Supplementary Material

Activated carbon coupled with advanced biological wastewater treatment: a review of the enhancement in micropollutant removal

Marina Gutiérrez[1], Vittoria Grillini[1], Dragana Mutavdžić Pavlović[2], Paola Verlicchi[1]*

1. Department of Engineering, University of Ferrara, Via Saragat 1, 44122 Ferrara, Italy marina.gutierrezpulpeiro@unife.it, vittoria.grillini@unife.it, paola.verlicchi@unife.it
2. Department of Analytical Chemistry, Faculty of Chemical Engineering, University of Zagreb, Trg Marka Marulića 19, 10000, Zagreb, Croatia dmutavdz@fkit.hr

* *Corresponding Author*

Summary

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S1. Identification of the studies by PRISMA guidelines.

In 2009, international experts established a protocol, known as the PRISMA guidelines, which defines the steps to follow to obtain a systematic review on a specific topic.

Following the guidelines, a research engine (Scopus) was chosen and key terms were identified in order to initially gather a wide collection of peer reviewed papers (records). The combination of terms and Boolean operators: "MBR" OR "membrane bioreactor" OR "membrane reactor" AND "activated carbon" OR "AC" led to a first list containing 379 records. A further 30 records were identified among the references of the collected papers. Out of these 409 records, 252 were rejected in the first screening, resulting in 157 selected records. The first selection was based on the title and the abstract of each record. In particular, eligibility criteria included only peer-reviewed papers written in English and concerning municipal or urban, domestic and hospital wastewater. Records related to drinking water supplies, groundwater injections and industrial processes were excluded as well as records related to reviews (30), book chapters (9) and conference papers (13).

After the first screening, selection criteria were applied to only include membrane bioreactors enhanced/coupled with AC. In this context, configurations including dynamic membranes (5), fluidised bed membrane bioreactors (30), microbial fuel cell bioreactors (6) and a further 47 records related to investigations on specific equipment configurations or conditions which did not fit the scope of the present review were excluded.

As a result of this process, a collection of 64 peer reviewed papers, published between 2009 and 2020, was defined. This included studies presenting and discussing the new trends in the enhancement of the performance of membrane bioreactors in combination with AC, in terms of removal efficiency of macro- (BOD_5, COD, nitrogen compounds, phosphorus compounds) and micro-pollutants, and fouling reduction and control (**Figure S1**). Based on these studies and following the PRISMA guidelines, a qualitative synthesis was carried out. Then a further refinement was carried out, leading to the identification of 26 records on which a quantitative synthesis was carried out referring to removal of MPs in MBR coupled AC (PAC or GAC). The list of 64 papers is reported with the full details at the end of the Supplementary Material, references in bold refer to the 26 records selected for MP removal analysis.

List of papers

(Abegglen et al., 2009)**(Alvarino et al., 2016)(Alvarino et al., 2017)(Asif et al., 2020)(Baresel et al., 2019)**(Cho et al., 2011)**(Echevarría et al., 2019)**(Gao et al., 2016)(Gkotsis et al., 2020)**(Grover et al., 2011)**(Guo et al., 2008)**(Itzel et al., 2018)**(Iversen et al., 2009a)(Iversen et al., 2009b)(Johir et al., 2011)(Johir et al., 2013)(Johir et al., 2016)(Jamal Khan et al., 2012)**(Kovalova et al., 2013)(Langenhoff et al., 2013)**(Lee et al., 2009)(Lee et al., 2010)(Lee et al., 2016)(Lei et al., 2019)**(Li et al., 2011)**(Lin et al., 2011)**(Lipp et al., 2012)(Löwenberg et al., 2014)**(Ma et al., 2014b)(Ma et al., 2014a)**(Margot et al., 2013)**(Mohamadi et al., 2019)(Navaratna et al., 2016)(Ng et al., 2013)**(Nguyen et al., 2012)(Nguyen et al., 2013a)(Nguyen et al., 2013b)(Nguyen et al., 2014)**(Nielsen et al., 2013)(Pan et al., 2016)**(Paredes et al., 2018)(Paulus et al., 2019)**(Plakas et al., 2016)(Remy et al., 2010)**(Remy et al., 2012)(Sbardella et al., 2018)(Serrano et al., 2011)**(Torretta et al., 2013)(Wang et al., 2016)**(Wei et al., 2016)**(Wong et al., 2016)(Woo et al., 2016)(Woo et al., 2020)(Xiao et al., 2017)(Yang et al., 2010)**(Yang et al., 2012)(Yang et al., 2019)(Yu et al., 2014)**(Zhang and Zhao, 2014)(Zhang et al., 2017)(Zhang et al., 2019b)(Zhang et al., 2019a)(Ziemba et al., 2020)(Zouboulis et al., 2017)

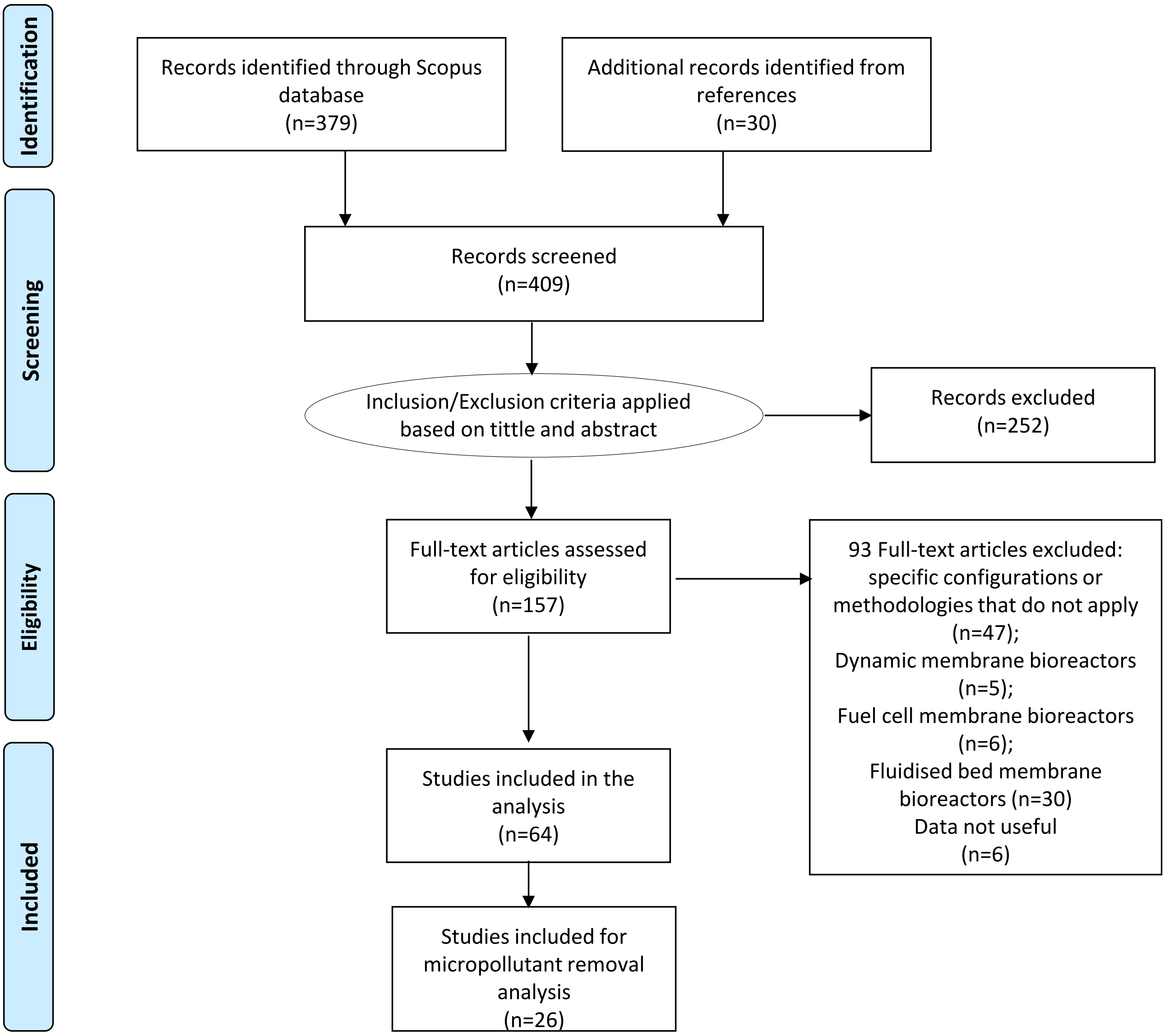
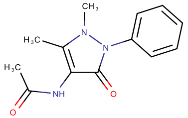
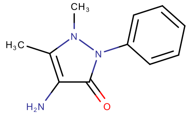
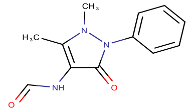
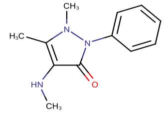
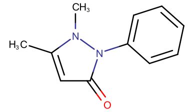
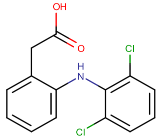
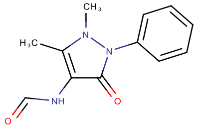
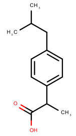
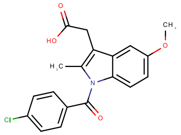
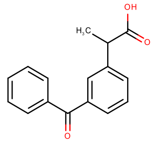
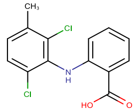
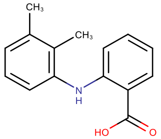
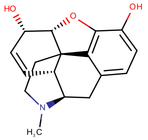
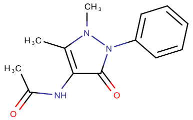
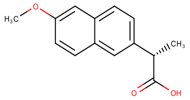
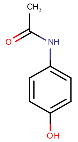
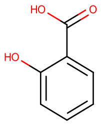
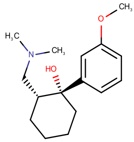
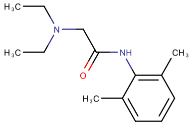
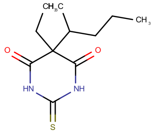
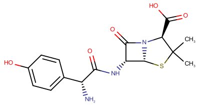
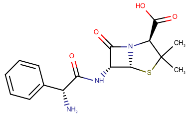
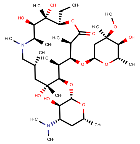
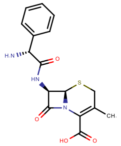


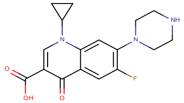
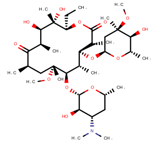
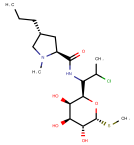
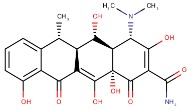
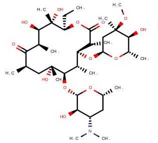
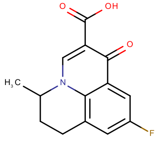
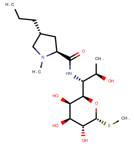
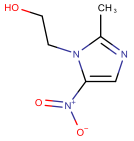
Figure S1. Steps of the review according to PRISMA Guidelines.

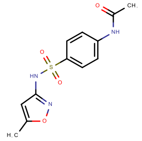
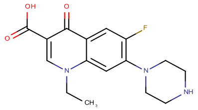
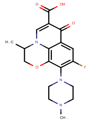
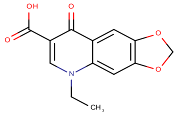
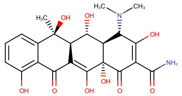
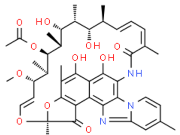
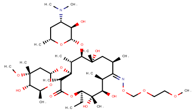
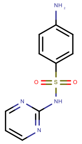
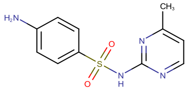
Table S1. List of compounds included in the review together with their main chemical and physical properties

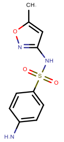
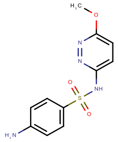
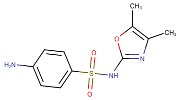
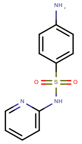
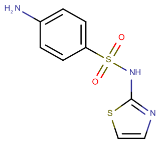
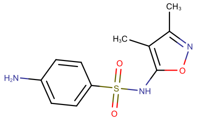
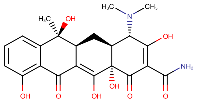
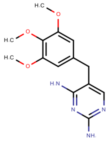
Class	Compound	Molecular Weight (g/mol)	Structure	Molecular formula	Log K_{ow}	Strongest acidic pK_a	Strongest basic pK_a	Log D_{ow} (pH=6)	Log D_{ow} (pH=8)	Charge (pH=7)	A,N,Z,C*
Analgesics/Anti-inflammatories	*4-Acetamidoantipyrine*	245.28		C13H15N3O2	0.15	12.52	--	0.15	0.15	0	N
Analgesics/Anti-inflammatories	*4-Aminoantipyrine*	203.25		C11H13N3O	0.33	--	0.07	0.33	0.33	0	N
Analgesics/Anti-inflammatories	*4-Formylaminoantipyrine*	231.26		C12H13N3O2	0.11	12.66	--	0.11	0.11	0	N
Analgesics/Anti-inflammatories	*4-Methylaminoantipyrine*	217.27		C12H15N3O	0.77	--	1.24	0.77	0.77	0	N
Analgesics/Anti-inflammatories	*Antipyrine/Phenazone*	188.23		C11H12N2O	1.22	--	0.49	1.22	1.22	0	N
Analgesics/Anti-inflammatories	*Diclofenac*	296.15		C14H11Cl2NO2	4.26	4.00	--	2.26	0.85	-1	A
Analgesics/Anti-inflammatories	*Formyl-4-aminoantipyrine*	231.26		C12H13N3O2	0.11	12.66	--	0.11	0.11	0	N
Analgesics/Anti-inflammatories	*Ibuprofen*	206.29		C13H18O2	3.84	4.85	--	2.67	0.85	-0.99	A

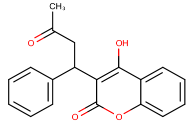
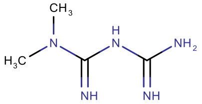
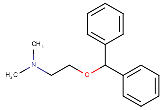
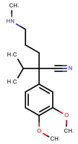
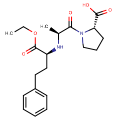
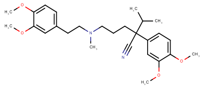
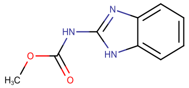
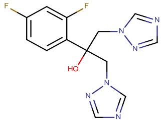
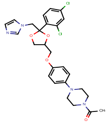
Class	Compound	Molecular Weight (g/mol)	Structure	Molecular formula	Log K_{ow}	Strongest acidic pK_a	Strongest basic pK_a	Log D_{ow} (pH=6)	Log D_{ow} (pH=8)	Charge (pH=7)	A,N,Z,C*
Analgesics/Anti-inflammatories	*Indometacin*	357.79		C19H16ClNO4	3.53	3.79	--	1.34	0.08	-1	A
Analgesics/Anti-inflammatories	*Ketoprofen*	254.29		C16H14O3	3.61	3.88	--	1.51	0.18	-1	A
Analgesics/Anti-inflammatories	*Meclofenamic acid*	296.15		C14H11Cl2NO2	6.09	3.79	--	3.90	2.64	-1	A
Analgesics/Anti-inflammatories	*Mefenamic acid*	241.29		C15H15NO2	5.40	3.89	--	3.30	1.97	-1	A
Analgesics/Anti-inflammatories	*Morphine*	285.34		C17H19NO3	0.90	10.26	9.12	-1.83	-0.03	0.99	C
Analgesics/Anti-inflammatories	*N-acetyl-4-aminoantipyrine*	245.28		C13H15N3O2	0.15	12.52	--	0.15	0.15	0	N
Analgesics/Anti-inflammatories	*Naproxen*	230.26		C14H14O3	2.99	4.19	--	1.18	-0.36	-1	A
Analgesics/Anti-inflammatories	*Paracetamol/ Acetaminophen*	151.17		C8H9NO2	0.91	9.46	--	0.91	0.89	0	N

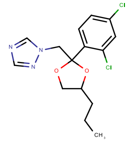
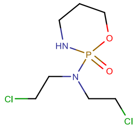
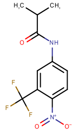
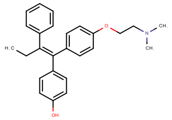
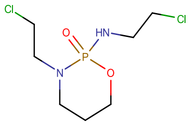
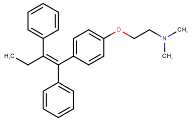
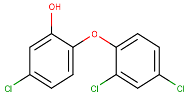
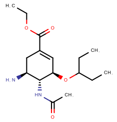
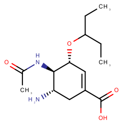
Class	Compound	Molecular Weight (g/mol)	Structure	Molecular formula	Log K_{ow}	Strongest acidic pK_a	Strongest basic pK_a	Log D_{ow} (pH=6)	Log D_{ow} (pH=8)	Charge (pH=7)	A,N,Z,C*
Analgesics/Anti-inflammatories	*Salicylic acid*	138.12		C7H6O3	1.98	2.79	--	-1.06	-1.54	-1	A
Analgesics/Anti-inflammatories	*Tramadol*	263.38		C16H25NO2	2.45	13.80	9.23	-0.59	1.20	0.99	C
Anaesthetics	*Lidocaine*	234.34		C14H22N2O	2.84	13.78	7.75	1.09	2.65	0.85	C
Anaesthetics	*Thiopental*	242.34		C11H18N2O2S	2.78	7.20	--	2.76	1.95	-0.39	N/A
Antibacterials	*Amoxicillin*	365.40		C16H19N3O5S	-2.31	3.23	7.22	-2.32	-3.04	-0.38	Z
Antibacterials	*Ampicillin*	349.41		C16H19N3O4S	-2.00	3.24	7.23	-2.02	-2.72	-0.37	Z
Antibacterials	*Azithromycin*	749.00		C38H72N2O12	2.44	12.43	9.57	-3.64	-0.08	1.99	C
Antibacterials	*Cephalexin*	347.39		C16H17N3O4S	-2.14	3.26	7.23	-2.16	-2.85	-0.37	Z

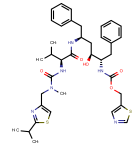
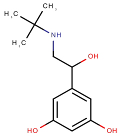
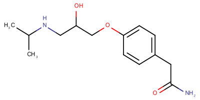
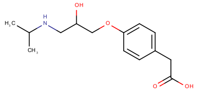
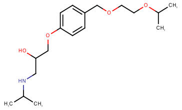
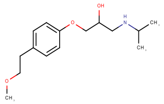
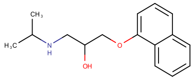
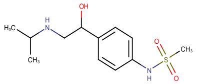
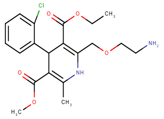
Class	Compound	Molecular Weight (g/mol)	Structure	Molecular formula	Log K_{ow}	Strongest acidic pK_a	Strongest basic pK_a	Log D_{ow} (pH=6)	Log D_{ow} (pH=8)	Charge (pH=7)	A,N,Z,C*
Antibacterials	*Ciprofloxacin*	331.35		C17H18FN3O3	-0.86	5.56	8.77	-0.96	-0.91	0.05	Z
Antibacterials	*Clarithromycin*	747.96		C38H69NO13	3.24	12.46	9.00	0.36	2.20	0.99	C
Antibacterials	*Clindamycin*	424.98		C18H33ClN2O5S	1.04	12.41	7.55	-0.52	0.91	0.78	C
Antibacterials	*Doxycycline*	444.44		C22H24N2O8	-3.34	3.27	8.33	-3.35	-4.14	-0.34	Z
Antibacterials	*Erythromycin*	733.94		C37H67NO13	2.60	12.45	9.00	-0.29	1.55	0.99	C
Antibacterials	*Flumequine*	261.25		C14H12FNO3	2.42	5.81	--	2.01	0.25	-0.94	A
Antibacterials	*Lincomycin*	406.54		C18H34N2O6S	-0.32	12.37	7.97	-2.28	-0.60	0.9	C
Antibacterials	*Metronidazole*	171.16		C6H9N3O3	-0.46	15.41	3.03	-0.46	-0.46	0	Z

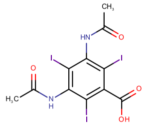
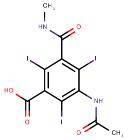
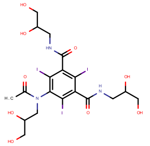
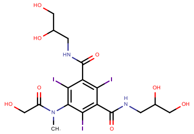
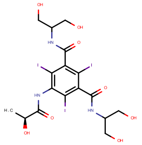
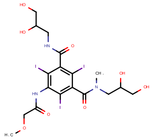
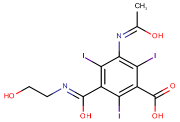
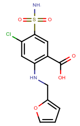
Class	Compound	Molecular Weight (g/mol)	Structure	Molecular formula	Log K_{ow}	Strongest acidic pK_a	Strongest basic pK_a	Log D_{ow} (pH=6)	Log D_{ow} (pH=8)	Charge (pH=7)	A,N,Z,C*
Antibacterials	*N4-acetylsulfamethoxazole*	295.31		C12H13N3O4S	0.86	5.88	0.38	0.55	-0.06	-0.93	A
Antibacterials	*Norfloxacin*	319.34		C16H18FN3O3	-0.97	5.58	8.77	-1.07	-1.01	0.05	Z
Antibacterials	*Ofloxacin*	361.37		C18H20FN3O4	0.09	5.35	6.72	0.09	-1.02	-0.61	Z
Antibacterials	*Oxolinic acid*	261.23		C13H11NO5	1.35	5.39	--	0.65	-1.21	-0.98	A
Antibacterials	*Oxytetracycline*	460.44		C22H24N2O9	-4.54	3.18	8.29	-4.56	-5.46	-0.4	N/A
Antibacterials	*Rifaximin*	785.89		C43H51N3O11	4.59	6.69	5.88	4.59	3.14	--	--
Antibacterials	*Roxithromycin*	837.06		C41H76N2O15	3.00	12.45	9.08	0.06	1.89	0.99	C
Antibacterials	*Sulfadiazine*	250.28		C10H10N4O2S	0.39	6.99	2.01	0.35	-0.33	-0.51	N/A
Antibacterials	*Sulfamerazine*	264.30		C11H12N4O2S	0.52	6.99	2.00	0.48	-0.20	-0.5	N/A

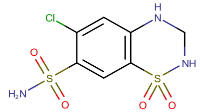
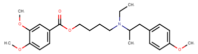
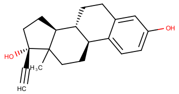
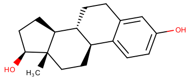
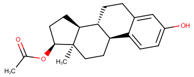
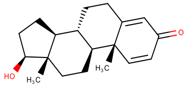
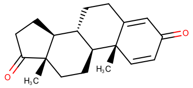
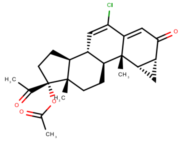
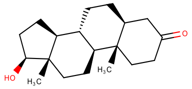
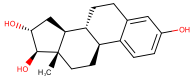
Class	Compound	Molecular Weight (g/mol)	Structure	Molecular formula	Log K_{ow}	Strongest acidic pK_a	Strongest basic pK_a	Log D_{ow} (pH=6)	Log D_{ow} (pH=8)	Charge (pH=7)	A,N,Z,C*
Antibacterials	*Sulfamethoxazole*	253.28		$C_{10}H_{11}N_3O_3S$	0.79	6.16	1.97	0.60	-0.11	-0.87	A
Antibacterials	*Sulfamethoxypyridazine*	280.30		$C_{11}H_{12}N_4O_3S$	0.47	6.84	2.02	0.41	-0.30	-0.59	N/A
Antibacterials	*Sulfamoxole*	267.30		$C_{11}H_{13}N_3O_3S$	0.59	6.81	1.94	0.53	-0.19	-0.61	N/A
Antibacterials	*Sulfapyridine*	249.29		$C_{11}H_{11}N_3O_2S$	1.01	6.24	2.14	0.84	0.12	-0.85	A
Antibacterials	*Sulfathiazole*	255.31		$C_9H_9N_3O_2S_2$	0.98	6.93	2.04	0.93	0.24	-0.54	N/A
Antibacterials	*Sulfisoxazole*	267.30		$C_{11}H_{13}N_3O_3S$	0.73	5.80	2.17	0.39	-0.19	-0.94	A
Antibacterials	*Tetracycline*	444.44		$C_{22}H_{24}N_2O_8$	-3.49	3.26	9.25	-3.50	-4.28	-0.32	Z
Antibacterials	*Trimethoprim*	290.32		$C_{14}H_{18}N_4O_3$	1.28	17.33	7.16	0.27	1.23	0.93	N/C

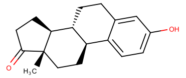
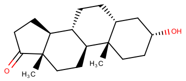
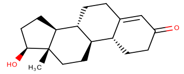
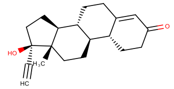
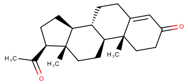
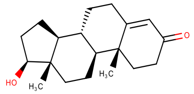
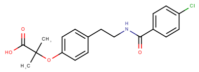
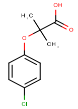
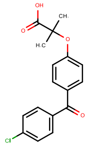
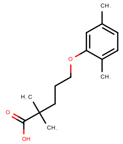
Class	**Compound**	**Molecular Weight (g/mol)**	**Structure**	**Molecular formula**	**Log K_{ow}**	**Strongest acidic pK_a**	**Strongest basic pK_a**	**Log D_{ow} (pH=6)**	**Log D_{ow} (pH=8)**	**Charge (pH=7)**	**A,N,Z,C***
Anticoagulants	*Warfarin*	308.33		C19H16O4	2.74	5.56	--	2.17	0.45	-0.96	A
Antidiabetics	*Metformin*	129.17		C4H11N5	-0.92	19.17	12.33	-5.74	-5.37	2	C
Anti-histamines	*Diphenhydramine*	255.36		C17H21NO	3.65	--	8.87	0.87	2.73	0.99	C
Anti-hypertensives	*3-(3,4-Dimethoxyphenyl)-2-methyl-6-methylaminohexane-3-carbonitrile (D617)*	290.41		C17H26N2O2	2.96	--	10.54	-0.26	0.50	1	C
Anti-hypertensives	*Enalapril*	376.45		C20H28N2O5	0.59	3.67	5.20	-0.07	-1.22	-0.98	A
Anti-hypertensives	*Verapamil*	454.61		C27H38N2O4	5.04	--	9.68	1.76	3.36	1	C
Antimycotics	*Carbendazim*	191.19		C9H9N3O2	1.80	9.70	4.28	1.79	1.79	0	N
Antimycotics	*Fluconazole*	306.28		C13H12F2N6O	0.56	12.68	2.30	0.56	0.56	0	N
Antimycotics	*Ketoconazole*	531.43		C26H28Cl2N4O4	4.19	--	6.42	3.85	4.18	0.21	N/C

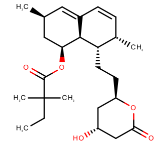
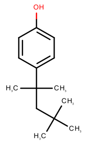
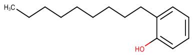
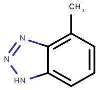
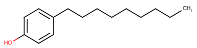
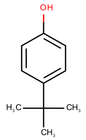
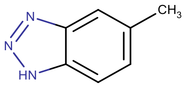
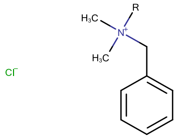
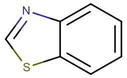
Class	**Compound**	**Molecular Weight (g/mol)**	**Structure**	**Molecular formula**	**Log K_{ow}**	**Strongest acidic pK_a**	**Strongest basic pK_a**	**Log D_{ow} (pH=6)**	**Log D_{ow} (pH=8)**	**Charge (pH=7)**	**A,N,Z,C***
Antimycotics	*Propiconazole*	342.22		C15H17Cl2N3O2	4.33	--	1.95	4.33	4.33	0	N
Antineoplastics	*Cyclophosphamide*	261.08		C7H15Cl2N2O2P	0.10	13.48	--	0.10	0.10	0	N
Antineoplastics	*Flutamide*	276.22		C11H11F3N2O3	3.27	12.81	--	3.27	3.27	0	Z
Antineoplastics	*Hydroxytamoxifen*	387.52		C26H29NO2	5.69	9.45	8.66	3.36	5.20	0.97	C
Antineoplastics	*Ifosfamide*	261.08		C7H15Cl2N2O2P	0.10	14.64	--	0.10	0.10	0	N
Antineoplastics	*Tamoxifen*	371.52		C26H29NO	6.35	--	8.76	3.66	5.52	0.98	C
Antiseptics	*Triclosan*	289.54		C12H7Cl3O2	4.98	7.68	--	4.97	4.50	-0.17	N/A
Antivirals	*Oseltamivir*	312.41		C16H28N2O4	1.16	14.03	9.26	-1.67	-0.11	0.99	C
Antivirals	*Oseltamivir carboxylate*	284.36		C14H24N2O4	-1.84	4.19	9.29	-1.84	-1.86	0	Z

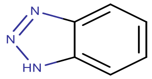
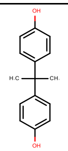
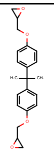
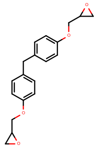
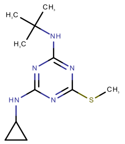
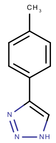
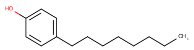
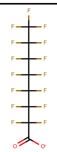
Class	**Compound**	**Molecular Weight (g/mol)**	**Structure**	**Molecular formula**	**Log K_{ow}**	**Strongest acidic pK_a**	**Strongest basic pK_a**	**Log D_{ow} (pH=6)**	**Log D_{ow} (pH=8)**	**Charge (pH=7)**	**A,N,Z,C***
Antivirals	*Ritonavir*	720.95		C37H48N6O5S2	5.22	13.68	2.84	5.22	5.22	0	N
Beta-agonists	*Terbutaline*	225.29		C12H19NO3	0.44	8.86	9.76	-1.70	-0.19	0.98	C
Beta-blockers	*Atenolol*	266.34		C14H22N2O3	0.43	14.08	9.67	-2.68	-1.24	1	C
Beta-blockers	*Atenolol acid*	267.33		C14H21NO4	-1.24	3.54	9.67	-1.24	-1.25	0	Z
Beta-blockers	*Bisoprolol*	325.45		C18H31NO4	2.20	14.09	9.67	-0.91	0.53	1	C
Beta-blockers	*Metoprolol*	267.37		C15H25NO3	1.76	14.09	9.67	-1.34	0.09	1	C
Beta-blockers	*Propranolol*	259.35		C16H21NO2	2.58	14.09	9.67	-0.52	0.92	1	C
Beta-blockers	*Sotalol*	272.36		C12H20N2O3S	-0.40	10.07	9.43	-3.04	-1.56	0.99	C
Calcium channel blockers	*Amlodipine*	408.88		C20H25ClN2O5	1.64	16.62	9.30	-1.21	0.33	0.99	C

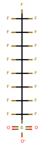
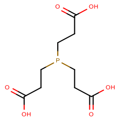
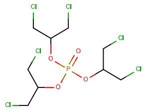
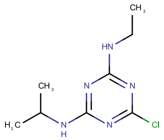
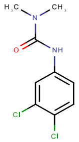
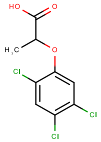
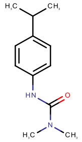
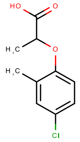
Class	Compound	Molecular Weight (g/mol)	Structure	Molecular formula	Log K_{ow}	Strongest acidic pK_a	Strongest basic pK_a	Log D_{ow} (pH=6)	Log D_{ow} (pH=8)	Charge (pH=7)	A,N,Z,C*
Contrast media	*Amidotrizoic acid (diatrizoate)*	613.92		C11H9I3N2O4	2.89	2.17	--	-0.46	-0.63	-1	A
Contrast media	*Iothalamic acid*	613.92		C11H9I3N2O4	2.73	2.13	--	-0.64	-0.80	-1	A
Contrast media	*Iohexol*	821.14		C19H26I3N3O9	-1.95	11.73	--	-1.95	-1.95	0	N
Contrast media	*Iomeprol*	777.09		C17H22I3N3O8	-1.45	11.73	--	-1.45	-1.45	0	N
Contrast media	*Iopamidol*	777.09		C17H22I3N3O8	-0.74	11.00	--	-0.74	-0.74	0	N
Contrast media	*Iopromide*	791.12		C18H24I3N3O8	-0.44	11.09	--	-0.44	-0.45	0	N
Contrast media	*Ioxitalamic acid*	643.94		C12H11I3N2O5	3.23	2.87	1.91	-1.17	-4.89	-0.94	A
Diuretics	*Furosemide*	330.74		C12H11ClN2O5S	1.75	4.25	--	0.00	-1.58	-1	A

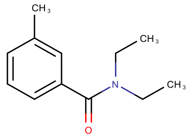
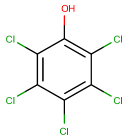
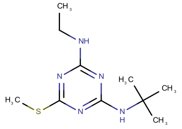
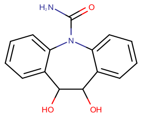
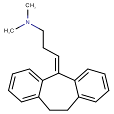
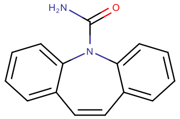
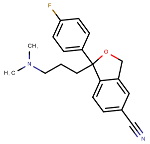
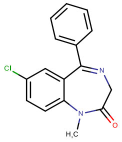
Class	**Compound**	**Molecular Weight (g/mol)**	**Structure**	**Molecular formula**	**Log K_{ow}**	**Strongest acidic pK_a**	**Strongest basic pK_a**	**Log D_{ow} (pH=6)**	**Log D_{ow} (pH=8)**	**Charge (pH=7)**	**A,N,Z,C***
Diuretics	*Hydrochlorothiazide*	297.73		C7H8ClN3O4S2	-0.58	9.09	--	-0.58	-0.61	0	N
Gastrointestinal disorder drugs	*Mebeverine*	429.56		C25H35NO5	4.89	--	10.31	1.45	2.60	1	C
Hormones	*17α-ethinylestradiol (EE2)*	296.41		C20H24O2	3.90	10.33	--	3.90	3.90	0	N
Hormones	*17β-estradiol (Estradiol/E2β)*	272.39		C18H24O2	3.75	10.33	--	3.75	3.74	0	N
Hormones	*17β-estradiol-acetate*	314.43		C20H26O3	4.19	10.33	--	4.19	4.18	0	N
Hormones	*Boldenone*	286.42		C19H26O2	3.36	18.39	--	3.36	3.36	0	N
Hormones	*Boldione*	284.40		C19H24O2	3.93	18.39	--	3.93	3.93	0	N
Hormones	*Cyproterone acetate*	416.94		C24H29ClO4	3.64	17.83	--	3.64	3.64	0	N
Hormones	*Dihydrotestosterone*	290.45		C19H30O2	3.41	19.38	--	3.41	3.41	0	N
Hormones	*Estriol (E3)*	288.39		C18H24O3	2.67	10.33	--	2.67	2.67	0	N

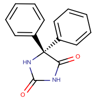
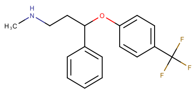
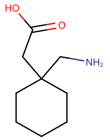
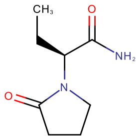
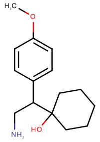
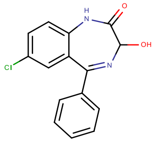
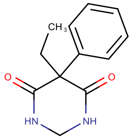
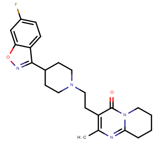
Class	**Compound**	**Molecular Weight (g/mol)**	**Structure**	**Molecular formula**	**Log K_{ow}**	**Strongest acidic pK_a**	**Strongest basic pK_a**	**Log D_{ow} (pH=6)**	**Log D_{ow} (pH=8)**	**Charge (pH=7)**	**A,N,Z,C***
Hormones	*Estrone (E1)*	270.37		C18H22O2	4.31	10.33	--	4.31	4.31	0	N
Hormones	*Etiocholanolone*	290.45		C19H30O2	3.77	18.30	--	3.77	3.77	0	N
Hormones	*Nandrolone*	274.40		C18H26O2	3.07	18.25	--	3.07	3.07	0	N
Hormones	*Norethindrone*	298.43		C20H26O2	3.22	17.59	--	3.22	3.22	0	N
Hormones	*Progesterone*	314.47		C21H30O2	4.15	18.47	--	4.15	4.15	0	N
Hormones	*Testosterone*	288.43		C19H28O2	3.37	18.52	--	3.37	3.37	0	N
Lipid regulators	*Bezafibrate*	361.82		C19H20ClNO4	3.99	3.83	--	1.83	0.55	-1	A
Lipid regulators	*Clofibric acid*	214.65		C10H11ClO3	2.90	3.37	--	0.32	-0.60	-1	A
Lipid regulators	*Fenofibric acid*	318.75		C17H15ClO4	4.36	3.10	--	1.55	0.85	-1	A
Lipid regulators	*Gemfibrozil*	250.34		C15H22O3	4.39	4.42	--	2.80	1.14	-1	A

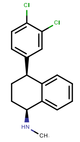
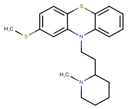
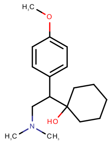
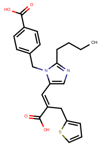
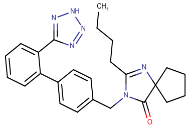
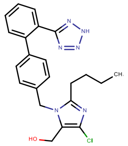
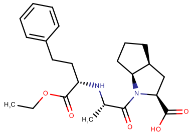
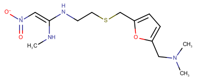
Class	Compound	Molecular Weight (g/mol)	Structure	Molecular formula	Log K_{ow}	Strongest acidic pK_a	Strongest basic pK_a	Log D_{ow} (pH=6)	Log D_{ow} (pH=8)	Charge (pH=7)	A,N,Z,C*
Lipid regulators	*Simvastatin*	418.57		C25H38O5	4.46	14.91	--	4.46	4.46	0	N
Non-ionic surfactants	*4-tert-octylphenol*	206.33		C14H22O	4.69	10.23	--	4.69	4.69	0	N
Non-ionic surfactants	*Nonylphenol*	220.36		C15H24O	5.74	10.30	--	5.74	5.74	0	N
Other	*4-Methylbenzotriazole*	133.15		C7H7N3	1.81	8.93	0.78	1.81	1.77	0	N
Other	*4-n-nonylphenol*	220.36		C15H24O	5.74	10.31	--	5.74	5.74	0	N
Other	*4-tert-butylphenol*	150.22		C10H14O	3.21	10.24	--	3.21	3.21	0	N
Other	*5-Methylbenzotriazole*	133.15		C7H7N3	1.81	8.86	1.02	1.81	1.76	0	N
Other	*Benzalkonium chloride*	170.66		C9H13ClN	1.68	17.90	--	1.68	1.68	--	--
Other	*Benzothiazole*	135.18		C7H5NS	2.11	--	2.28	2.11	2.11	0	N

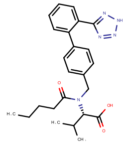
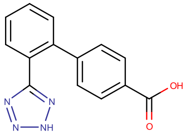
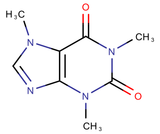
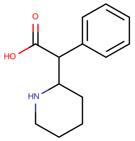
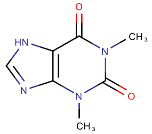
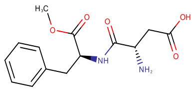
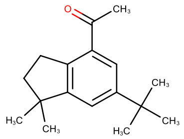
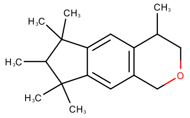
Class	Compound	Molecular Weight (g/mol)	Structure	Molecular formula	Log K_{ow}	Strongest acidic pK_a	Strongest basic pK_a	Log D_{ow} (pH=6)	Log D_{ow} (pH=8)	Charge (pH=7)	A,N,Z,C*
Other	*Benzotriazole*	119.13		C6H5N3	1.30	8.63	0.60	1.30	1.21	0	N
Other	*Bisphenol A*	228.29		C15H16O2	4.04	9.78	--	4.04	4.04	0	N
Other	*Bisphenol A diglycidyl ether*	340.42		C21H24O4	4.02	--	--	4.02	4.02	0	N
Other	*Bisphenol F diglycidyl ether*	312.37		C19H20O4	3.43	--	--	3.43	3.43	0	N
Other	*Irgarol (Cybutryne)*	253.37		C11H19N5S	2.99	14.13	6.68	2.24	2.97	0.32	N/C
Other	*Methylbenzotriazole*	159.19		C9H9N3	2.44	8.95	0.10	2.44	2.40	0	N
Other	*Octylphenol*	206.33		C14H22O	5.30	10.31	--	5.30	5.29	0	N
Other	*Perfluorooctanoate (PFOA)*	413.06		C8F15O2	5.11	--	--	1.58	1.58	-1	A

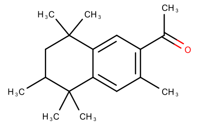
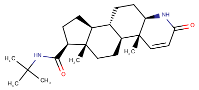
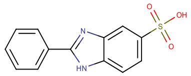
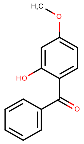
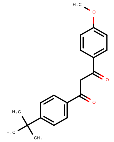
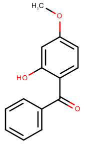
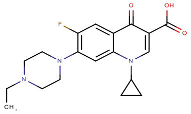
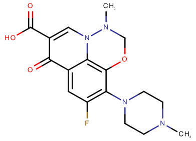
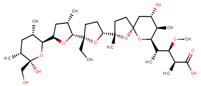
Class	Compound	Molecular Weight (g/mol)	Structure	Molecular formula	Log K_{ow}	Strongest acidic pK_a	Strongest basic pK_a	Log D_{ow} (pH=6)	Log D_{ow} (pH=8)	Charge (pH=7)	A,N,Z,C*
Other	*Perfluorooctane sulfonate (PFOS)*	499.12		C8F17O3S	5.43	--	--	3.05	3.05	-1	A
Other	*tris(2-carboxyethyl) phosphine (TCEP)*	250.19		C9H15O6P	-1.24	3.22	8.94	-7.30	-10.78	-2.01	A
Other	*tris(1,3-dichloroisopropyl) phosphate (TDCPP)*	430.89		C9H15Cl6O4P	4.28	--	--	4.28	4.28	0	N
Pesticides	*Atrazine*	215.69		C8H14ClN5	2.20	14.48	4.20	2.19	2.20	0	N
Pesticides	*Diuron*	233.09		C9H10Cl2N2O	2.53	13.18	--	2.53	2.53	0	N
Pesticides	*Fenoprop*	269.50		C9H7Cl3O3	3.67	2.70	--	0.57	0.15	-1	A
Pesticides	*Isoproturon*	206.29		C12H18N2O	2.57	13.79	--	2.57	2.57	0	N
Pesticides	*Mecoprop*	214.65		C10H11ClO3	2.98	3.47	--	0.49	-0.51	-1	A

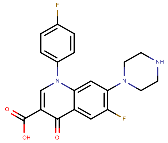
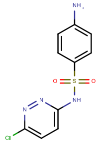
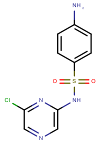
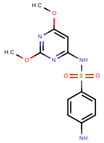
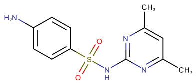
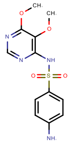
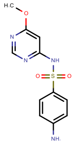
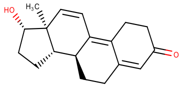
Class	Compound	Molecular Weight (g/mol)	Structure	Molecular formula	Log K_{ow}	Strongest acidic pK_a	Strongest basic pK_a	Log D_{ow} (pH=6)	Log D_{ow} (pH=8)	Charge (pH=7)	A,N,Z,C*
Pesticides	*N,N-diethyl-m-toluamide (DEET)*	191.27		C12H17NO	2.50	--	--	2.50	2.50	0	N
Pesticides	*Pentachlorophenol*	266.32		C6HCl5O	4.69	4.98	--	3.67	2.68	-0.99	A
Pesticides	*Terbutryn*	241.36		C10H19N5S	2.88	14.31	6.72	2.11	2.85	0.34	N/C
Psychiatric drugs	*10,11-Dihydro-10,11-dihydroxycarbamazepine*	270.29		C15H14N2O3	0.81	12.84	--	0.81	0.81	0	N
Psychiatric drugs	*Amitriptyline*	277.41		C20H23N	4.81	--	9.76	1.50	3.05	1	C
Psychiatric drugs	*Carbamazepine*	236.27		C15H12N2O	2.77	15.96	--	2.77	2.77	0	N
Psychiatric drugs	*Citalopram*	324.40		C20H21FN2O	3.76	--	9.78	0.44	1.98	1	C
Psychiatric drugs	*Diazepam*	284.74		C16H13ClN2O	3.08	--	2.92	3.08	3.08	0	N

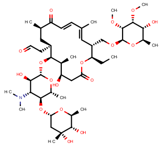
Class	Compound	Molecular Weight (g/mol)	Structure	Molecular formula	Log K_{ow}	Strongest acidic pK_a	Strongest basic pK_a	Log D_{ow} (pH=6)	Log D_{ow} (pH=8)	Charge (pH=7)	A,N,Z,C*
Psychiatric drugs	*Dilantin*	252.27		C15H12N2O2	2.15	8.49	--	2.15	2.03	0	N
Psychiatric drugs	*Fluoxetine*	309.33		C17H18F3NO	4.17	--	9.80	1.04	2.38	1	C
Psychiatric drugs	*Gabapentin*	171.24		C9H17NO2	-1.27	4.63	9.91	-1.29	-1.28	0.01	Z
Psychiatric drugs	*Levetiracetam*	170.21		C8H14N2O2	-0.59	16.09	--	-0.59	-0.59	0	N
Psychiatric drugs	*N,N-didesvenlafaxine*	249.35		C15H23NO2	1.92	14.42	9.43	-0.96	0.49	1	C
Psychiatric drugs	*Oxazepam*	286.72		C15H11ClN2O2	2.92	10.61	--	2.92	2.92	0	N
Psychiatric drugs	*Primidone*	218.26		C12H14N2O2	1.12	11.50	--	1.12	1.12	0	N
Psychiatric drugs	*Risperidone*	410.49		C23H27FN4O2	2.63	--	8.76	-0.08	1.80	0.99	C

Class	**Compound**	**Molecular Weight (g/mol)**	**Structure**	**Molecular formula**	**Log K_{ow}**	**Strongest acidic pK_a**	**Strongest basic pK_a**	**Log D_{ow} (pH=6)**	**Log D_{ow} (pH=8)**	**Charge (pH=7)**	**A,N,Z,C***
Psychiatric drugs	*Sertraline*	306.23		C17H17Cl2N	5.15	--	9.56	2.08	3.58	1	C
Psychiatric drugs	*Thioridazine*	370.57		C21H26N2S2	5.47	--	8.93	2.64	4.49	0.99	C
Psychiatric drugs	*Venlafaxine*	277.41		C17H27NO2	2.74	14.42	8.91	-0.07	1.78	0.99	C
Receptor antagonists	*Eprosartan*	424.52		C23H24N2O4S	3.75	3.47	6.67	2.02	-0.78	-1.68	A
Receptor antagonists	*Irbesartan*	428.54		C25H28N6O	5.39	5.85	4.12	5.13	4.04	-0.93	A
Receptor antagonists	*Losartan*	422.92		C22H23ClN6O	5.00	5.85	3.85	4.72	3.63	-0.93	A
Receptor antagonists	*Ramipril*	416.52		C23H32N2O5	1.47	3.75	5.20	0.84	-0.36	-0.98	A
Receptor antagonists	*Ranitidine*	314.40		C13H22N4O3S	0.99	--	7.80	-0.80	0.78	0.86	Z

Class	Compound	Molecular Weight (g/mol)	Structure	Molecular formula	Log K_{ow}	Strongest acidic pK_a	Strongest basic pK_a	Log D_{ow} (pH=6)	Log D_{ow} (pH=8)	Charge (pH=7)	A,N,Z,C*
Receptor antagonists	*Valsartan*	435.53		C24H29N5O3	5.27	4.35	--	3.27	0.50	-1.93	A
Receptor antagonists	*Valsartan acid*	266.26		C14H10N4O2	3.18	4.03	--	0.85	-1.71	-1.93	A
Stimulant	*Caffeine*	194.19		C8H10N4O2	-0.55	--	--	-0.55	-0.55	0	N
Stimulant	*Ritalinic acid*	219.28		C13H17NO2	-0.36	3.73	10.08	-0.36	-0.37	0	Z
Stimulant	*Theophylline*	180.17		C7H8N4O2	-0.77	7.82	--	-0.78	-1.11	-0.13	N/A
Sweetener	*Aspartame*	294.31		C14H18N2O5	-2.22	3.53	8.53	-2.22	-2.32	-0.03	Z
Synthetic musks	*Celestolide*	244.38		C17H24O	4.67	16.18	--	4.67	4.67	0	N
Synthetic musks	*Galaxolide*	258.41		C18H26O	4.72	--	--	4.72	4.72	0	N

Class	**Compound**	**Molecular Weight (g/mol)**	**Structure**	**Molecular formula**	**Log K_{ow}**	**Strongest acidic pK_a**	**Strongest basic pK_a**	**Log D_{ow} (pH=6)**	**Log D_{ow} (pH=8)**	**Charge (pH=7)**	**A,N,Z,C***
Synthetic musks	*Tonalide*	258.41		C18H26O	4.96	16.30	--	4.96	4.96	0	N
Urological drug	*Finasteride*	372.55		C23H36N2O2	3.07	14.53	0.33	3.07	3.07	0	N
UV filters	*2-phenyl-5-benzimidazolesulfonic acid*	274.29		C13H10N2O3S	-0.14	--	4.55	0.08	0.09	-1	A
UV filters	*Benzophenone-3*	228.25		C14H12O3	3.62	7.07	--	3.59	2.67	-0.46	A
UV filters	*Butyl methoxydibenzoylmethane*	310.39		C20H22O3	4.56	9.92	--	4.56	4.56	0	N
UV filters	*Oxybenzone*	228.25		C14H12O3	3.62	7.07	--	3.59	2.67	-0.46	N/A
Veterinary drugs	*Enrofloxacin*	359.40		C19H22FN3O3	0.51	5.55	7.24	0.51	-0.14	-0.3	Z
Veterinary drugs	*Marbofloxacin*	362.36		C17H19FN4O4	-0.61	5.28	6.69	-0.61	-1.74	-0.63	Z
Veterinary drugs	*Monensin*	670.88		C36H62O11	4.82	4.24	--	3.05	1.49	-1	A

Class	Compound	Molecular Weight (g/mol)	Structure	Molecular formula	Log K_{ow}	Strongest acidic pK_a	Strongest basic pK_a	Log D_{ow} (pH=6)	Log D_{ow} (pH=8)	Charge (pH=7)	A,N,Z,C*
Veterinary drugs	*Sarafloxacin*	385.37		C20H17F2N3O3	0.52	5.55	8.76	0.43	0.47	0.05	Z
Veterinary drugs	*Sulfachloropyridazine*	284.72		C10H9ClN4O2S	0.85	6.60	2.02	0.77	0.02	-0.72	N/A
Veterinary drugs	*Sulfaclozine*	284.72		C10H9ClN4O2S	0.62	6.49	1.90	0.51	-0.24	-0.76	N/A
Veterinary drugs	*Sulfadimethoxine*	310.33		C12H14N4O4S	1.26	6.91	1.99	1.22	0.52	-0.55	N/A
Veterinary drugs	*Sulfadimidine*	278.33		C12H14N4O2S	0.65	6.99	2.00	0.61	-0.06	-0.5	N/A
Veterinary drugs	*Sulfadoxine*	310.33		C12H14N4O4S	0.58	6.12	3.44	0.37	-0.32	-0.88	A
Veterinary drugs	*Sulfamonomethoxine*	280.30		C11H12N4O3S	0.74	7.15	3.53	0.71	0.09	-0.41	N/A
Veterinary drugs	*Trenbolone*	270.37		C18H22O2	2.25	18.40	--	2.25	2.25	0	N

Class	**Compound**	**Molecular Weight (g/mol)**	**Structure**	**Molecular formula**	**Log K_{ow}**	**Strongest acidic pK_a**	**Strongest basic pK_a**	**Log D_{ow} (pH=6)**	**Log D_{ow} (pH=8)**	**Charge (pH=7)**	**A,N,Z,C***
Veterinary drugs	*Tylosin*	916.11		C46H77NO17	2.32	12.45	8.43	-0.08	1.75	0.96	C

***A**=anionic, **N**=neutral, **Z**=zwitterionic, **C**=cationic (at pH=7)

Source: J Chem for Office was used for calculating the physical and chemical properties, JChem for Office 20.11.0, ChemAxon (https://www.chemaxon.com). Last access on 4 February 2021

Table S2: Main characteristics of the peer reviewed studies included in this survey (See Excel file)

Table S3: Compounds for which the removal in MBR is equal or higher than the removal achieved in MBR+PAC, (corresponding reference in the first column). Removal efficiencies are considered the same if the difference between the two percentages is less than 2. The reported value is the highest one.

Paper	***Compounds*** $(\eta_{MBR} = \eta_{MBR+PAC})$	***Compounds*** $(\eta_{MBR} > \eta_{MBR+PAC})$
(Alvarino et al., 2016)	ibuprofen *(≈98%)*; sulfamethoxazole (*≈93%)*	--
(Alvarino et al., 2017)	17-α ethinylestradiol (EE2) *(≈96% (UF));* ibuprofen *(≈93% (MF), ≈99.9% (UF))*; diclofenac *(≈63% (UF));* estrone (E1) *(≈99% (MF), ≈99% (UF));* naproxen (*≈94% (MF));* roxithromycin (*≈99.9% (UF));* sulfamethoxazole *(≈82% (MF))*	17-α ethinylestradiol (EE2) (*96%>87% (MF), 96%>91% (MF), 96%>89% (UF), 96%>84% (UF));* estrone (E1) (*99%>96% (UF), 99%>92% (UF)*); naproxen (*94%>91% (MF), 94%>90% (MF)*); sulfamethoxazole (*80%>73% (MF), 74%>68% (UF)*)
(Asif et al., 2020)	oxytetracycline *(≈99.9%);* paracetamol *(≈99.9%);* salicylic acid *(99.9%)*	--
(Echevarría et al., 2019)	atenolol *(≈97%)*; nonylphenol *(≈95%);* octylphenol *(89%);* paracetamol *(99%)*	sulfamethoxazole (*60%>54%*)
(Li et al., 2011)	--	sulfamethoxazole (*63%>40%*); carbamazepine (*12%>–90%*)
(Nguyen et al., 2013a)	17β-estradiol (Estradiol/E2ß) *(≈99.9%)*; 17β-estradiol-acetate *(≈99%)*; 4-n-nonylphenol *(97%);* 4-tert-butylphenol *(≈95%);* 4-tert-octylphenol *(≈98%);* estriol *(≈98%);* estrone *(≈97%);* gemfibrozil *(≈99%)*; ibuprofen *(≈96%)*; salicylic acid (*98%*); triclosan *(≈99%)*	estriol (E3) (*97%>86%*); paracetamol (*87%>81%*); salicylic acid (*98%>93%*)
(Remy et al., 2012)	caffeine *(99.9%)*	--

Table S4: Compounds for which the removal in MBR is equal or higher than the removal achieved in MBR→GAC, (corresponding reference in the first column). Removal efficiencies are considered the same if the difference between the two percentages is less than 2. The reported value is the highest one.

Reference	***Compounds*** ($\eta_{MBR} = \eta_{MBR\rightarrow GAC}$)	***Compounds*** ($\eta_{MBR} > \eta_{MBR+PAC}$)
(Nguyen et al., 2013a)	17β-estradiol (Estradiol / E2ß) *(≈99.9%)*; 17β-estradiol-acetate *(≈99.9%)*; 4-n-nonylphenol *(≈99%);* 4-tert-octylphenol *(≈99%)*; estriol (E3) *(≈99%)*; gemfibrozil *(≈99.9%)*; paracetamol *(87%)*; salicylic acid *(≈98%);* triclosan (*≈99.9%)*	--
(Nguyen et al., 2013b)	17α ethinylestradiol (EE2) *(≈96%);* 17β-estradiol (Estradiol / E2ß) *(99.9%)*; 17β-estradiol-acetate *(≈99.9%)*; 4-n-nonylphenol *(≈99.9%)*; 4-tert-octylphenol *(≈99.9%)*; bisphenol A *(99.9%)*; estriol (E3) *(≈99.9%)*; estrone (E1) *(≈99.9%)*; fenoprop *(32%)*; gemfibrozil *(≈99.9%)*; ibuprofen *(≈99.9%);* paracetamol *(96%)*; primidone *(99.9%);* salicylic acid *(≈99.9%)*; triclosan *(99.9%)*	--

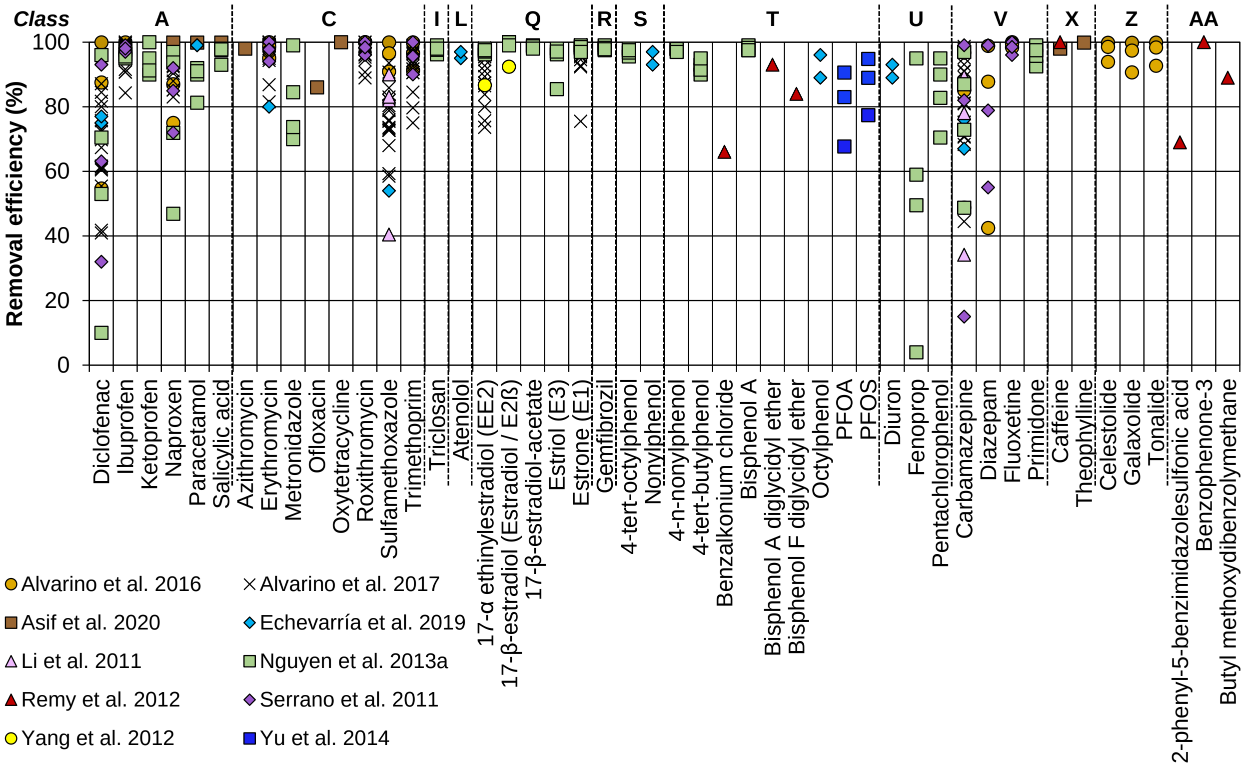


Figure S2. Removal efficiencies for the investigated compound in MBR+PAC with submerged and side stream membrane unit (see Table 1 of the manuscript) in the studies included in the review, reported in the legend. Data from: (Alvarino et al., 2017, 2016; Asif et al., 2020; Echevarría et al., 2019; Li et al., 2011; Nguyen et al., 2013a; Remy et al., 2012; Serrano et al., 2011; Yang et al., 2012; Yu et al., 2014)

Release of the compounds are not reported in the graph. Release data refer to carbamazepine, according to (Li et al., 2011).

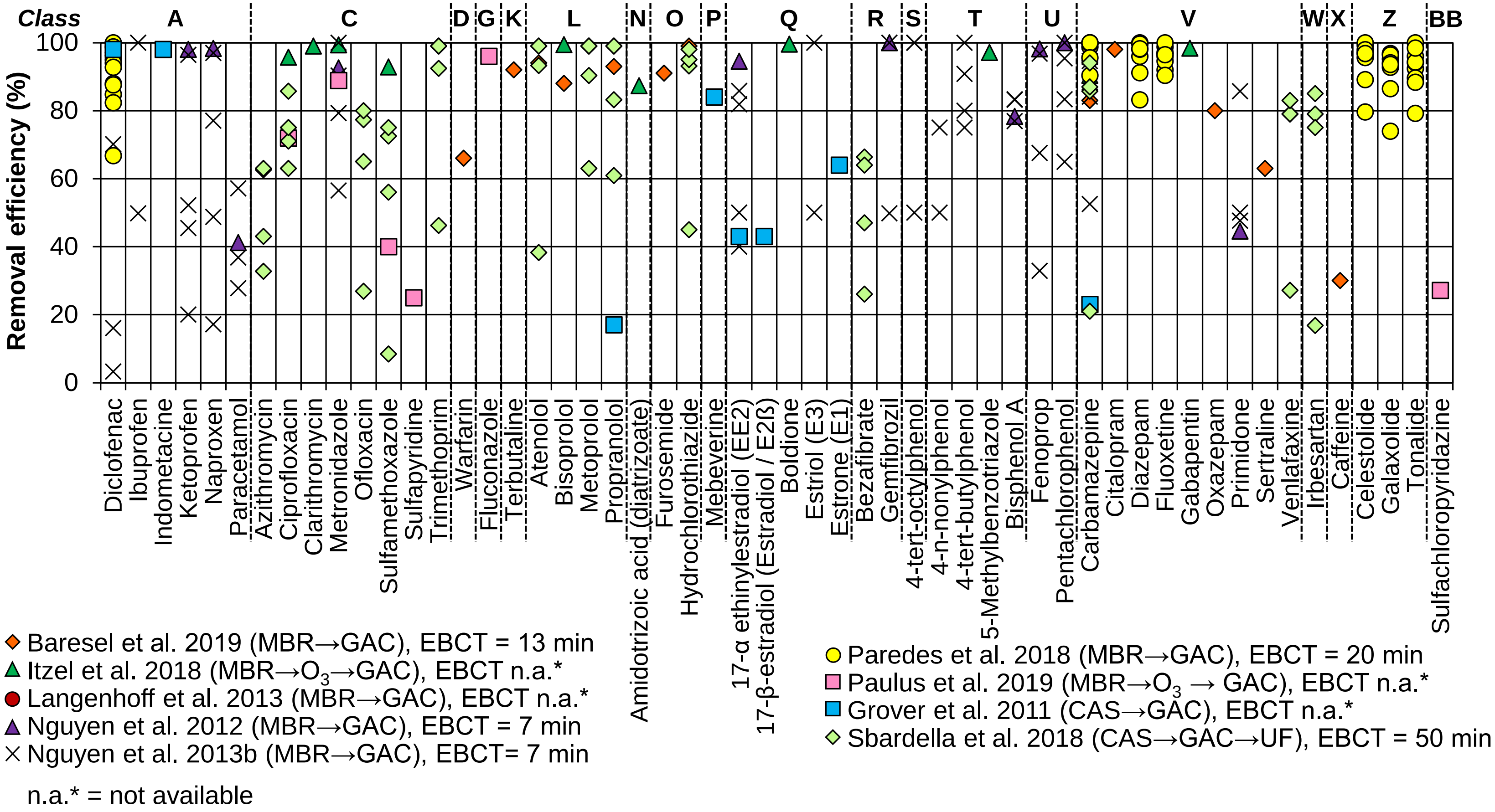


Figure S3. Removal efficiencies for the investigated MPs in GAC column acting as a post treatment (polishing) grouped according to the Authors. Plant configurations in which GAC is included are in brackets (as reported in Table 1 of the manuscript). Data from: (Baresel et al., 2019; Grover et al., 2011; Itzel et al., 2018; Langenhoff et al., 2013; Nguyen et al., 2013b, 2012; Paredes et al., 2018; Paulus et al., 2019; Sbardella et al., 2018)

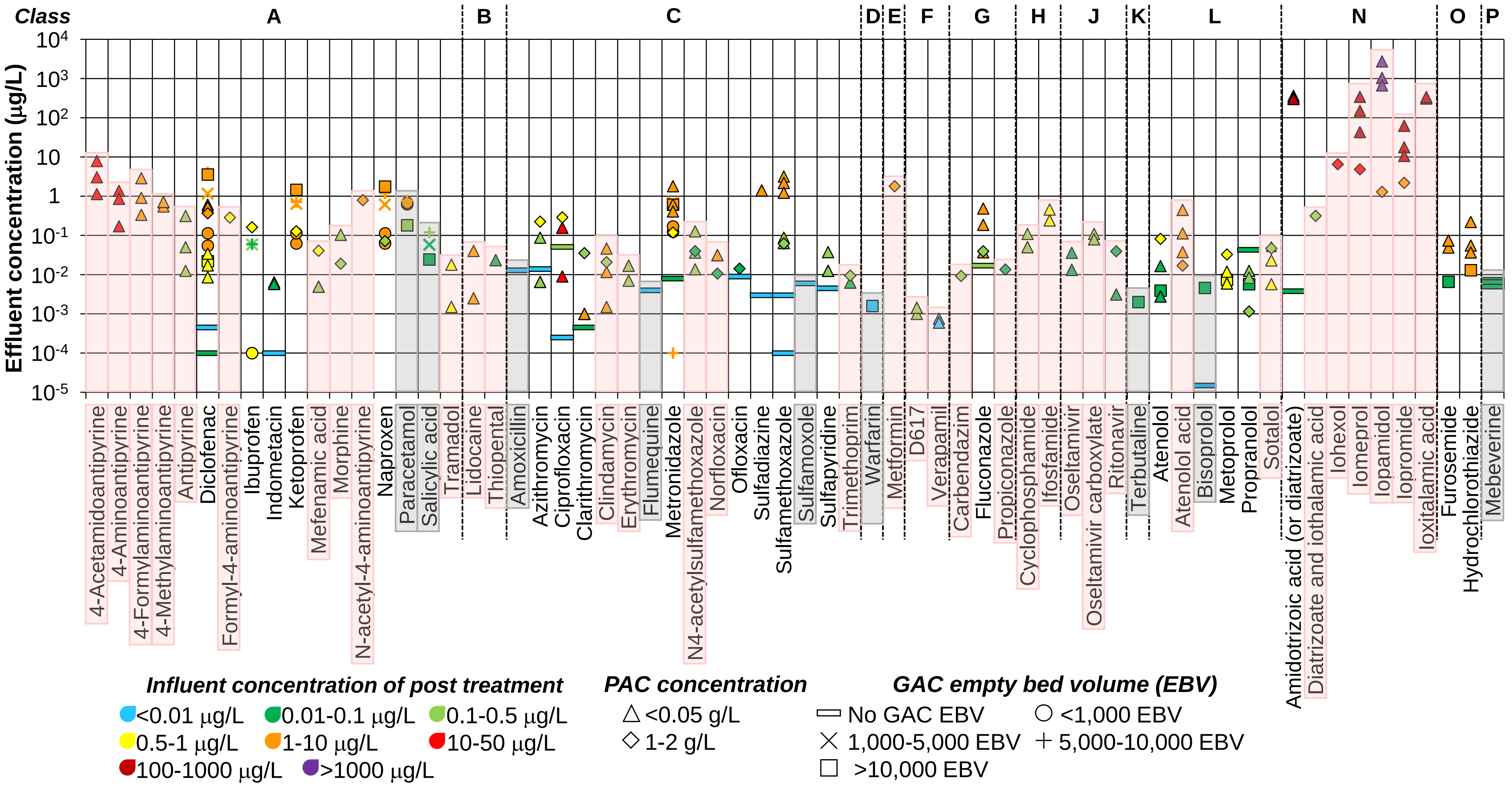


Figure S4. Concentration in the effluent of a PAC/GAC unit acting as a PT (part 1). Data from: (Baresel et al., 2019; Grover et al., 2011; Itzel et al., 2018; Kovalova et al., 2013; Löwenberg et al., 2014; Margot et al., 2013; Nguyen et al., 2013b, 2012; Paulus et al., 2019). It is important to remark that the investigated configurations in (Itzel et al., 2018) and (Paulus et al., 2019) include an ozonation step between the MBR and the GAC unit and the reported values of removal efficiencies refer to the whole treatment train. Compounds in light pink refer to only PAC and in light grey to only GAC. Those not highlighted refer to both PAC and GAC units.

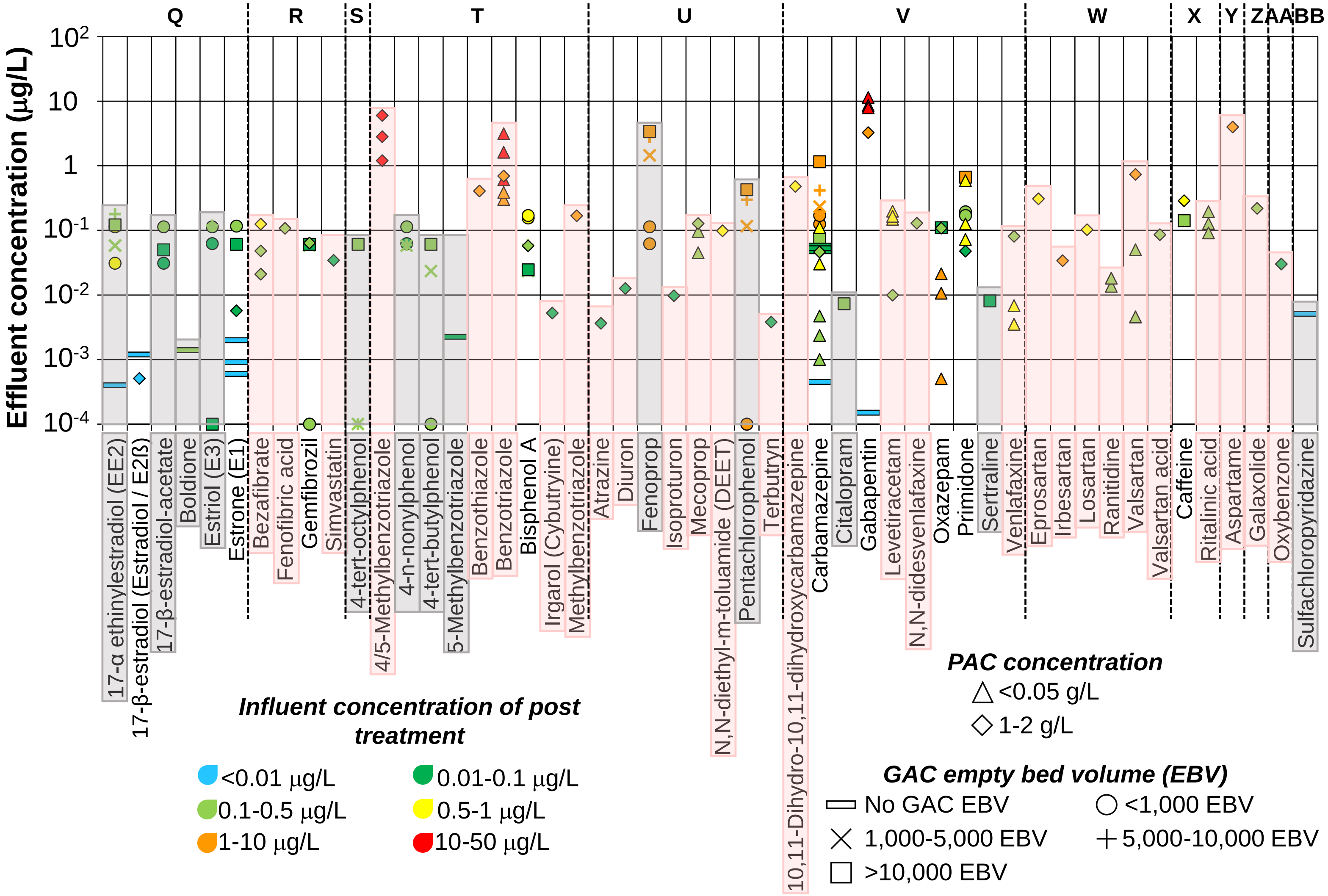


Figure S5. Concentration in the effluent of a PAC/GAC unit acting as a PT (part 2). Data from: (Baresel et al., 2019; Grover et al., 2011; Itzel et al., 2018; Kovalova et al., 2013; Löwenberg et al., 2014; Margot et al., 2013; Nguyen et al., 2013b, 2012; Paulus et al., 2019). It is important to remark that the investigated configurations in (Itzel et al., 2018) and (Paulus et al., 2019) include an ozonation step between the MBR and the GAC unit and the reported values of removal efficiencies refer to the whole treatment train. Compounds in light pink refer to only PAC and in light grey to only GAC. Those not highlighted refer to both PAC and GAC units

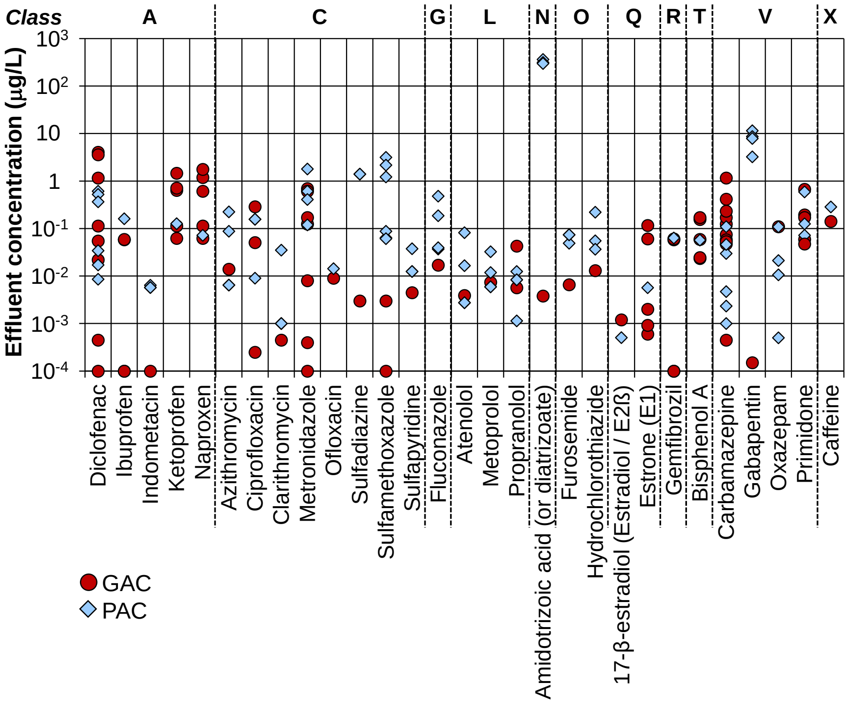


Figure S6. Concentration in the effluent of a PAC/GAC unit acting as a PT. Data from: (Baresel et al., 2019; Grover et al., 2011; Itzel et al., 2018; Kovalova et al., 2013; Löwenberg et al., 2014; Margot et al., 2013; Nguyen et al., 2013b, 2012; Paulus et al., 2019). It is important to remark that the investigated configurations in (Itzel et al., 2018) and (Paulus et al., 2019) include an ozonation step between the MBR and the GAC unit and the reported values of removal efficiencies refer to the whole treatment train.

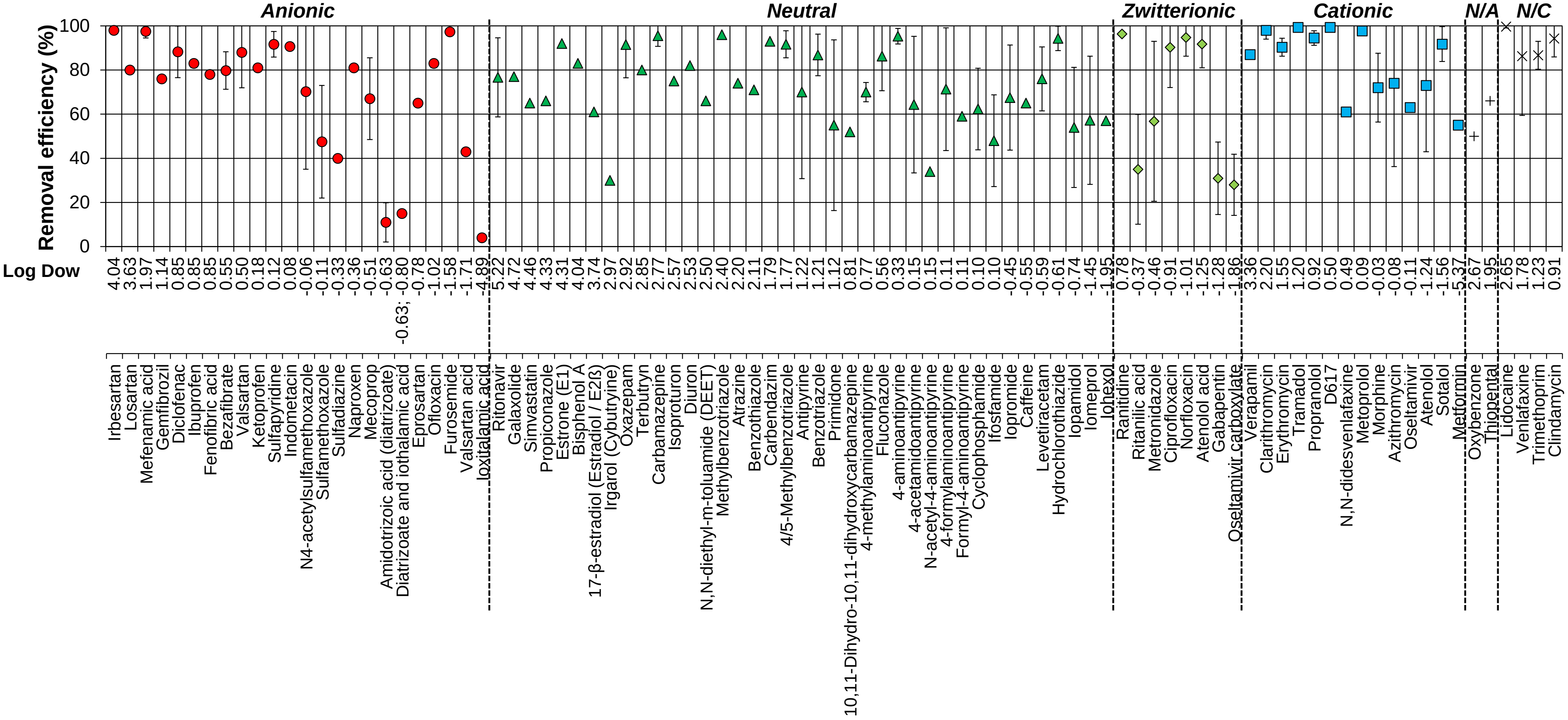


Figure S7. Removal efficiencies in PAC units acting as a PT for the compounds grouped according to their charge and in descending order according to Log *D*$_{ow}$. Data from: (Kovalova et al., 2013; Löwenberg et al., 2014; Margot et al., 2013)

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(the studies included in the quantitative analysis of MP removal by enhanced MBR are shown in bold)

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