nucleotides & Nucleic Acids* **2008**, *27*, 1227-1237).



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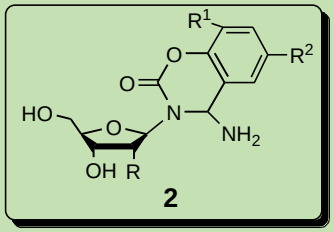

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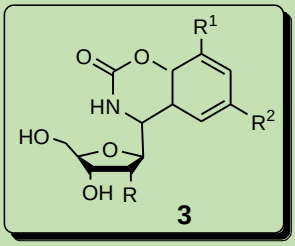

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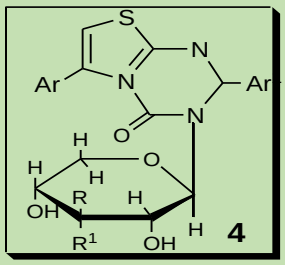
[B]. Synthesis of Glycon Modified *N*-nucleosides:



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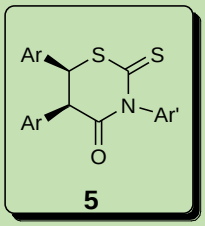
A green protocol involving novel three-component one-pot cyclocondensation reaction of 2-amino-4-aryl-thiazololes, aromatic aldehydes and ammonium thiocyanate under solvent- free MW irradiation conditions expeditiously yields thiazolo-s-triazine nucleobases, which afford the corresponding pyrano N-nucleosides **4** on iodine promoted glycosylation with 1,2,3,4-tetra-O-acetyl-beta-D-ribo-/xylopyranose under MW irradiation followed by deacetylation (Ref. 5).

Ref. 5. ***Lett. Org. Chem.*** **2007**, *4*, 47.

[C]. Stereo/-Chemo/- and Regeoselective Syntheses:

Nowadays, selectivity in organic reactions, *i.e.* stereoselectivity, regioselectivity and chemoselectivity has become a much challenging and demanding area for synthetic chemists. In this respect, we have developed ***diastereoselective synthetic protocols*** for 1,3-thiazines **5** (Ref. 5) and azolopyrimidines **6** (*Tetrahedron* **2006**, *62*, 5464) using 2-methyl-2-phenyl-1,3-oxathiolan-5-one, a novel mercaptoacetyl transfer agent **7** reported from our laboratory (*Tetrahedron* **2005**, *61*, 10013). In addition, we have also developed a ***diastereoselective green protocol*** for annulation of *s*-triazine ring on thiazoles **8** (*Green Chem.* **2006**, *8*, 455) and have devised a ***chemoselective annulation*** of 1,3-dithiin, -thiazine and -oxathiin rings on thiazoles **9**, **10**, and **11** involving tandem Knoevenagel, Michael and ring transformation reactions employing solvent-free MW irradiation conditions in a one-pot procedure (*Tetrahedron* **2006**, *62*, 8029). Very recently, ***regio/-*** *and* ***stereoselective synthetic routes*** for amino/ mercaptodithiazolopyrimidines **12** from thiourea have been developed by us (*Tetrahedron* **2007**, *63*, 6924, *Synthesis* **2007**, 3831).



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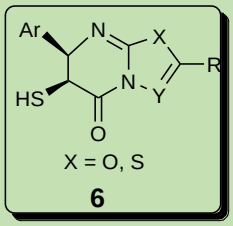

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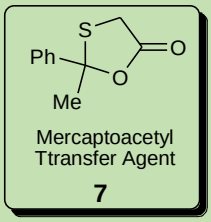

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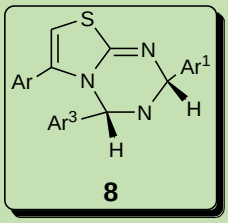

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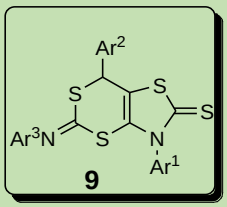

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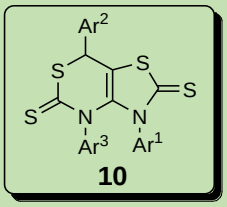

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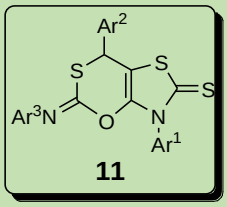

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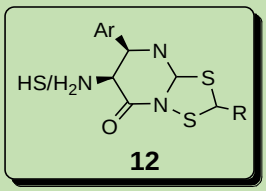

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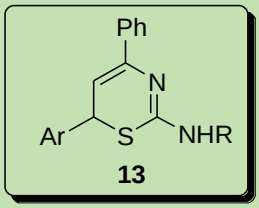
[D]. Active-Copper Promoted *N*-Arylations in Aqueous Media:

We have reported active-copper-promoted mild and expeditious *N*-arylations of amines, amides, imides, and β-lactams with aryl halides under MW irradiation conditions. These reactions can be performed in aqueous media as well as under solvent-free conditions to give good yields (*Synthesis* **2006**, 1868). Interestingly, no base is used in these reactions and the active copper itself acts as the halogen acceptor. Very recently, we have reported the catalyst-free synthesis of pharmaceutically and chemically important 3-mercaptocoumarins in water (*Green Chem.* **2009**, *11*, 878).

[E]. Ionic Liquid Mediated Organic Synthesis:

We have disclosed an efficient conjugate hydrothiocyanation of chalcones with a *task-specific ionic liquid* ([Bmim]SCN), The application of this protocol in heterocyclic chemistry is demonstrated by a one-pot synthesis of 1,3-thiazines **13** (*Tetrahedron Lett.* **2007**, *48*, 7793). A chiral ionic liquid-catalyzed, efficient and unprecedented version of the Biginelli reaction using novel variants of its active methylene component, viz. 2-phenyl-1,3-oxazol-5-one/2-methyl-2-phenyl-1,3-oxathiolan-5-one, with benzaldehyde and urea/thiourea enantio- and diastereoselectively, yields 5-amino-/mercaptoperhydropyrimidines **14** (*Tetrahedron* **2008**, *64*, 1420). Recently, a stereocontrolled route to mercaptopyranothiazole **15** has been developed using one-pot multi-component protocol in chiral ionic liquid (*J. Heterocyclic Chem.* **2008**, *45*, 1315). Furthermore, we have also developed a one-pot protocol for 2-amino-5-mercapto or 2,5-diamino-1,3-thiazines using ionic-liquid ([Bmim]Br) (*Tetrahedron* **2009**, *65*, 1306). Very recently, we have reported the one-pot [Bmim]OH-mediated synthesis of 3-benzamidocoumarins **16** (*Tetrahedron Lett.* **2009**, *50*, 2208).



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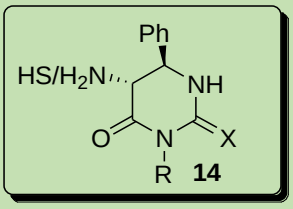

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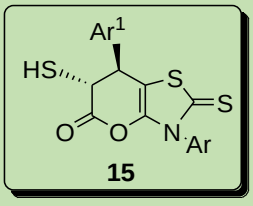

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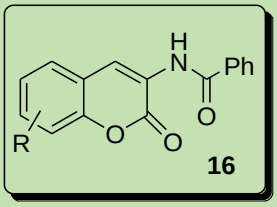

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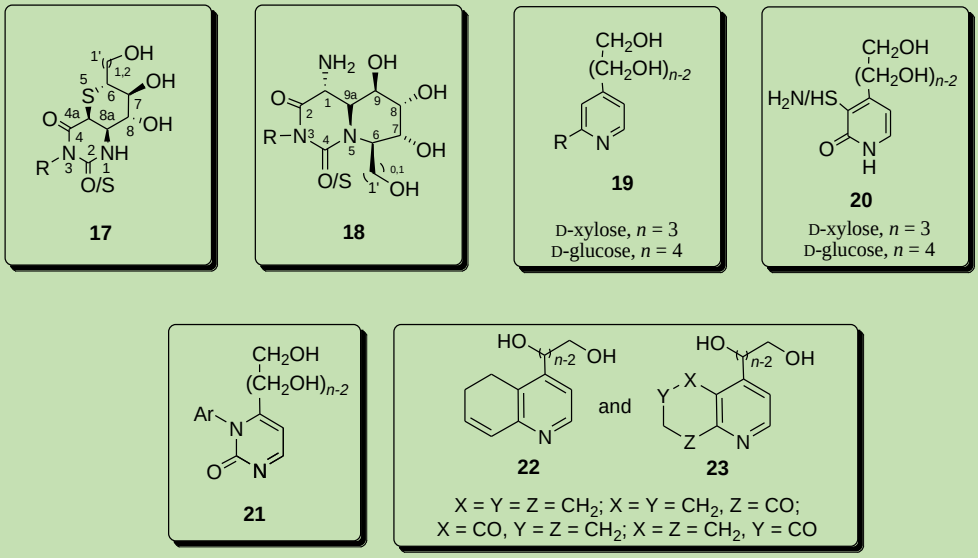
[E]. Biorenewable Resources in Organic Synthesis:

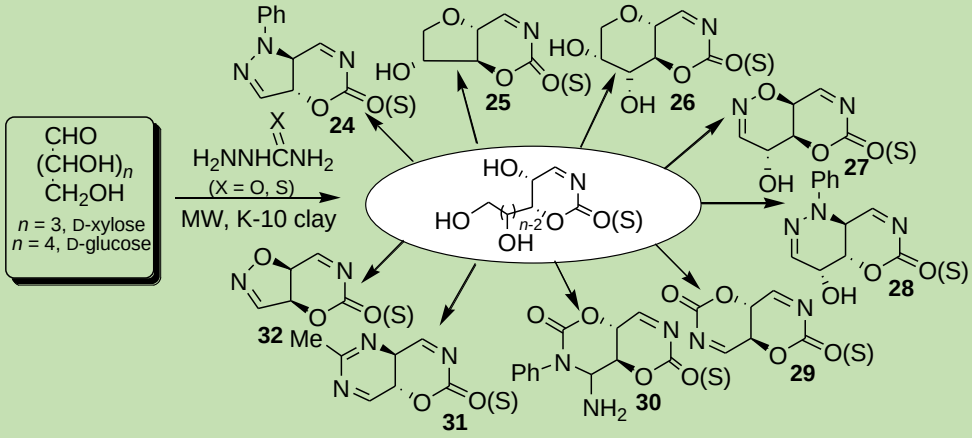
"*A raw material as feedstock should be renewable rather than depleting wherever technically and economically practicable.*" This quotation is one of the 12 principles of green chemistry and thus, "renewable resources" is a new and rapidly developing concept in the environmental and chemical sciences that concerns the wide use of biorenewable materials for industry. In this context, we have utilized carbohydrate feedstocks as raw material in "***Biginelli Reaction*"** and we have developed an efficient Ce(III)-catalyzed diastereoselective synthesis of iminosugar annulated-(**17,** *Synlett* **2007**, 1905) and montmorillonite K-10 clay-catalyzed annulated **(18**, *Tetrahedron Lett.* **2007**, *48*, 4899**)** polyfunctionalized pyrimidine scaffolds of pharmacological potential under solvent-free MW irradiation conditions in a one-pot procedure. Recently, we have developed an original method for polyhydroxyalkylpyridines **(19)** and their 3-amino/mercapto-2-pyridinone analogues **(20)** using unprotected aldoses as biorenewable resources via enol-driven Michael-type addition of lactones/ketones to aldose-derived 1,3-oxazin-2-

ones followed by decarboxylative ring transformation (*Synlett* **2008**, 529). Very recently, we envisaged a K-10 clay-catalyzed amine-driven dehydrative ring transformation approach to pyrimidines (**21**, *Tetrahedron Lett.* **2008**, *49*, 2377) and enol-driven ring transformation approach to dihydro- (**22**, *Synlett* **2008**, 2257) and tetrahydroquinolines (**23**, *Synlett* **2008**, 2257) from carbohydrates as biorenewable resources.



[F]. Diversity Oriented Synthesis:

We have developed a general, straightforward diversity oriented synthetic approach for the synthesis of various 1,3-oxazin-2-one(thione)-fused *N*- and *O*-heterocyclic systems (**24**-**32**) using D-glucose and D-xylose as biorenewable resources under solvent-free microwave irradiation conditions (*Tetrahedron* **2008**, *64*, 4246) and also by employing $Cu(OTf)_2$ as catalyst (*J. Chem. Res.* **2009**, 522) where, $Cu(OTf)_2$ acts as dehydrazinating and N-arylating reagent.

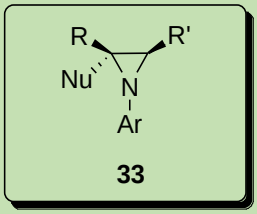


[G]. Synthesis of Small Ring *N*-Heterocycles:

Owing to the inherent strain in small ring heterocycles, they are useful as feedstocks in organic synthesis to provide functionalized carbon chain. A general method for a convenient synthesis of 1,2,4-trisubstituted azetidines **34** by reductive cyclization of readily available aza-Michael adducts of chalcones and diethyl *N*-arylphosphoramidates in a one-pot procedure is reported (*Tetrahedron Lett.* **2007**, *48*, 8037), which may find application in organic synthesis. Furthermore, we have developed a novel and efficient aziridination of α-halo ketones (*Tetrahedron Lett.* **2008**, *49*, 687). The reaction of α-halo ketones with diethyl *N*-arylphosphoramidates affords diethyl *N*-aryl-*N*-(2-oxoalkyl)phosphoramidates which undergo reductive (H^--induced) cyclization with sodium borohydride followed by sodium hydride to give 1,2-disubstituted and 1,2,3-

trisubstituted aziridines. The cyclization induced by NCS^- or PhS^- affords substituted aziridines functionalized at position 2. The reactions give excellent yields and are highly diastereoselective in favour of *cis* aziridines **33**.

Recently, tricyclic β-lactam antibiotics, generally referred as "*trinems*", have been the subject of considerable study owing to their broad spectrum of antibacterial activity. Besides, the ever-growing new applications of 2-azetidinones in fields ranging from enzyme inhibition to the use of these products as starting materials to develop new synthetic methodologies has triggered a renewed interest in the building of new polycyclic β-lactam systems in an attempt to move away from the classical β-lactam antibiotic structures. In this regard, we envisaged the straightforward synthesis of trinem class of antibiotics, viz highly derivatized azetidino[2,1-*b*]-thiazolo[3,4-*d*]-3*H*-1,3,4-oxadiazol-6-ones **35** (*Tetrahedron Lett.* **2008**, *49*, 5553).



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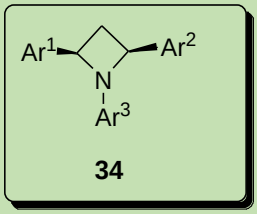

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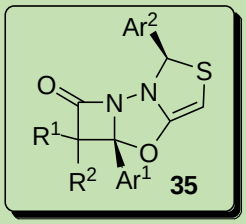
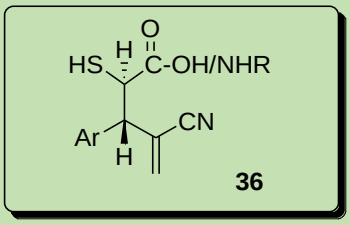


35

[I]. Morita-Baylis-Hillman (MBH) Chemistry:

Morita-Baylis-Hillman (MBH) adducts bearing allylic hydroxyl and Michael acceptor units and their derivatives have been illustrated as valuable synthons and starting materials for the generation of diverse molecular skeletons employing simple alternatives.[1] Especially, regioselective introduction of nucleophiles at either α- or γ- position of the MBH acetates enables the construction of a variety of bioactive molecules and has become a powerful tool in synthetic organic chemistry. Thus, we have performed the first regio- and diastereoselective direct introduction of α-mercaptoacetic acid/amide units into MBH acetates **36** (*Tetrahedron Lett.* **2009**, *50*, 2414). Furthermore, we have also reported a novel one-pot stereoselective synthesis of *N*-protected α-Amino acids from MBH Acetates **37** (*Synlett* **2009**, 1423).



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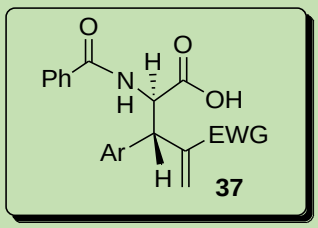

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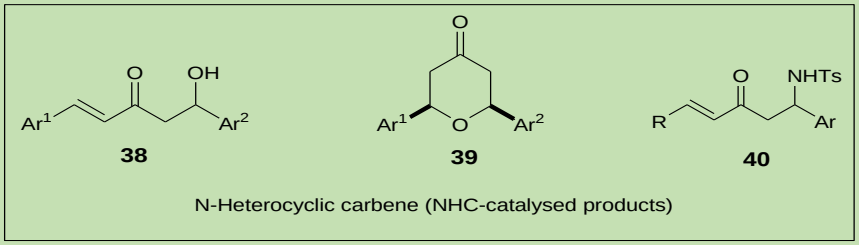
[J]. N-Heterocyclic Carbenes (NHCs)-catalyzed organic synthesis:

Over the last decade, there have been a continuously growing number of successful and novel applications of *N*-heterocyclic carbenes (NHCs) as organocatalysts and reagents for an expanding set of reactions. This is not only because of the great versatility of these organocatalytic transformations, but also due to the possibilities that arise from the NHC's characteristic causing inversion of the classical reactivity, that is, umpolung. We have disclosed an NHC-catalyzed efficient synthesis of aldol products β′-hydroxy-α,β-unsaturated ketones **38** via carbonyl umpolung reaction of enals with terminal epoxides. Furthermore, we also demonstrated its synthetic application and developed a straightforward, convenient, and one-pot process for the synthesis of tetrahydropyran-4-ones **39** in excellent yields (87-90%) via oxy-Michael intramolecular reaction of **38** (*Synlett* **2010**, 240-246). Recently, we have reported an unprecedented synthesis of β'-amino-α,β-unsaturated ketones **40** via regioselective aziridine ring opening. The protocol involves carbonyl umpolung reactivity of enals in which the carbonyl carbon attacks nucleophilically on electrophilic terminal aziridines regiselectively (*Tetrahedron Lett.* **2010**, 51, 1657).



[H]. Synthesis of Graphene-based materials:

We have prepared Fe_3O_4 decorated Naf/DMAP linked graphene oxide (Fe_3O_4-Naf/DMAP-GO) (**Fig. 41**) nanohybrid film which worked well as highly selective non-enzymatic electrochemical sensor. The linking of 3,7-bis (Dimethylamino)-phenothiazin-5-ium chloride (DMAP) occurs via electrostatic interaction of cationic organic compound with negatively charged oxygen containing groups (-COO^- and $–O^-$) available on the edge of graphene oxide (***RSC Advances*, 2016, *6*, 104868**). Recently we have reported facile construction of AuNPs modulated SDS wrapped G-TC tailored electrode (**Fig. 42**) for sensitive detection of ascorbic acid (***New J. Chem.* 2017, *41*, 6489**).

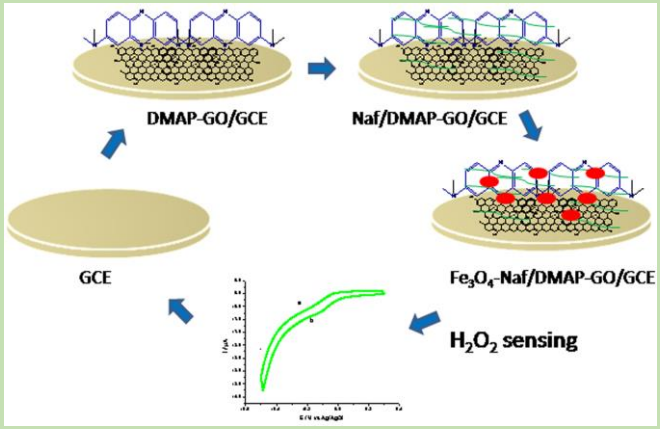


Fig. 41: Preparation of Fe_3O_4 decorated GO.

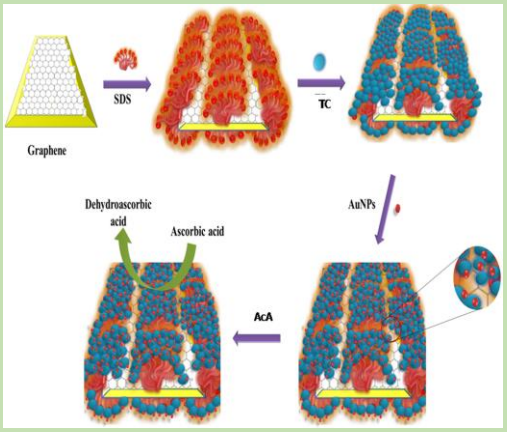
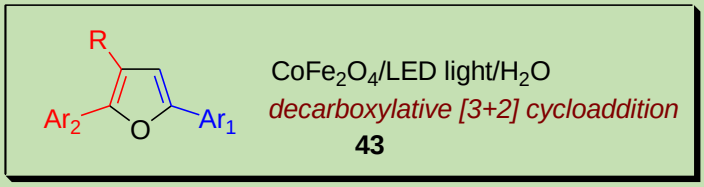
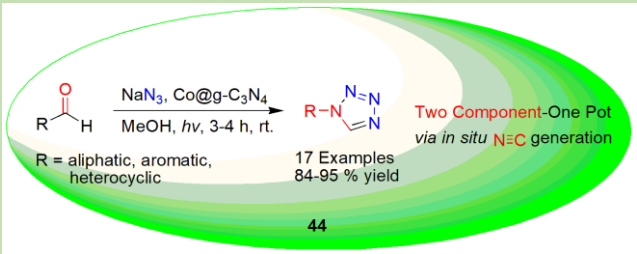


Fig. 42: Preparation of Au-decorated GO.

[I]. Synthesis of Nano-materials and Photo-catalysis:

We are involved in synthesis of nanomaterials and its application in phot-catalysis. We have reported synthesis of $CoFe_2O_4$ nanoparticles and its catalytic behaviour as its co-operative effect along with visible light photo-catalysis for green synthesis of furans in water (Fig. 43). Though, the reported method is efficient without catalyst in presence of visible light (70% yield in 4h at rt), the use of catalyst not only increases the yield (91%) but also accelerates the conversion rate (2h, rt) (***New J. Chem.* 2017, *41*, 4937**). Recently, a novel and green Co@g-C_3N_4 catalyzed visible light driven direct regioselective synthesis of 1*H*-tetrazoles (**44**) directly from various aldehydes and sodium azide is reported (***Green Chem.* 2018,** DOI: 10.1039/C8GC01321G). Herein, NaN_3 not only behaves as three-nitrogen donor of tetrazole ring but also it converts aldehyde in to isocyanide as one-nitrogen source.





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