Synthesis and antimicrobial activity of *N*-(indol-5-yl)trifluoroacetamides and indol-5-ylaminium trifluoroacetates substituted in the pyrrole ring*

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Based on a series of 1*H*-indol-5-ylamines substituted in the pyrrole ring, the corresponding *N*-(indol-5-yl)trifluoroacetamides and indol-5-ylaminium trifluoroacetates were prepared. An *in silico* study showed a wide range of their biological activity, including antimicrobial, antiviral, antiprotozoal, anthelmintic, and antifungal effects. The results of *in silico* and *in vitro* screening for antimicrobial activity correlate with each other. All compounds are capable of inhibiting the growth of the tested microorganism strains. The dependence of minimum inhibitory concentrations on the nature of the substituents at the benzene and pyrrole rings of the indole system was revealed.

Key words: indol-5-ylamines, indole derivatives, trifluoroacetamides, ammonium salts, trifluoroacetic acid, trifluoroacetates, biological activity, antimicrobial activity.

Chemistry of indole derivatives retains its relevancy[1,2] as these compounds are involved in metabolic processes in living systems. A special attention in the indole chemistry is paid to indolylamines with an amino group in the benzene ring. We continue the studies devoted to compounds based on substituted 1*H*-indolylamines and possessing potential biological activity that were begun at the Lomonosov Moscow State University under the guidance of A. N. Kost.[3] Previously, we synthesized trifluoromethylacetoacetamides and trifluoroacetamides based on 4-, 5-, 6-, and 7-amino-1*H*-indoles, which efficiently inhibited the growth of various strains of microorganisms. The dependence of antimicrobial activity on the nature of the substituents in the benzene and pyrrole rings of the indole system, as well as on the position of the amide group was revealed.[4—10] In our opinion, a significant role in the emergence of biological activity belongs to the trifluoromethyl group combined in these molecules with a substituted pharmacophore indole system. Therefore, the search for synthetic trifluoromethyl-containing biologically active compounds is promising. In the present study, the behavior of substituted 1*H*-indol-5-ylamines **1a—e** in the trifluoroacetylation reaction of indolylamines with ethyl trifluoroacetate, which we previously[5] developed, is explored. Corresponding *N*-(1*H*-indol-5-yl)-2,2,2-trifluoroacetamides **2a—e** were synthesized. Water soluble substituted 1*H*-indol-5-ylaminium trifluoroacetates **3a—e** were also prepared from indolylamines **1a—e** (Scheme 1).

In addition to the formation of the corresponding indolylamides and indolylaminium trifluoroacetates, electrophilic substitution of the H(3) atom of the indole moiety with the trifluoroacetyl group could also be expected in the reactions of 1*H*-indol-5-yl amines **1c—e** with ethyl trifluoroacetate or trifluoroacetic acid. Previously,[9] the substitution of this type was observed when pyrroloquinoline quinones were prepared on the basis of 1-methyl-2-phenyl-1*H*-indol-5-yl amine. However, it turned out that indolylamines **1c—e** reacted similarly to 3-substituted indolylamines **1a,b**.

The structure of products **2a—e** and **3a—e** was confirmed by ^{1}H and ^{19}F NMR and UV spectroscopy and mass spectrometry. Mass spectra of compounds **2a,b** and **3a—e** (see the experimental part) do not give an idea of the structure of the fragment ions. Therefore, we present the schemes of fragmentation of compounds **2a,b** and **3a—e** under the conditions of high-tempera-

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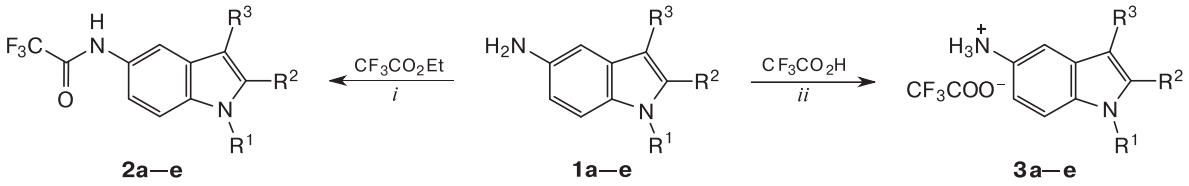
Scheme 1



R^1 = H, R^2 = R^3 = Me (**a**); R^1 = R^2 = R^3 = Me (**b**); R^1 = R^3 = H, R^2 = Me (**c**), Ph (**d**); R^1 = Me, R^2 = Ph, R^3 = H (**e**)

Reagents and conditions: *i*. AcOH (cat.), benzene, 80 °C; *ii*. benzene, 80 °C.

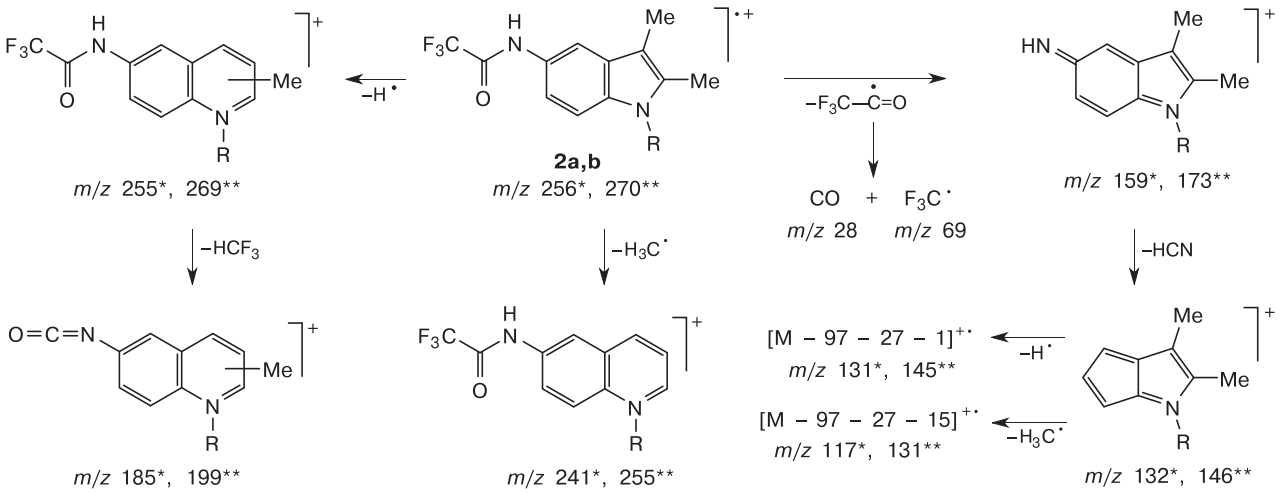
ture electron ionization (Schemes 2—4). Schemes 2—4 show structures of the fragment ions and their *m/z* values and are based on the data on fragmentation of molecular ions of substituted indoles, aromatic amines, and carbon acids.[11—14]

The *in silico* prediction of biological activity of compounds **2a—e** and **3a—e** was carried out using a local version of the PASS program (version 9.1).[15—17] This program predicts the probability of the biological activity that a particular compound may exhibit, but does not indicate the level of this activity or the conditions necessary for its manifestation such as dose, method of administration, biological object, gender, age, *etc*. Thus, although the PASS program predicts the spectra of biological activity of specific compounds and, therefore, allows narrowing the scope of experimental tests, its predictions require experimental confirmation. The results of the assessment of the spectra of biological activity of compounds **2a—e** and **3a—e** using the PASS program are shown in Table 1. For compounds **2a—e** and **3d**, the program also predicted additional antiprotozoal, anthelmintic, and antifungal activity.

According to *in silico* predicted interactions with molecular targets, the compounds under study can show an antimicrobial effect,[18—25] and the probability of their antiviral activity is high as well. In this connection, because of the current epidemiological situation in the world, the activity against the 3C-like protease ($3CL^{pro}$) is of particular interest since this protease belongs to the enzyme family found in the polyprotein of coronavirus. Protease $3CL^{pro}$ (M^{pro}, EC 3.4.22.69)[26] is the main protease of the SARS coronavirus that cleaves polyprotein at two self-cleavage sites.

The prediction of antimicrobial activity made using the PASS program correlates with laboratory test results. We found that compounds **2a—e** and **3a—e** inhibited the growth of the tested microorganism strains at various minimum inhibitory concentrations (MICs) (Table 2). The revealed antimicrobial activity of indolyl amides **2a—e** and indolylaminium trifluoroacetates **3a—e**

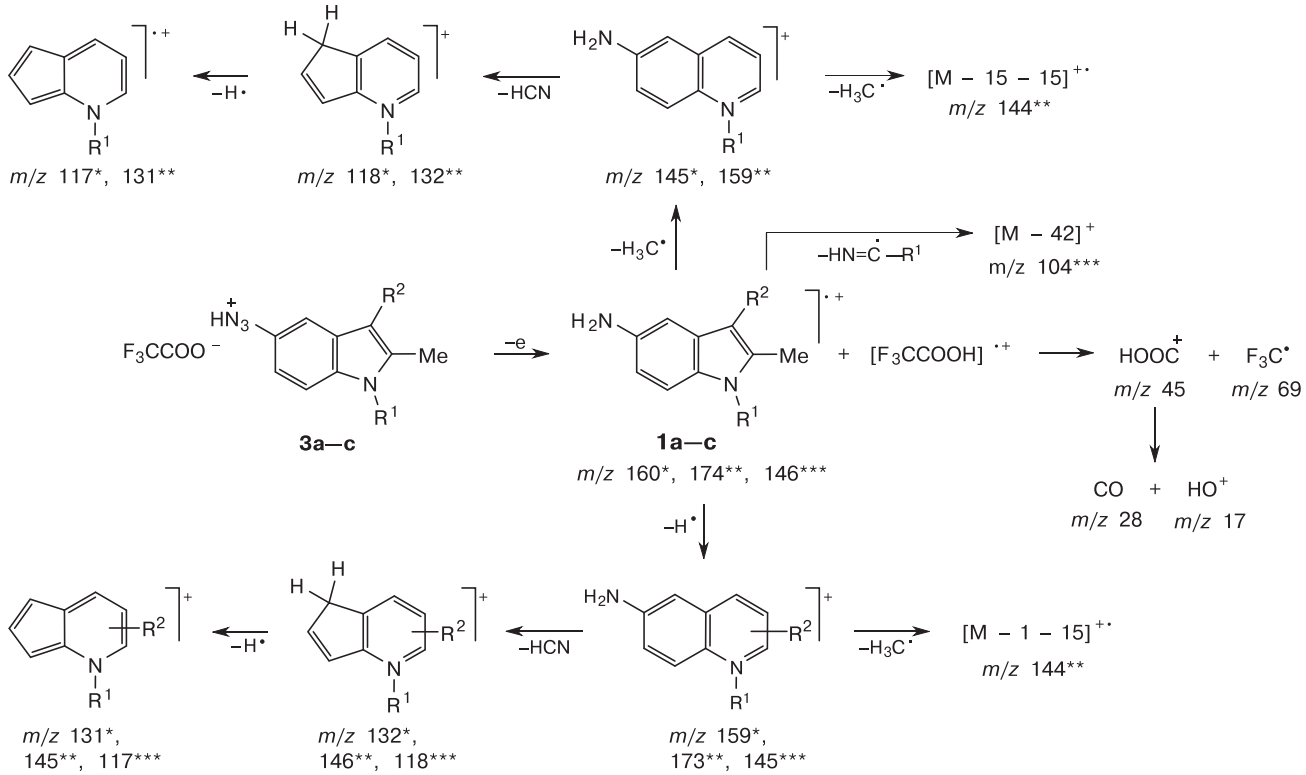
Scheme 2



R = H (**a**), R = Me (**b**)

Note. Fragment ions, which are formed during fragmentation of compounds **2a** and **2b**, are denoted by symbols * and **, respectively.

Scheme 3



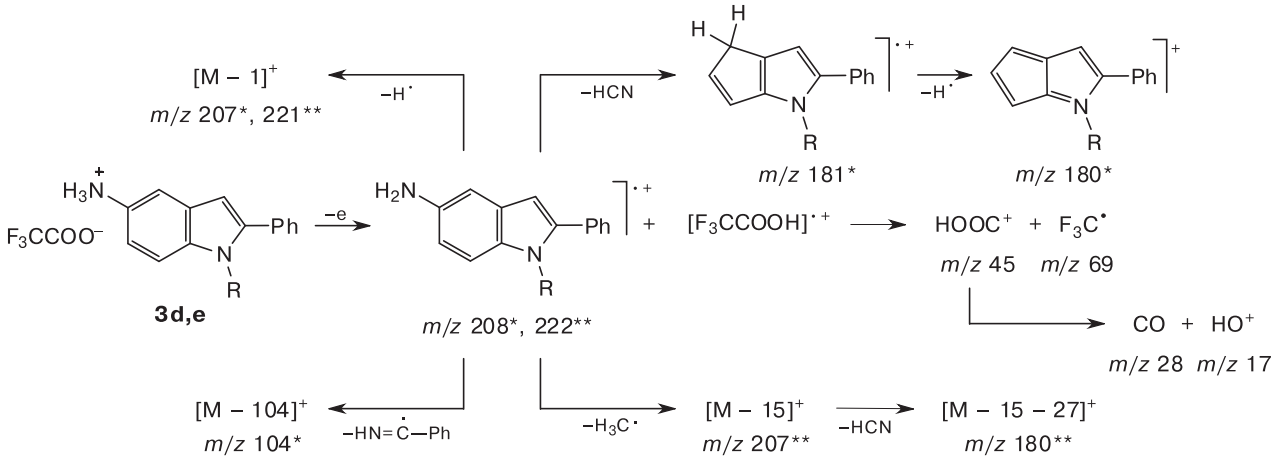
R^1 = H, R^2 = Me (**a**); R^1 = R^2 = Me (**b**); R^1 = R^2 = H (**c**)

Note. Fragment ions, which are formed during fragmentation of compounds **3a**, **3b**, and **3c**, are denoted by symbols *, **, and ***, respectively.

exceeds the activity of dioxidine,[27] which was used as a comparator drug.

Compounds **2d** and **3b**,**d**,**e** were the most active against the test strain of *Staphylococcus aureus* 6538-P. All compounds except **2b** and **3a** were efficient against *Escherichia coli* 25922 ATCC. Compounds **2a**,**d** and **3b**,**c** were the most active against this strain. Compounds **2a**,**c**,**e** and **3c**—**e** showed the highest activity against

Scheme 4



R = H (**d**), R = Me (**e**)

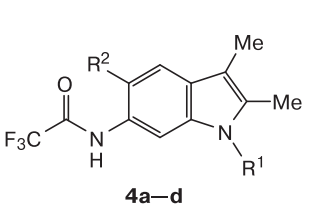
Note. Fragment ions, which are formed during fragmentaion of compounds **3d** и **3e**, are denoted by symbols * and **, respectively.

Table 1. Biological activities predicted by the PASS program (version 9.1) for compounds **2a—e** and **3a—e**

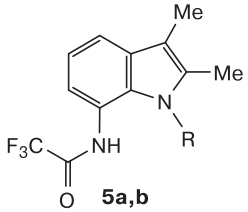
Compound	Activities	Probability (Pa)
2a—e, **3a—e**	Pseudolysin inhibitor	0.311—0.585
2 a,**c**,**d**, **3a**,**c**,**d**	Omptin inhibitor	0.194—0.339
2a,**c**,**e**, **3c**,**d**	MurG transferase inhibitor	0.188—0.244
2a,**c**,**e**	Uridine diphosphate-*N*-acetylglucosamine-4-epimerase inhibitor	0.283—0.310
2a,**c—e**	Bacterial efflux pump inhibitor	0.124—0.136
2a,**c**	Antituberculosis activity	0.199—0.270
2a,**b**,**d**	Antihelicobacter activity	0.197—0.263
2b—d, **3a—d**	Inhibitor of cysteine protease secreted by *Porphyromonas gingivalis*	0.221—0.240
2a—e, **3a**,**c—e**	Botulinum neurotoxin A light chain inhibitor	0.205—0.409
2a—c,**e**	Viral entry inhibitor	0.198—0.226
2a—c,**e**, **3a**,**b**	Antiadenoviral activity	0.249—0.375
2a—c,**e**	Antiinfluenza activity	0.279—0.370
2a—d, **3e**	Antipicornavirus activity	0.307—0.415
2a—e	Coronavirus 3C-like proteinase inhibitor	0.212—0.301

Pseudomonas aeruginosa 27853 ATCC. Substituted 1*H*-indol-5-ylaminium trifluoroacetates **3a—e** were more active against all tested strains than corresponding trifluoroacetamides **2a—e**. It is apparently due to better water solubility of trifluoroacetates.

We have analyzed the dependence of antimicrobial activity on the structure of *N*-(indol-5-yl)trifluoroacetamides **2a—e**, which were synthesized during this study, and previously prepared *N*-(indol-6-yl)trifluoroacetamides (**4a—d**)[7] and *N*-(indol-7-yl)trifluoroacetamides (**5a,b**).[6] The MIC values of these compounds were used as a criterion for their antimicrobial efficiency. It was found that the efficacy of compounds **2a—e**, **4a—d**, and **5a,b** depended on the position of the trifluoroacetamide group and the substitution type. 5-Methoxy (**4b,d**[5]) and 2-phenyl derivatives (**2d,e**) exhibit the highest activity. The antimicrobial activity of 1-methyl-substituted compounds is in general lower than that of derivatives unsubstituted at the nitrogen atom in the cycle.



4a—d



5a,b

4: R^1 = H, R^2 = Me (**a**), OMe (**b**);
R^1 = R^2 = Me (**c**); R^1 = Me, R^2 = OMe (**d**)
5: R = H (**a**), Me (**b**)

To sum up, we have carried out a study devoted to the search for synthetic biologically active compounds combining the trifluoromethyl group and the pharmacophore substituted indole system. By the reactions of 1*H*-indol-5-ylamines with ethyl trufluoroacetate and trufluoroacetic acid, a series of new substituted in the pyrrole ring 1*H*-indol-5-yltrifluoroacetamides and 1*H*-indol-5-ylaminium trufluoroacetates were synthesized. Computer screening of the prepared compounds using a local version of the PASS program predicted a wide spectrum of their biological activity, including an antimicrobial activity. The results of the performed experimental study of antimicrobial activity of the synthesized compounds correlate with the *in silico* prediction. All compounds inhibit the growth of the tested microorganism strains at various minimum inhibitory concentrations. The relationship between the structural features of the synthesized compounds and the efficacy of their antimicrobial action was analyzed.

Table 2. Antimicrobial activity of compounds **2a—e** and **3a—e**

Compound	MICs (μg mL^{-1})		
	S. aureus 6538-P	*E. coli* 25922 ATCC	*P. aeruginosa* 27853 ATCC
2a	125.0	0.98	62.5
2b	250.0	>250.0	250.0
2c	125.0	125.0	62.5
2d	31.1	1.96	125.0
2e	125.0	125.0	1.96
3a	125.0	>250.0	125.0
3b	31.1	0.98	125.0
3c	125.0	0.98	0.98
3d	62.5	125.0	31.1
3e	62.5	125.0	0.98
Dioxidine[27]	125.0—1000.0[a]	8.0—50.0[b]	125.0—1000.0[c]

[a] Against *Staphylococcus* spp. [b] Against *E. coli*. [c] Against *P. aeruginosa*.

Experimental

Starting substituted 1*H*-indol-5-ylamines **1a—e** were prepared according to reported procedures.[28] ^{1}H NMR spectra were recorded in DMSO-d_6 on a JEOL JNM-ECX400 spectrometer (operating frequencies are 400.13 (^{1}H) and 376.50 (^{19}F) MHz). Chemical shifts in ^{1}H and ^{19}F NMR spectra are given relative to the residual solvent signal (DMSO-d_6: δ: 2.50) and relative to the $C_6H_5CF_3$ signal (δ: −60.94), respectively. Electronic absorption spectra were obtained using a LEKI SS2109UV spectrophotometer in ethanol. Mass spectra were recorded with the use of a Finnigan MAT INCOS-50 mass spectrometer with a direct sample introduction using 70 eV electron ionization. Elemental analysis was carried out using a vario MICRO cube analyzer. The reaction progress and the purity of the obtained compounds were monitored by TLC on Silufol UV-254 plates, spots of the compounds were visualized with iodine vapor. The PASS program (version 9.1) was used to predict biological activity of compounds.

***N*-(2,3-Dimethyl-1*H*-indol-5-yl)-2,2,2-trifluoroacetamide (2a).** A mixture of 2,3-dimethyl-1*H*-indol-5-ylamine (**1a**, 0.3 g, 1.88 mmol), ethyl trifluoroacetate (21.5 g, 0.15 mol), glacial acetic acid (a catalytic amount), and anhydrous benzene (125 mL) was refluxed on a water bath for 101 h (TLC monitoring). The solvent was evaporated, the residue was purified on a column filled with aluminium oxide using chloroform as an eluent. Yield 0.2 g (42%), light gray powder, m.p. 176 °C. Found (%): C, 56.01; H, 4.17. $C_{12}H_{11}N_2OF_3$. Calculated (%): C, 56.25; H, 4.33. UV (EtOH), λ_{max}/nm (lgε): 204 (4.06), 253 (4.31), 293 (3.80). ^{1}H NMR, δ: 2.13 (s, 3 H, C(3)CH_3); 2.31 (s, 3 H, C(2)CH_3); 7.22 (virt. t, 2 H, C(6,7)H, J = 9.1 Hz); 7.66 (s, 1 H, C(4)H); 10.71 (s, 1 H, C(5)NH); 10.95 (s, 1 H, N(1)H). ^{19}F NMR, δ: −73.66 (s, 3 F, CF_3). MS, m/z (I_{rel} (%)): 257 (12.21), 256 (89.89), 255 (38.44), 241 (19.52), 185 (14.41), 159 (43.04), 132 (30.23), 131 (21.52), 130 (19.62), 118 (4.00), 117 (17.92), 97 (16.82), 69 (100.00), 52 (13.01), 51 (14.51), 50 (11.51), 42 (14.71), 28 (48.55), 27 (19.32), 18 (42.74; 12.91), 16 (15.02; 11.31).

2,2,2-Trifluoro-*N*-(1,2,3-trimethyl-1*H*-indol-5-yl)acetamide (2b) was synthesized similarly to compound **2a** from 1,2,3-trimethyl-1*H*-indol-5-ylamine (**1b**, 0.244 g, 1.4 mmol) and ethyl trifluoroacetate (15.5 g, 0.11 mol). The reaction time was 70 h. Yield 0.24 g (63%), light gray powder, m.p. 132—133 °C. Found (%): C, 58.01; H, 4.60. $C_{13}H_{13}N_2OF_3$. Calculated (%): C, 57.78; H, 4.85. UV (EtOH), λ_{max}/nm (lgε): 206 (4.28), 256 (4.54), 300 (4.00). ^{1}H NMR, δ: 2.17 (s, 3 H, C(3)CH_3); 2.32 (s, 3 H, C(2)CH_3); 3.63 (s, 3 H, N(1)CH_3); 7.32 (d, 1 H, C(6)H, J = 9.1 Hz); 7.33 (d, 1 H, C(7)H, J = 9.1 Hz); 7.72 (s, 1 H, C(4)H); 10.99 (s, 1 H, C(5)NH). ^{19}F NMR, δ: −73.66 (s, 3 F, CF_3). MS, m/z (I_{rel} (%)): 271 (14.41), 270 (100.00), 269 (51.95), 255 (26.33), 199 (13.31), 173 (35.04), 146 (25.03), 145 (12.31), 131 (12.01), 130 (12.41), 97 (9.01), 69 (86.39), 51 (6.61), 28 (14.71), 27 (8.91), 18 (51.85; 11.31), 16 (20.32).

2,2,2-Trifluoro-*N*-(2-methyl-1*H*-indol-5-yl)acetamide (2c) was synthesized similarly to compound **2a** from 2-methyl-1*H*-indol-5-ylamine (**1c**, 0.2 g, 1.37 mmol) and ethyl trifluoroacetate (13.1 g, 0.09 mol). Yield 0.13 g (39%), light gray powder, m.p. 141—142 °C. R_f 0.43 (benzene—ethyl acetate, 10 : 1). Found (%): C, 54.28; H, 3.49. $C_{11}H_9N_2OF_3$. Calculated (%): C, 54.55; H, 3.75. UV (EtOH), λ_{max}/nm (lgε): 207 (4.29), 248 (4.46), 280 (4.03). ^{1}H NMR, δ: 2.37 (s, 3 H, C(2)CH_3); 6.14 (s, 1 H, C(3)H); 7.22 (d, 1 H, C(7)H, J = 8.5 Hz); 7.27 (d, 1 H, C(6)H, J = 8.5 Hz); 7.72 (s, 1 H, C(4)H); 10.59 (s, 2 H, N(1)H, C(5)NH). ^{19}F NMR, δ: −73.63 (s, 3 F, CF_3).

2,2,2-Trifluoro-*N*-(2-phenyl-1*H*-indol-5-yl)acetamide (2d) was synthesized similarly to compound **2a** from 2-phenyl-1*H*-indol-5-ylamine (**1d**, 0.3 g, 1.44 mmol) and ethyl trifluoroacetate (13.1 g, 0.09 mol). The reaction time was 61 h. Yield 0.08 g (18%), gray powder, m.p. >205 °C (decomp.). R_f 0.57 (benzene—ethyl acetate, 10 : 1). Found (%): C, 62.83; H, 3.39. $C_{16}H_{11}N_2OF_3$. Calculated (%): C, 63.16; H, 3.64. UV (EtOH), λ_{max}/nm (lgε): 206 (4.30), 230 (4.25), 267 (4.29), 322 (4.34). ^{1}H NMR, δ: 6.93 (s, 1 H, C(3)H); 7.34 (d, 2 H, C(7)H, p-H_{Ph}, J = 8.0 Hz); 7.41 (s, 1 H, C(4)H); 7.47 (t, 2 H, m-H_{Ph}, J = 8.0 Hz); 7.86 (d, 2 H, o-H_{Ph}, J = 8.0 Hz); 7,96 (d, 1 H, C(6)H, J = 8.0 Hz); 11.05 (s, 1 H, C(5)NH); 11.61 (s, 1 H, N(1)H). ^{19}F NMR, δ: −73.57 (s, 3 F, CF_3).

2,2,2-Trifluoro-*N*-(1-methyl-2-phenyl-1*H*-indol-5-yl)-acetamide (2e) was synthesized similarly to compound **2a** from 1-methyl-2-phenyl-1*H*-indol-5-ylamine (**1e**, 0.26 g, 1.17 mmol) and ethyl trifluoroacetate (13.1 g, 0.09 mol). Yield 0.21 g (57%), gray powder, m.p. 203—204 °C (decomp.). R_f 0.74 (benzene—ethyl acetate, 10 : 1). Found (%): C, 64.31; H, 4.01. $C_{17}H_{13}N_2OF_3$. Calculated (%): C, 64.15; H, 4.12. UV (EtOH), λ_{max}/nm (lgε): 206 (4.45), 235 (4.48), 263 (4.49), 302 (4.29). ^{1}H NMR, δ: 3.75 (s. 3 H, N(1)CH_3); 6.61 (s, 1 H, C(3)H); 7.42 (d, 1 H, C(6)H, J = 8.5 Hz); 7.44 (d, 1 H, C(7)H, J = 8.5 Hz); 7.52 (virt. t, 3 H, p-H_{Ph} и m-H_{Ph}, J = 8.0 Hz), 7.60 (d, 2 H, o-H_{Ph}, J = 8.0 Hz); 7.93 (s, 1 H, C(4)H); 11.09 (s, 1 H, C(5)NH). ^{19}F NMR, δ: −73.60 (s, 3 F, CF_3).

2,3-Dimethyl-1*H*-indol-5-ylammonium trifluoroacetate (3a). Trifluoroacetic acid (0.115 g, 1.01 mmol) in benzene (10 mL) was added to a refluxing solution of 2,3-dimethyl-1*H*-indol-5-ylamine (**1a**, 0.15 g, 0.94 mmol) in benzene (30 mL). The reaction mixture was cooled, the formed precipitate was filtered, washed successively with benzene and hot hexane, and dried in air. Yield 0.25 g (97%), light gray crystals, m.p. 162 °C (decomp.). Found (%): C, 52.29; H, 4.90. $C_{12}H_{13}N_2O_2F_3$. Calculated (%): C, 52.56; H, 4.78. UV (EtOH), λ_{max}/nm (lgε): 207 (4.11), 233 (4.41), 290 (3.74). ^{1}H NMR, δ: 2.15 (s, 3 H, C(3)CH_3); 2.32 (s, 3 H, C(2)CH_3); 6.96 (d, 1 H, C(6)H, J = 9.1 Hz); 7.30 (s, 1 H, C(4)H); 7.35 (d, 1 H, C(7)H, J = 9.1 Hz); 9.86 (br.s, 3 H, C(5)NH_3); 10.96 (s, 1 H, N(1)H). ^{19}F NMR, δ: −73.57 (s, 3 F, CF_3). MS, m/z (I_{rel} (%)): 161 (10.71), 160 (100.00), 159 (77.38), 145 (34.53), 132 (8.31), 131 (5.51), 130 (7.81), 118 (4.00), 117 (7.91), 69 (22.52), 52 (14.91), 51 (22.92), 50 (22.02), 45 (29.73), 42 (13.71), 41 (12.01), 31 (13.61), 28 (33.33), 27 (30.93), 16 (12.91).

1,2,3-Trimethyl-1*H*-indol-5-ylammonium trifluoroacetate (3b) was synthesized similarly to compound **3a** from 1,2,3-trimethyl-1*H*-indol-5-ylamine (**1b**, 0.31 g, 1.78 mmol) and trifluoroacetic acid (0.21 g, 1.84 mmol). Yield 0.15 g (29%),

light gray crystals, m.p. 168 °C (decomp.). Found (%): C, 53.90; H, 5.41. $C_{13}H_{15}N_2O_2F_3$. Calculated (%): C, 54.17; H, 5.25. UV (EtOH), λ_{max}/nm (lgε): 207 (4.27), 234 (4.61), 294 (3.91). ^{1}H NMR, δ: 2.18 (s, 3 H, C(3)CH_3); 2.34 (s, 3 H, C(2)CH_3); 3.66 (s, 3 H, N(1)CH_3); 7.04 (d, 1 H, C(6)H, J = 9.1 Hz); 7.36 (s, 1 H, C(4)H); 7.44 (d, 1 H, C(7)H, J = 9.1 Hz), 9.93 (br.s, 3 H, C(5)NH_3). ^{19}F NMR, δ: −73.60 (s, 3 F, CF_3). MA, m/z (I_{rel} (%)): 175 (12.91), 174 (100.00), 173 (82.08), 159 (47.45), 158 (19.02), 146 (8.31), 145 (5.11), 144 (9.11), 132 (3.60), 131 (7.71), 130 (13.01), 87 (10.91), 69 (29.73), 52 (8.31), 51 (22.02), 50 (17.82), 45 (35.04), 42 (12.41), 41 (8.71), 39 (11.61), 31 (11.81), 28 (34.63), 27 (25.03), 18 (12.01; 16.02), 15 (46.65).

2-Methyl-1*H*-indol-5-ylammonium trifluoroacetate (3c) was synthesized similarly to compound **3a** from 2-methyl-1*H*-indol-5-ylamine (**1c**, 0.1 g, 0.69 mmol) and trifluoroacetic acid (0.081 g, 0.71 mmol). Yield 0.12 g (67%), light gray crystals, m.p. 154 °C (decomp.), Found (%): C, 50.49; H, 4.10. $C_{11}H_{11}N_2O_2F_3$. Calculated (%): C, 50.77; H, 4.26. UV (EtOH), λ_{max}/nm (lgε): 213 (4.37), 224 (4.55), 280 (3.97). ^{1}H NMR, δ: 2.37 (s, 3 H, C(2)CH_3); 6.10 (s, 1 H, C(3)H); 6.81 (d, 1 H, C(6)H, J = 8.0 Hz); 7.17 (s, 1 H, C(4)H); 7.25 (d, 1 H, C(7)H, J = 8.0 Hz); 8.80 (br.s, 3 H, C(5)NH_3); 10.98 (s, 1 H, N(1)H). ^{19}F NMR, δ: −73.54 (s, 3 F, CF_3). MS, m/z (I_{rel} (%)): 147 (10.51), 146 (100.00), 145 (87.39), 118 (10.41), 117 (12.51), 104 (5.21), 69 (16.42), 63 (11.71), 52 (24.22), 51 (17.12), 50 (16.32), 45 (20.22), 41 (10.31), 39 (16.42), 31 (9.91), 29 (8.21), 28 (18.52), 27 (13.21), 16 (6.21).

2-Phenyl-1*H*-indol-5-ylammonium trifluoroacetate (3d) was synthesized similarly to compound **3a** from 2-phenyl-1*H*-indol-5-ylamine (**1d**, 0.12 g, 0.58 mmol) and trifluoroacetic acid (0.08 g, 0.7 mmol). Yield 0.16 g (86%), lilac crystals, m.p. 184 °C (decomp.). Found (%): C, 59.39; H, 4.20. $C_{16}H_{13}N_2O_2F_3$. Calculated (%): C, 59.63; H, 4.07. UV (EtOH), λ_{max}/nm (lgε): 208 (4.29), 228 (4.25), 315 (4.26). ^{1}H NMR, δ: 6.99 (s, 1 H, C(3)H); 7.07 (d, 1 H, C(6)H, J = 8.0 Hz); 7.36 (s, 1 H, C(4)H); 7.46—7.52 (m, 4 H, C(7)H, p-H_{Ph}, m-H_{Ph}); 7.88 (d, 2 H, o-H_{Ph}, J = 8.0 Hz); 9.89 (br.s, 3 H, C(5)NH_3); 11.82 (s, 1 H, N(1)H). ^{19}F NMR, δ: −73.57 (s, 3 F, CF_3). MS, m/z (I_{rel} (%)): 209 (14.71), 208 (100.00), 207 (14.71), 181 (3.00), 180 (16.42), 104 (25.43), 77 (15.12), 69 (16.42), 52 (16.82), 51 (23.42), 50 (18.42), 45 (19.22), 39 (14.31), 28 (26.53), 27 (11.71), 18 (54.65), 17 (16.82).

1-Methyl-2-phenyl-1*H*-indol-5-ylammonium trifluoroacetate (3e) was synthesized similarly to compound **3a** from 1-methyl-2-phenyl-1*H*-indol-5-ylamine (**1e**, 0.1 g, 0.45 mmol) and trifluoroacetic acid (0.06 g, 0.53 mmol). Yield 0.12 g (79%), lilac crystals, m.p. 166 °C (decomp.). Found (%): C, 60.49; H, 4.28. $C_{17}H_{15}N_2O_2F_3$. Calculated (%): C, 60.71; H, 4.50. UV (EtOH), λ_{max}/nm (lgε): 209 (4.43), 230 (4.52), 303 (4.29). ^{1}H NMR, δ: 3.77 (s, 3 H, N(1)CH_3); 6.66 (s, 1 H, C(3)H); 7.16 (d, 1 H, C(6)H, J = 12.0 Hz); 7.45—7.63 (m, 7 H, C(4)H, C(7)H, C(2)C_6H_5); 9.97 (br.s, 3 H, C(5)NH_3). ^{19}F NMR, δ: −73.63 (s, 3 F, CF_3). MS, m/z (I_{rel} (%)): 223 (17.02), 222 (100.00), 221 (19.02), 207 (8.61), 194 (3.10), 180 (9.21), 145 (7.31) 77 (19.02), 69 (22.12), 52 (9.31), 51 (21.62), 50 (18.62), 45 (23.92), 39 (13.81), 31 (11.11), 29 (8.51), 27 (13.11), 18 (6.41), 17 (9.21), 16 (19.12).

Antibacterial activity of compounds 2a—e and 3a—e. In microbiological experiments, the synthesized compounds were used as the solutions. Dimexide for the preparation of solutions for external use (OJSC Marbiopharm) was used as a solvent for amides **2a—e**, and disinfected distilled water was used as a solvent for salts **3a—e**. The following museum strains obtained from the collection of the Museum of Living Cultures of the Federal State Budgetary Institution Scientific Center for Expertise of Medicinal Products of the Ministry of Health of Russian Federation were used in the study of antimicrobial activity of compounds **2a—e** and **3a—e**: *S. aureus* 6538-P ATCC, *E. coli* 25922 ATCC, *P. aeruginosa* 27853 ATCC. The results obtained were compared with the known data[27] for the antimicrobial drug dioxidine (a derivative of di-*N*-oxyquinoxaline) (Biosintes, a solution for topical, endotracheal, and intravenous administration, 10 μg mL^{-1}), which is widely used in medical practice. Determination of the antimicrobial activity of the prepared compounds was carried out by the method of serial dilutions in the cultural medium (the tube macromethod).[29—31]

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The authors declare no competing interests.

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