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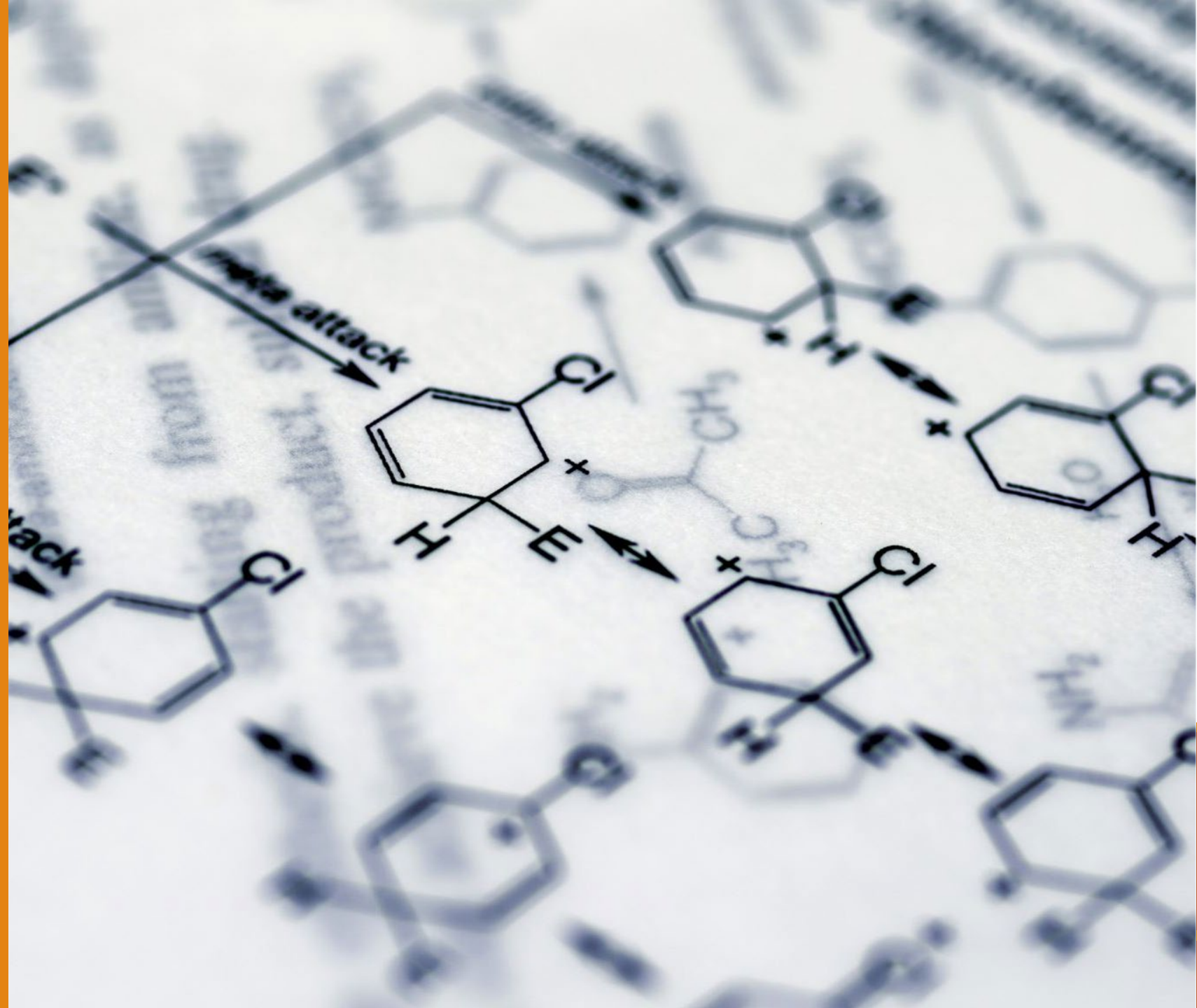

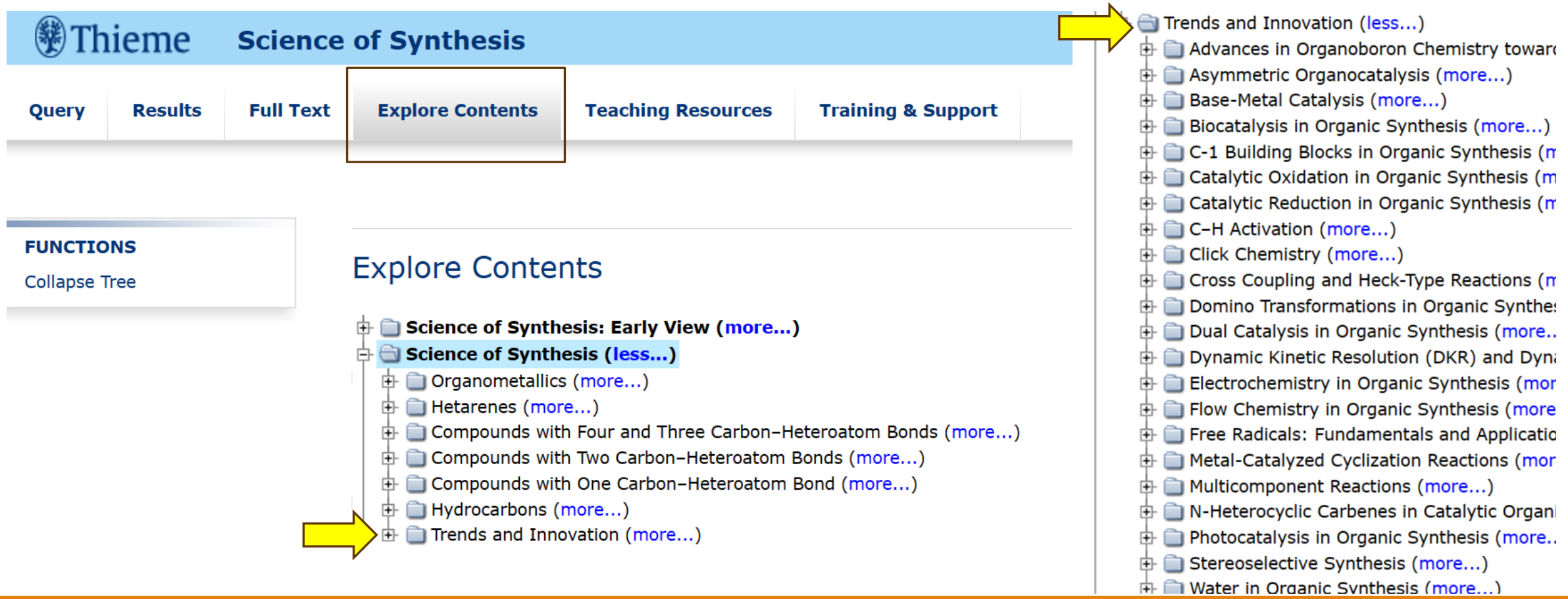

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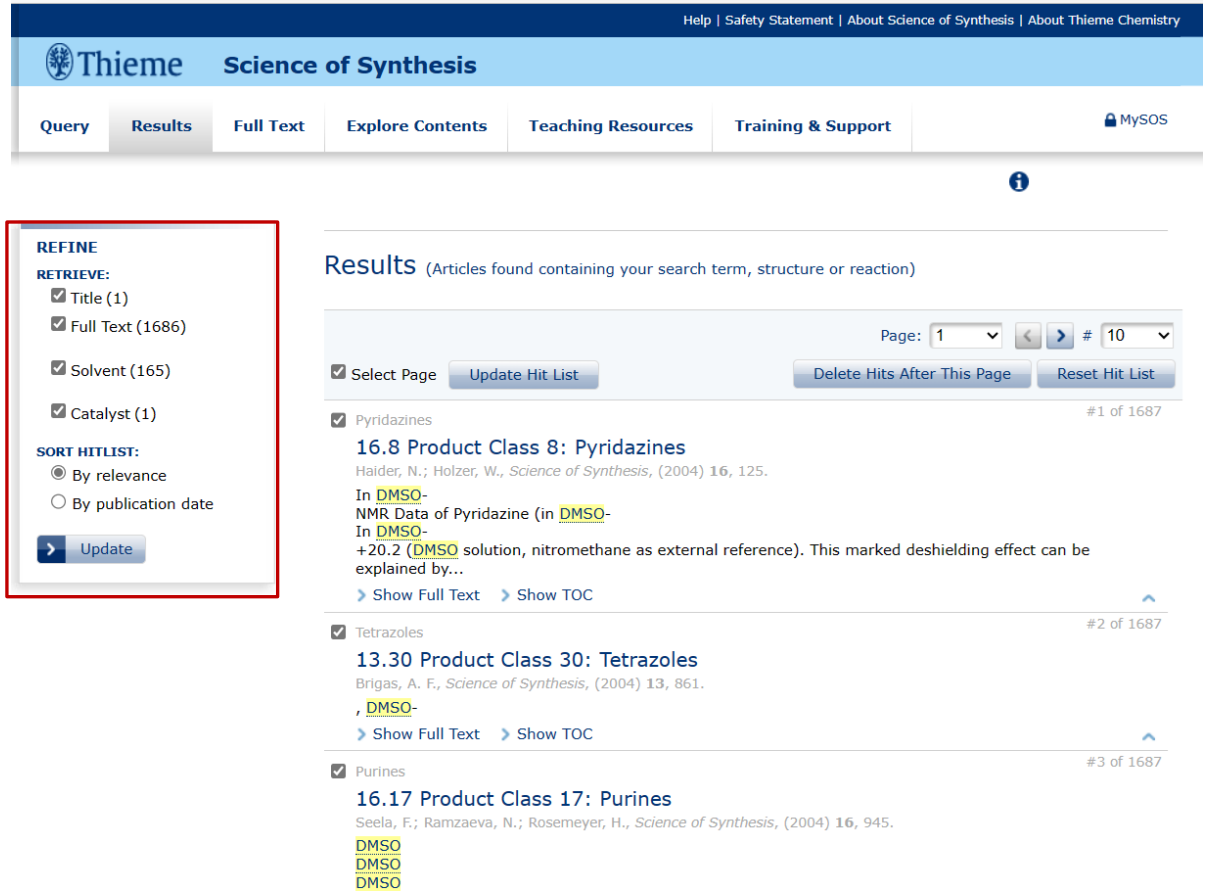

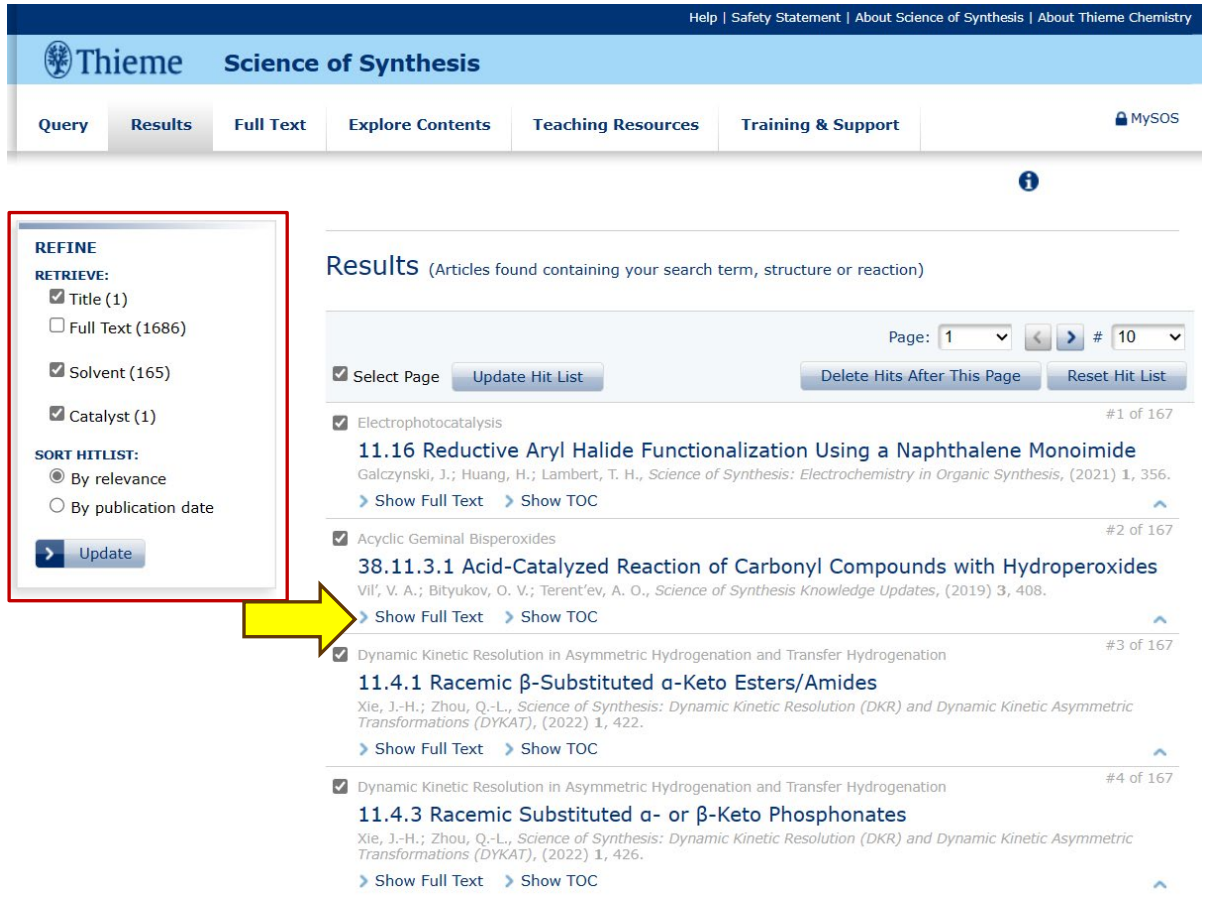

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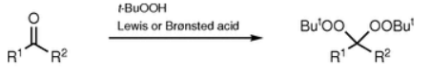
38.11.3.1 Acid-Catalyzed Reaction of Carbonyl Compounds with Hydroperoxides

DOI: 10.1055/sos-SD-138-00067

Vil', V. A.; Bityukov, O. V.; Terent'ev, A. O., *Science of Synthesis Knowledge Updates*, (2019) **3**, 408.

The reaction of carbonyl compounds **62** with *tert*-butyl hydroperoxide provides geminal di-*tert*-butyl peroxides **63** (**Scheme 28**). Synthesis proceeds in the presence of sulfuric, [128–131] hydrochloric, [132–136] perchloric, [133,137–142] 4-toluenesulfonic, [143] and other acids, usually with the use of dehydrators ($CaCl_2$, Na_2SO_4, B_2O_3, etc.) at 0–60°C. Molecular iodine can also be used as catalyst. [92]

Scheme 28 Acid-Catalyzed Synthesis of Geminal Bisperoxides from Carbonyl Compounds and *tert*-Butyl Hydroperoxide [92,128–143]



62 **63**

R^1	R^2	*t*-BuOOH (Equiv)	Conditions	Yield (%)	Ref
H	Et	2	35% HCl, 0–30°C	76	[132]
H	Pr	2	70% $HClO_4$, 5–7°C, then rt, then 60°C	85	[133]
H	iPr	2	70% $HClO_4$, 5–7°C, then rt, then 60°C	80	[133]
H	2-FC_6H_4	2	35% $HClO_4$, $CaCl_2$, benzene, 0–40°C	85	[137]

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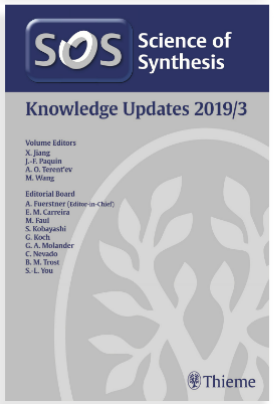

$(CH_2)_5$	*t*-Bu	1.1	40% aq HBF_4, pentane, rt, 2 h	33	[147]

2,2-Bis(*tert*-butylperoxy)-1-phenylpropane (63, R^1 = Bn; R^2 = Me); Typical Procedure by Catalysis with Concentrated Hydrochloric Acid: [136]

In a 50-mL, round-bottomed flask, 1-phenylpropan-2-one (**62**, R^1 = Bn; R^2 = Me; 1 g, 7.46 mmol) was dissolved in hexanes (6 mL) and the soln was cooled to 0°C (ice bath). Ground $CaCl_2$ (500 mg) was added, followed by 70% aq *t*-BuOOH (4 mL, 29.2 mmol) and concd HCl (0.5 mL), making sure the temperature did not exceed 5°C. The resulting mixture was vigorously stirred at 0°C for 4 h. Hexane (30 mL) was added and the phases were separated. The organic phase was then successively washed with 2 M aq NaOH (15 mL) and distilled H_2O (2 × 15 mL), dried (Na_2SO_4), filtered, and concentrated. The resulting clear liquid was purified by flash chromatography (silica gel prewashed with hexane containing 1% Et_3N, hexane) to afford the product as a white solid; yield: 1.85 g (83%).

4-*tert*-Butyl-1,1-bis(*tert*-butylperoxy)cyclohexane [63, R^1,R^2 = $(CH_2)_2CH(t\text{-Bu})(CH_2)_2$]; Typical Procedure by Molecular Iodine Catalysis: [92]

To a soln of I_2 (25.4 mg, 0.1 mmol, 10 mol%) and 60% *t*-BuOOH in decane (0.72 mL, 2 mmol) in MeCN (1 mL) was added 4-*tert*-butylcyclohexanone [**62**, R^1,R^2 = $(CH_2)_2CH(t\text{-Bu})(CH_2)_2$; 154 mg, 1 mmol], and the soln was stirred at 22°C for 24 h. The mixture was concentrated under reduced pressure (ca. 20 Torr), and the product was isolated by column chromatography (silica gel, petroleum ether/Et_2O 95:5); yield: 259 mg (82%).

Geminal Bisperoxides 69; General Procedure by Tetrafluoroboric Acid Catalysis: [146]

CAUTION: *Tetrafluoroboric acid is extremely destructive to the skin, eyes, and respiratory tract.*

50% aq HBF_4 (2–4 mmol) was added to a mixture of the acetal **67** (5 mmol), 70% aq *t*-BuOOH (**68**, R^3 = *t*-Bu; 15–25 mmol), $CaCl_2$ (0.56 g, 5 mmol), and petroleum ether (35 mL). The mixture was stirred at rt until the acetal had been completely converted (20–180 min, TLC monitoring). Petroleum ether (bp 40–70°C; 20 mL) was added, and the organic phase was washed with 5% aq NaOH (30 mL) and H_2O (2 × 20 mL), dried (Na_2SO_4), filtered, and concentrated.

References

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