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A Five-Year Perspective on DMAP as a Cutting-Edge Reagent in Heterocyclic Ring Formation

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Table 1. Summary of the DMAP promoted heterocyclic ring formations-Nutshell

Entry	Type of Heterocycle Synthesized	Role of DMAP	Comparison with other similar reagents	Reaction conditions	Reference
1	**Five-Membered Heterocycles**				
	Synthesis of 1,3,4-oxadiazoles	Reagent	DMAP excelled (92%) over DBU (25%), pyridine (5%), Et_3N (39%), and K_2CO_3 (50%)	DMAP (1.0 equiv.), CH_3CN, O_2, 70 °C, 15 h	38
	Synthesis of sulfur heterocycles	Catalyst	DMAP excelled (67%) over DBU (26%), pyridine (33%), or DABCO (38%)	DMAP (10 mol%), DCC, CH_3CN, rt, 16 h	39
	Synthesis of substituted imidazoles	Reagent	DMAP excelled (87% yield) over DBU (17%), NaOAc (35%), K_2CO_3 (59%), NaOH (42%), NaOEt (31%), and Et_3N (16%)	I_2 (1 equiv.), DMAP (1 equiv.), PhCl, 110 °C, 6 h	41
	Synthesis of 1,2,5-thiadiazoles/1,2,4-thiadiazolones	Reagent	DMAP excelled (68% yield) over NaOAc (ND), imidazole (32%), pyridine (56%), and Et_3N (66%)	TFAA (4.0 equiv.), DMAP (2.5 equiv.,), Na_2SO_4 (2.5 equiv.), DCE, 0-80 °C/ TFAA (3.5 equiv.), DMAP (2 equiv.,), NaOAc (2 equiv.), H_2O (1.1 equiv.), DCE, 0-80 °C	43
	Synthesis of 1,5-disubstituted tetrazoles	Reagent	DMAP (71%), Et_3N (16%), DBU (trace), pyridine (56%), and DABCO (56%)	DMAP (2.0 equiv), THF, reflux, 16 h	45
	Synthesis of substituted 2-oxazolines	Reagent	DMAP excelled (63%) over Et_3N (13%), DABCO (28%), DBU (<1%), DIPEA (21%), Na_2CO_3 (18%), K_2CO_3 (6%), and Cs_2CO_3 (<1%).	DMAP (2 equiv.), toluene, N_2, reflux, 12 h	47
	2-(3*H*)-oxazolones	Promoter	DMAP excelled (77%) over	1. $FeCl_3$ (5 mol%), CH_3CN,	48

			$TsOH{\cdot}H_2O$ (64%), CSA (73%), and Et_3N (38%) for isomerization	reflux, 1 h, 2. DMAP (30 mol%), 40 ^oC	
2	**Six-Membered Heterocycles**				
	Synthesis of tetrahydropyridazine derivatives	Catalyst	DMAP was uniquely effective (62%), whereas DABCO, pyridine, Cs_2CO_3, and tertiary phosphines were inactive.	DMAP (20 mol%), DCE, 0 ^oC, 12 h	50
	Synthesis of 2-pyrones derivatives	Catalyst	DMAP proved optimal (60%) over phosphines (PMe_3 47%, PBu_3 54%) and DABCO (48%), enabling efficient bromide displacement and cyclization	DMAP (20 mol%), KOH (1.5 equiv.), 1,4-dioxane, 60 ^oC, 4 A^o MS	52
	Synthesis of polyfunctionalized 2-amino-3-cyano-4*H*-pyran esters	Promoter	DMAP (57%) as optimal, outperforming Et_3N (48%), DIPEA (44%), DABCO (35%), DBU (41%), K_2CO_3 (31%), and Cs_2CO_3 (37%)	DMAP (40 mol%), EtOAc, 40 ^oC	54
	Synthesis of 1,3,4-oxadiazines	Promoter	DMAP (75%) as optimal, outperforming pyridine (13%), DBU (0%)	DMAP (30 mol%), toluene, rt, N_2	57
3	**[5,6]-Fused Heterocyclic Ring Systems**				
	Synthesis of pyranopyrazoles	Catalyst	DMAP outperformed piperidine (68%), DBU (74%), DABCO (79%), and NEt_3 (83%), giving 92% yield	DMAP (5 mol%), EtOH, rt	60
	Synthesis of substituted 2-hydroxybenzylideneindenediones	Promoter	DMAP provides the best yield (62%), while Et_3N (54%) and L-proline (51%) are comparable but slightly less effective. In contrast, inorganic bases (K_2CO_3 27%, NaOAc 25%) and piperidine (15%) perform poorly, likely due to competing side reactions	DMAP (30 mol%), EtOH, 70 ^oC, 2 h	62
4	**[6,6]-Fused Heterocyclic Ring Systems**				
	Synthesis of substituted 2-alkoxy quinolines	Co-catalyst	DMAP (62%) outperforming pyridine (21%), NMP (0%), and other pyridine derivatives which give significantly lower	CuCl (5 mol%), DMAP (20 mol%), $NaHCO_3$ (1.0 equiv), 1,10-Phenanthroline (7.5 mol%), CH_3CN (0.2 M), Ar,	64

			or negligible yields	70 °C, 12 h	
	Synthesis of quinazolinediones derivatives	Promoter	Notably, DMAP is essential, as other nucleophilic catalysts (e.g., DABCO, imidazole) are ineffective	DMAP (50 mol%), H_2O (2.0 equiv) K_3PO_4 (3.0 equiv), *t*-BuOH (0.2 M), rt, 18 h	66
	Synthesis of 3-cyano-2*H*-chromenes	Reagent	DMAP with highest yield (57%), outperforming DABCO (51%) quinuclidine (69%), 3-quinuclidinol (60%), and PPY (48%), while several strong bases (TBD, DBN, MTBD) and quinine are ineffective or poor	DMAP (2.0 equiv), neat, 70 °C, 18 h	68
5	**[6,6,6]-Fused Heterocyclic Ring Systems**				
	Synthesis of 1,3-diazaphenothiazines	Reagent	K_2CO_3 (21%), *t*-BuONa (trace), Et_3N (56%), $EtNH_2$ (52%), tripropylamine (TPrA, 48%), *N,N*-diisopropylethylamine (DIPEA, 67%), and 4-dimethylaminopyridine (DMAP, 78%) were tested, and DMAP achieved the best result in 78% isolated yield	DMAP (3 equiv.), EtOH, O_2 (balloon), 80 °C, 2 h	70
	Synthesis of functionalized benzo[*c*][2,7]naphthyridine skeletons	Reagent	Despite high selectivity, the catalytic efficiency is modest, with DMAP giving only 36% yield, while DABCO and phosphine catalysts are ineffective	DMAP (1.0 equiv), CH_2Cl_2, rt, 48 h	72
	Synthesis of substituted coumarins	Catalyst	DMAP (85%) significantly outperforms DABCO (40%) and other bases, while DBU diverts the reaction pathway	DMAP (20 mol%), K_2CO_3 (2.0 equiv), toluene (0.1 M), 130 °C, 6-8 h	74
	Synthesis of benzophenazine and pyrimidine tethered tri-substituted methanes	Catalyst	DMAP (97%) outperforming other catalysts (I_2 63%, CAN 57%, DABCO 67%)	DMAP (10 mol%), Ultrsound-assisted, H_2O, 3.5-5 h, RT	76
	Synthesis of 1,4-pyranonaphthoquinones	Catalyst	DMAP outperforming pyridine (10%), DABCO (60%), DBU (5%), and Et_3N (5%)	DMAP (20 mol%), microwave (80 °C, 150 W), EtOH, 20 min	78
	Synthesis of benzo[*c*]cinnolines derivatives	Ligand	DMAP acted as an effective ligand	CuBr (5 mol%), DMAP (10 mol%), 1,4-dioxane, 100 °C,	80

				O_2 balloon	
6	**Three Fused Heterocycles with Mixed Ring Sizes (5-6-7/10)**				
	Selective synthesis of furan-3(*2H*)-one fused 5- and 7-membered rings	Base	Among the bases tested K_2CO_3 (35%), *t*-BuOK (0%), DABCO (30%), DBU (12%), and DMAP afforded the highest yield (62%)	DMAP (2 equiv.), DMF, rt, 12 h in sealed tube	83
7	**Spiroheterocycles:** Synthesis of pyrazolinone-containing dispirocyclic compounds - [5,5]-Spiroheterocyclic Frameworks				
	Synthesis of benzofuran derivatives	Reagent	DMAP was optimal (70 in DCE) over inorganic (Na_2CO_3/K_2CO_3 50-52%, Cs_2CO_3 41%) and organic bases (DABCO 31%, Et_3N 45%, DBU 32%, TMG 36%, $NaHCO_3$ 42%), likely due to balanced nucleophilicity for sulfone displacement and cyclization.	DMAP (1.0 equiv), DCE, rt, 20 h	85
	Synthesis of 1,3-dioxolane skeletons	Catalyst	Among the catalysts screened, DMAP (72%) outperformed several other catalysts such as DABCO (trace), DBU (67%), TPP (NR), 4-pyrrolidinopyridine (62%), (1-pyridin-4-yl)piperidine (64%) and 4-(4-pyridinyl)morpholine (67%).	DMAP (20 mol%), K_2CO_3 (50 mol%), DCM, -20 °C, 48 h	87
8	**[5,6]-Spiroheterocyclic Frameworks**				
	Synthesis of spiro- and 3-methylene-hydroquinoline-indandiones	Catalyst	Using DMAP, the aza-1,4-/1,6-addition pathway could be selectively modulated, delivering products in 40-99% yields with excellent diastereoselectivities. Stronger bases such as DBU and TMG favored formation of 3-methylenehydroquinoline-indandiones in lower yields (25% and 55%, respectively).	DMAP (20 mol%), CH_2Cl_2, 30 °C	89

			(25% and 55%, respectively)		
	Synthesis of [3+3] spiroannulation reactions of isatin	Catalyst	Bases such as DBU, Et_3N, PPh_3, and imidazole produced only trace amounts of product, where as DMAP could yield 83% of the desired product.	DMAP (20 mol%), Toluene, rt	91
9	**[5,7]-Spiroheterocyclic Frameworks**				
	Synthesis of spiro[pyrazolone-azepine] scaffolds	Catalyst	DMAP gave yields up to 93%, and is uniquely effective while others are PPh_3, DABCO, and Et_3N were ineffective.	DMAP (20 mol%). Cs_2CO_3, toluene, 40 ^{o}C	94
	Synthesis of ninhydrin-derived MBH carbonates	Catalyst	DMAP was superior (82%); PPh_3 and Et_3N were ineffective.	DMAP (20 mol%). $CHCl_3$, 40 ^{o}C	96
	Synthesis of spiro[cyclohepta[c]pyrrole-6,2'-indene]-8-carboxylates	Catalyst	DMAP is critically superior (75%) to ineffective conventional amines (DABCO, DBU, quinuclidine), DMAP's unique nucleophilicity enables this higher-order mode.	DMAP (10 mol%). THF, rt, 24 h	97
10	**[5,5,5]-Spiroheterocyclic Frameworks**				
	Synthesis of multifunctional spiropyrazole derivatives	Catalyst	Screening of tertiary amine catalysts demonstrated that only DMAP (98% yield) was effective, whereas DABCO, DBU, β-ICD, and quinine were inactive	DMAP (20 mol%). CH_2Cl_2, rt, 48 h	98
	Diastereo- and regioselective synthesis of bis-spiroheterocyclic oxindoles	Catalyst	DMAP proved optimal (91%) versus milder bases (Et_3N 80%, DABCO 79%, DIPEA 75%, K_2CO_3/Cs_2CO_3 56-77%) and stronger ones (DBU 52%, NaOEt 25%), revealing alkalinity sweet-spot control	DMAP (20 mol%). EtOH, rt	100
	Synthesis of dispirocyclic compounds	Catalyst	DMAP (83%) clearly outperformed the alternative catalysts tested such as DABCO or PCy_3 (trace), TPP (40%).	DMAP (20 mol%). CH_2Cl_2, rt, 12 h	101

	Synthesis of contiguous dispiroheterocyclic scaffolds	Catalyst	DMAP (95%) slightly outperformed other effective bases (DABCO 90%, Et_3N 68%, DBU 70%; DPP inactive), underscoring its catalytic efficiency in this racemic transformation	DMAP (10 mol%), CH_2Cl_2, rt	103
11	**[5,5,6]-Spiroheterocyclic Frameworks**				
	Synthesis of bisspiro(oxindole)s	Catalyst	DMAP gave yields (72%) with excellent diastereoselectivity (>20:1 dr). Uniquely effective versus alternatives pyridine/DBU gave traces, PPh_3/DABCO failed	DMAP (10 mol%), CH_2Cl_2, rt, 6 h	105
12	**Miscellaneous Heterocyclic Ring Formations**				
	Synthesis of C-3 aminoquinolin-2(1*H*)-ones	Base	DMAP (82%) outperformed other base catalysts such as DABCO (33%), DIPEA (63%), K_2CO_3 (34%).	DMAP (1.2 equiv.), $Ir(dFppy)_3$ (2 mol%), CH_3CN, H_2O	107