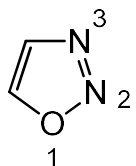
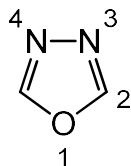


## ***6. Pierścienie pięcioczłonowe z trzema lub czterema heteroatomami***

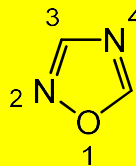
## 6.1. Azole - przykłady



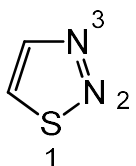
1,2,3-oksadiazol



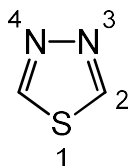
1,3,4-oksadiazol



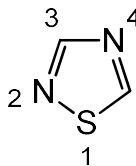
1,2,4-oksadiazol



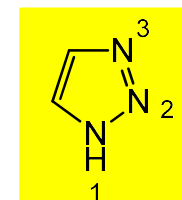
1,2,3-tiadiazol



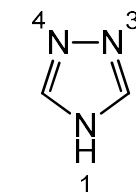
1,3,4-tiadiazol



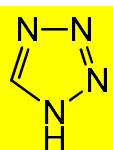
1,2,4-tiadiazol



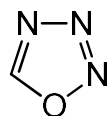
1,2,3-triazol



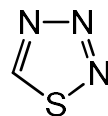
1,3,4-triazol



tetrazol

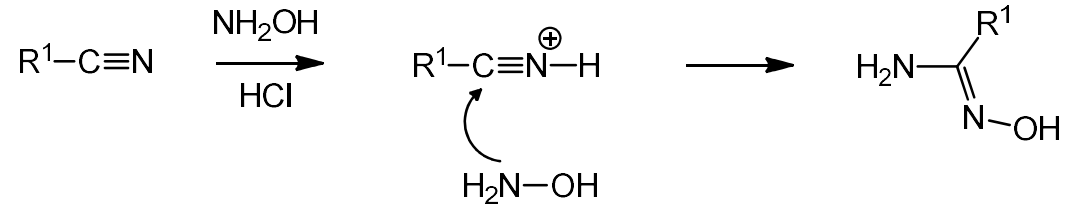
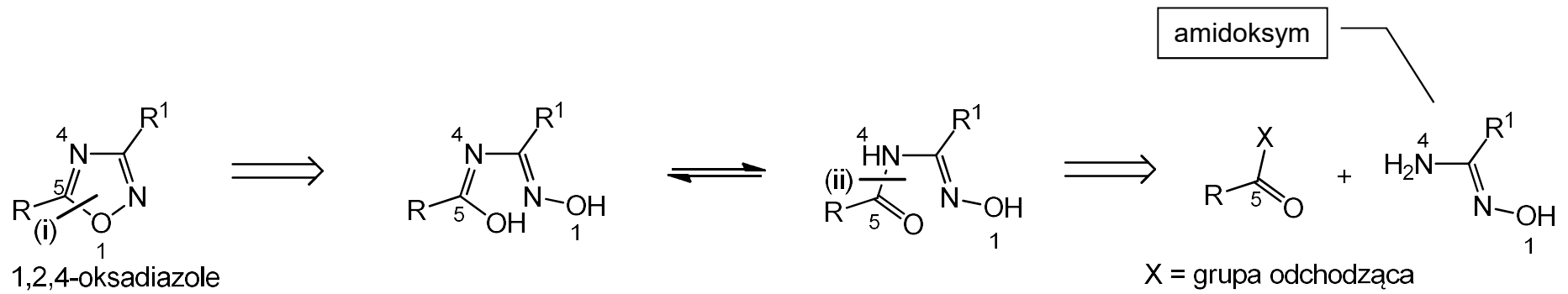


oksatriazol

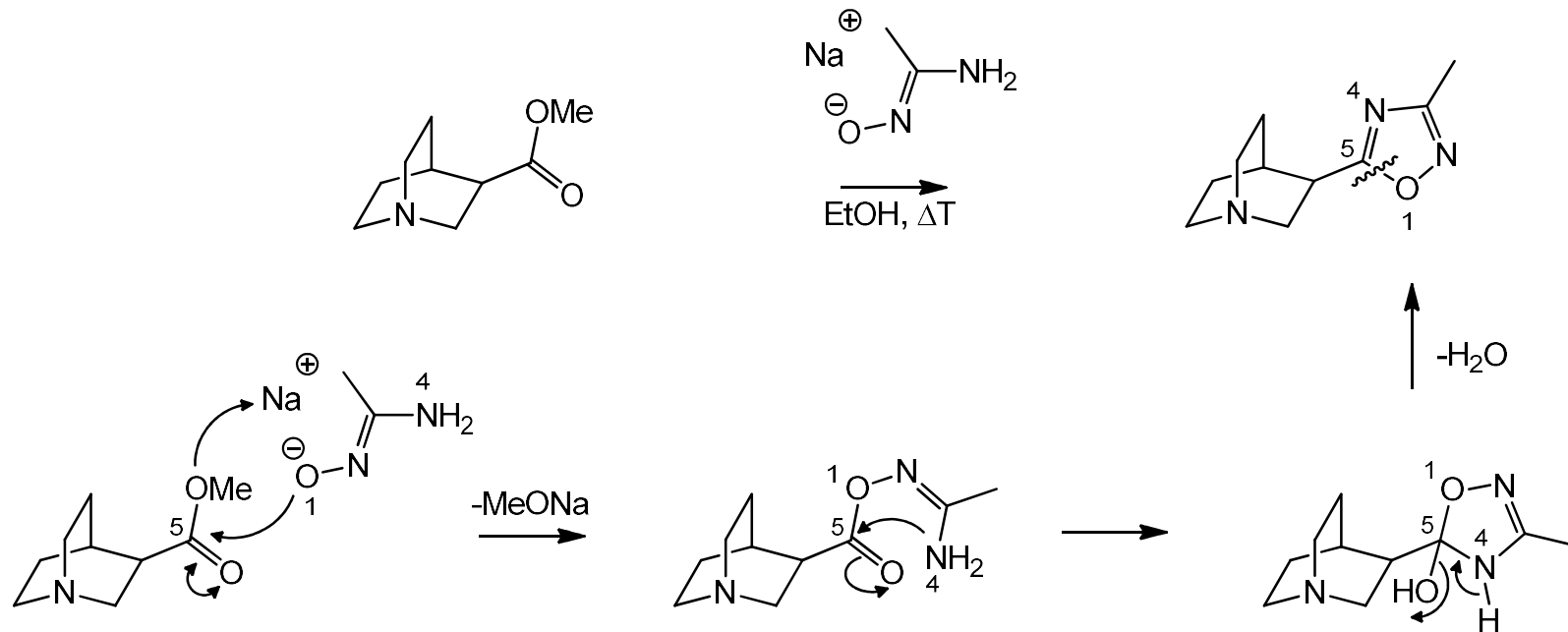


tiatriazol

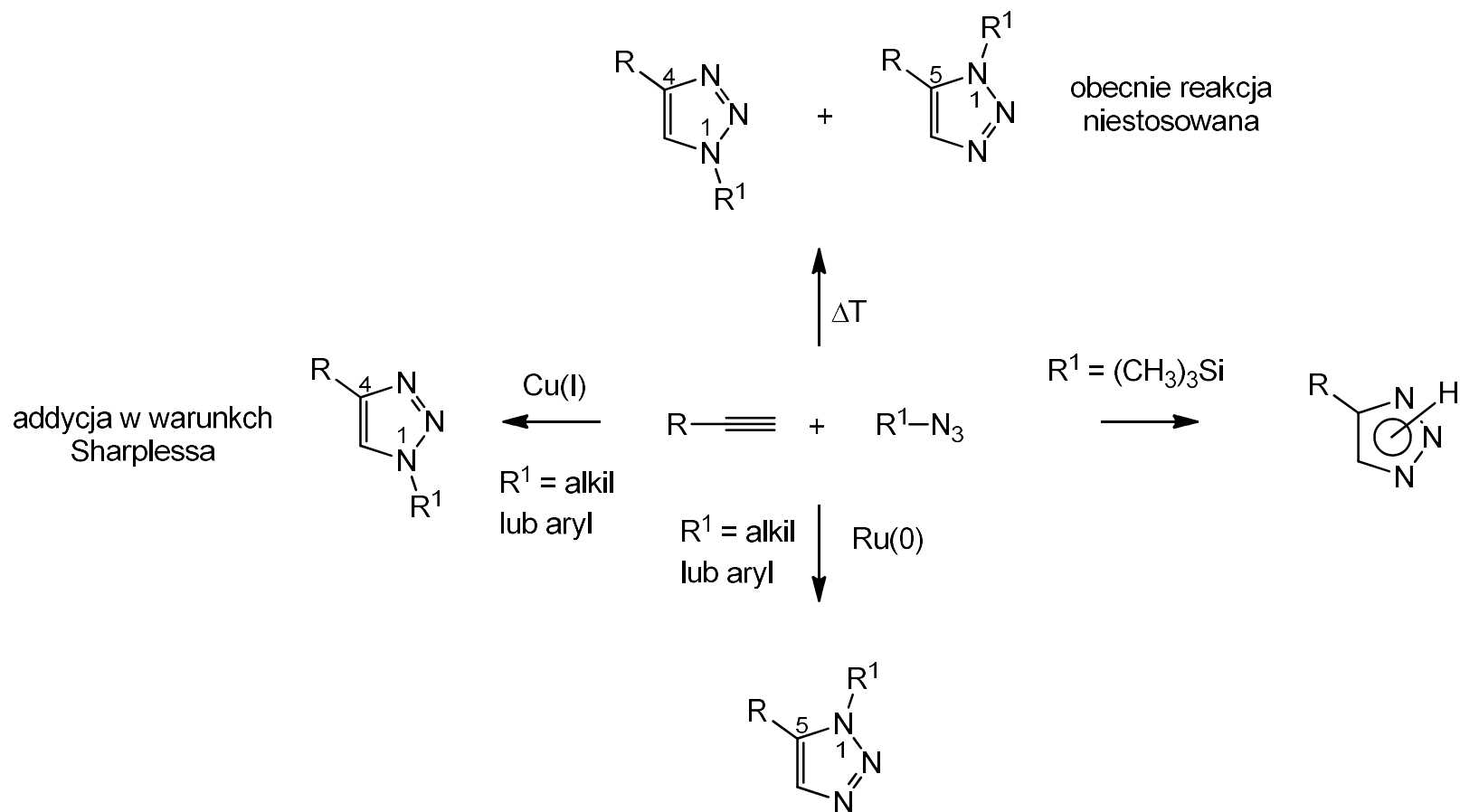
## 6.2. Azole - otrzymywanie 1,2,4-oksadiazoli, dyskonekcja



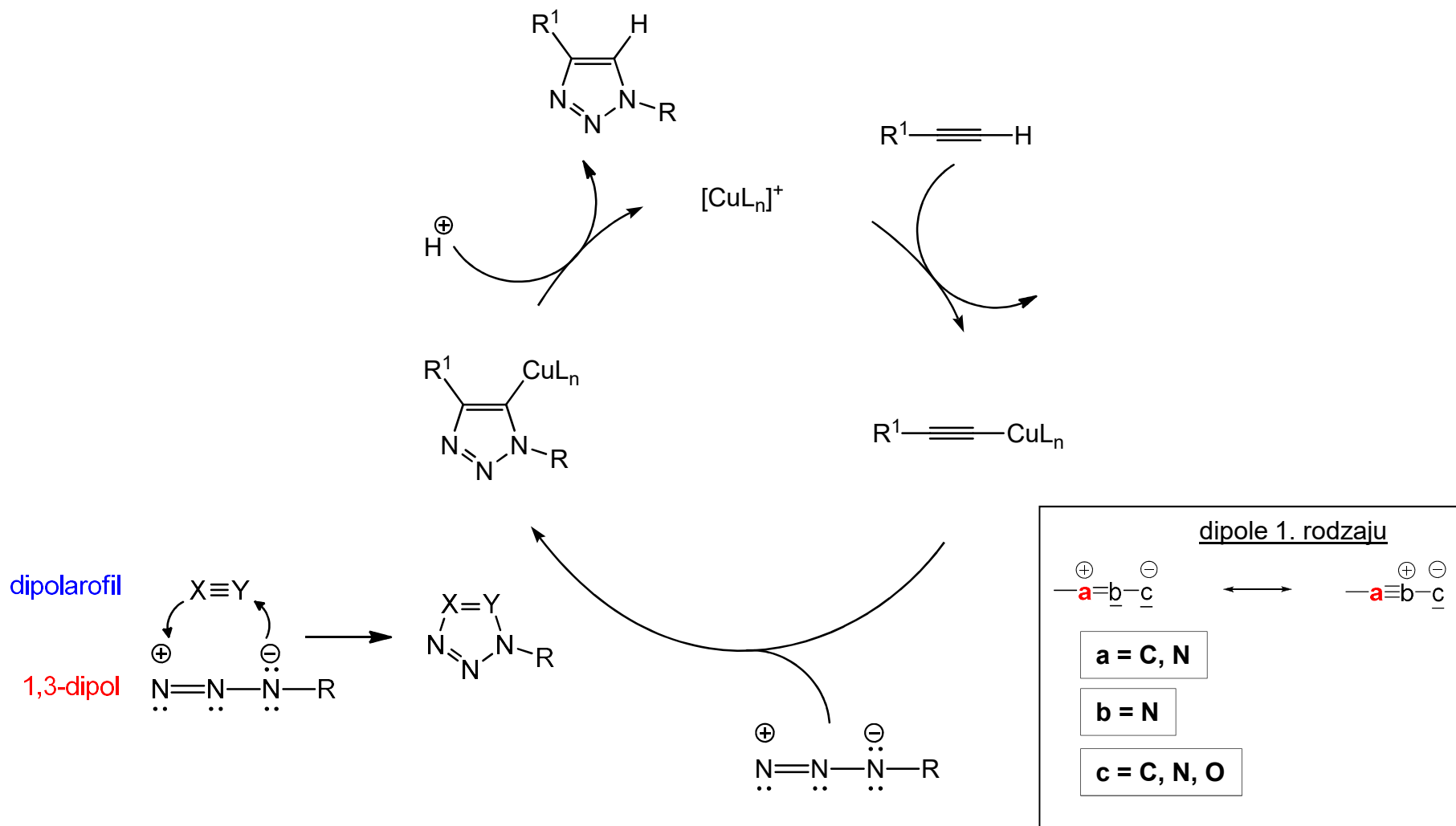
### 6.2.1. Azole - otrzymywanie 1,2,4-oksadiazoli, przykład



### 6.3. Azole - otrzymywanie 1,2,3-triazoli, 1,3-dipolarna cykloaddycja azydków do alkinów

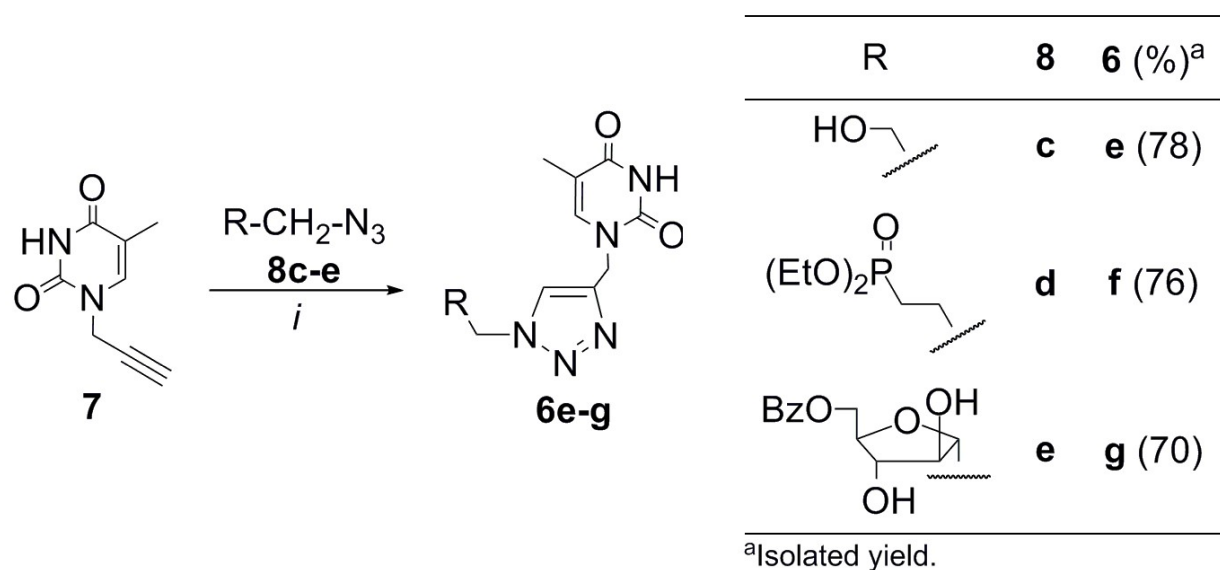


**6.3.1. Azole** - otrzymanie 1,2,3-triazoli, 1,3-dipolarna cykloaddycja azydków do alkinów w warunkach Sharplessa, mechanizm



S. Bräse, C. Gil, K. Knepper, V. Zimmermann *Angew. Chem. Int. Ed.* **2005**, *44*, 5188 – 5240.

**6.3.2. Azole** - otrzymanie 1,2,3-triazoli, 1,3-dipolarna cykloaddycja azydów do alkinów w warunkach Sharplessa, przykłady



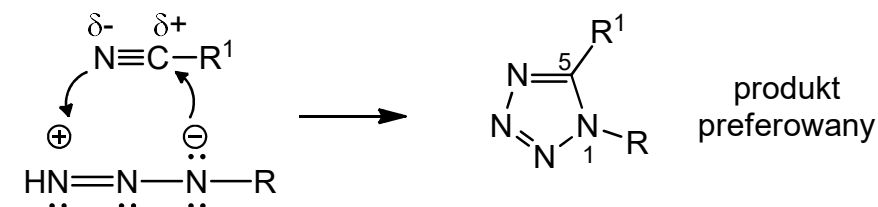
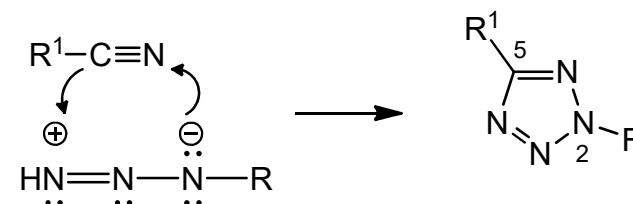
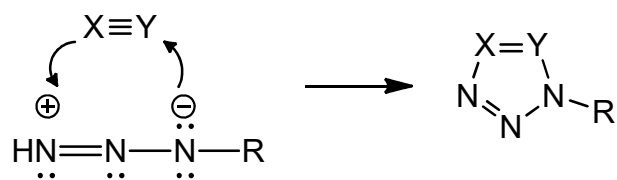
**Scheme 6.** Reagents and conditions: (i) CuI, DIPEA, THF, 70 °C, overnight.

M. Koszytkowska-Stawinska, E. Mironiuk-Puchalska, T. Rowicki *Tetrahedron* **2012**, 68, 214-225.

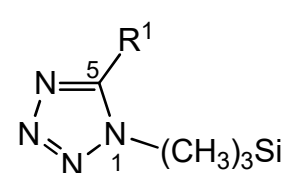
### 6.4. Azole - otrzymywanie tetrazoli, 1,3-dipolarna cykloaddycja azydków do nitryłów

dipolarofil

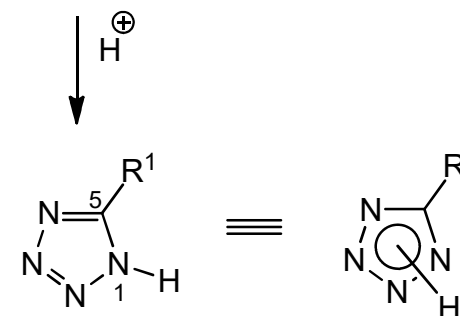
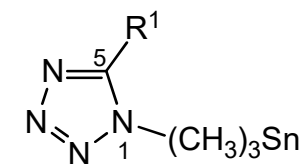
1,3-dipol



R = (CH<sub>3</sub>)<sub>3</sub>Si lub (CH<sub>3</sub>)<sub>3</sub>Sn

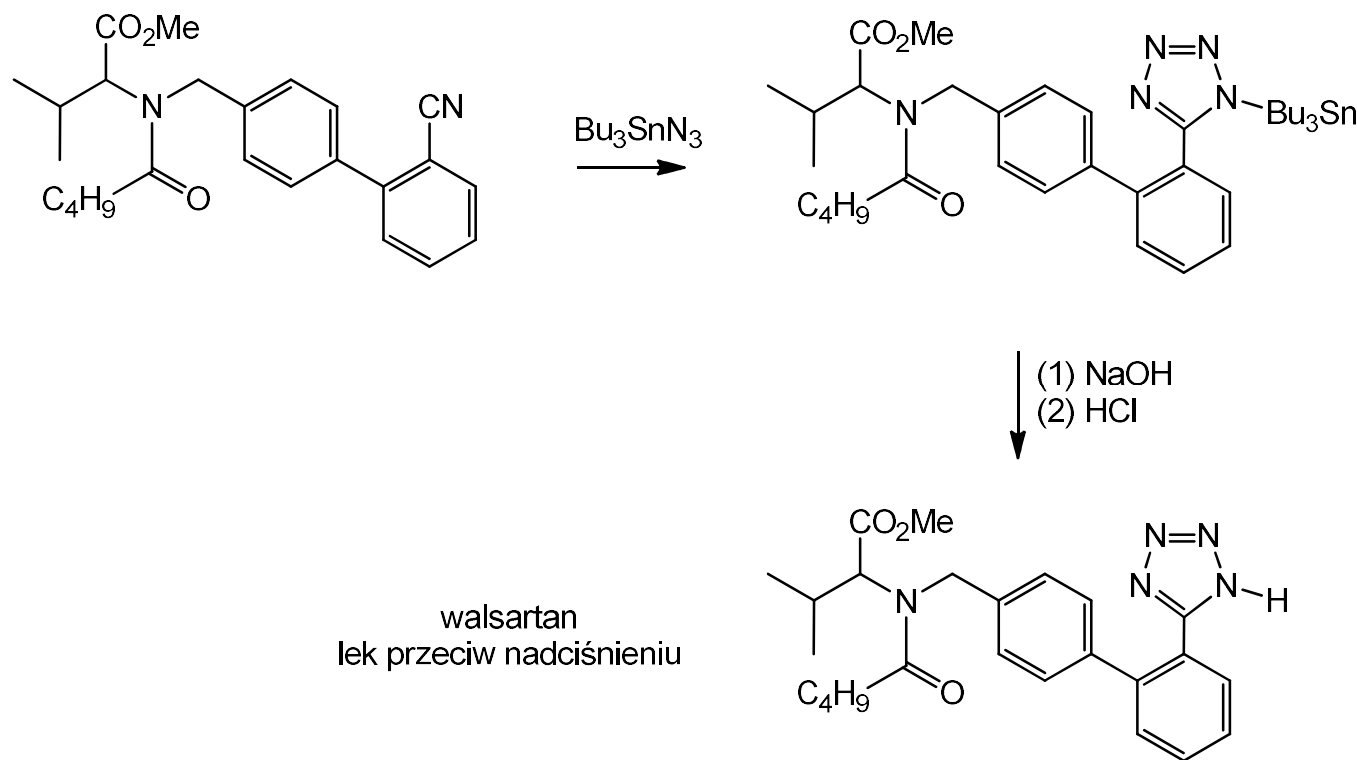


lub



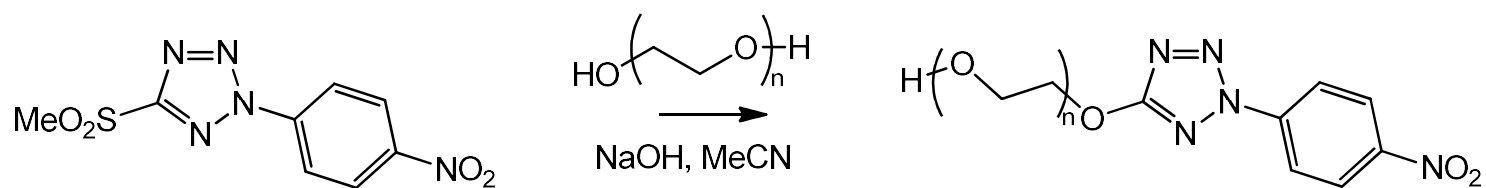
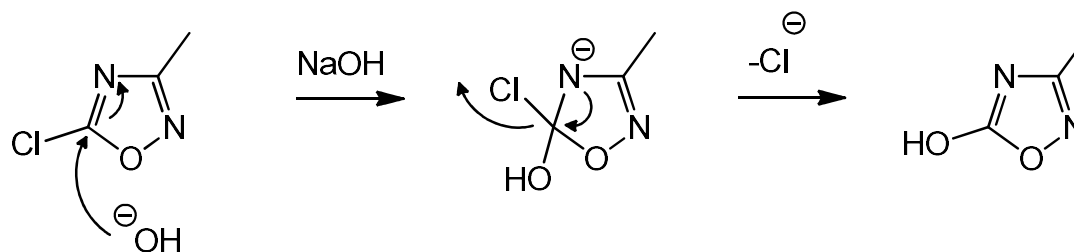


### 6.4.1. Azole - otrzymywanie tetrazoli, 1,3-dipolarna cykloaddycja azydków do nityrłów, przykłady

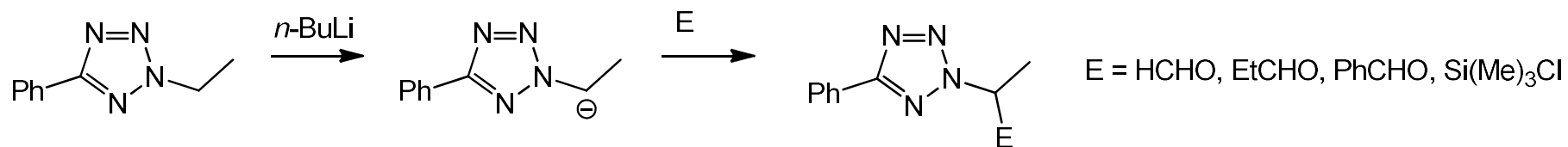
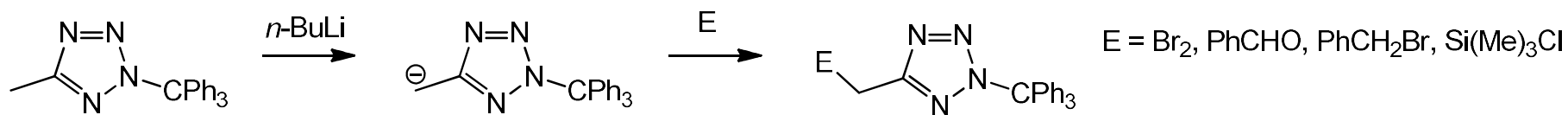
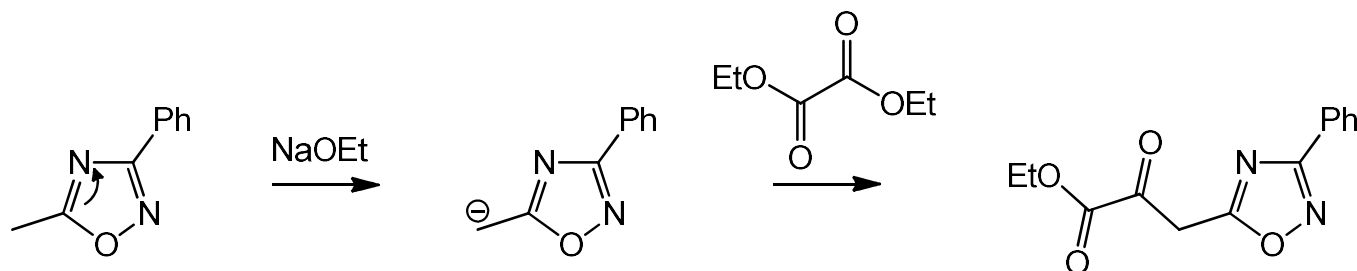


P. Bühlmayer, P. Furet, L. Criscione, M. de Gasparo, S. Whitebread, T. Schmidlin, R. Lattmann, J. Wood, *Bioorg. Med. Chem. Lett.* **1994**, 4, 29-34.

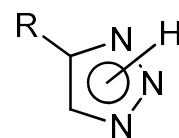
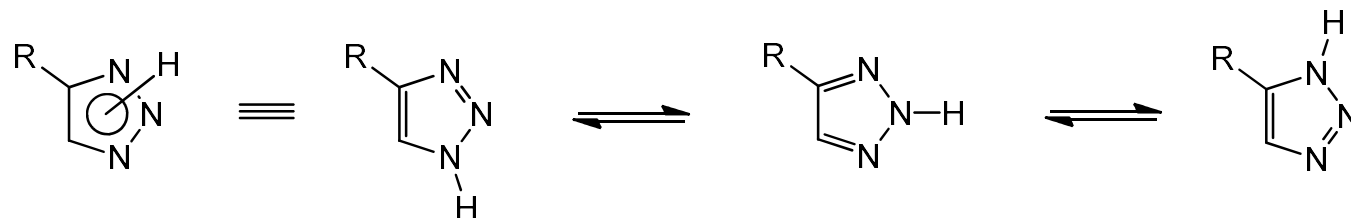
### 6.5. Azole - substytucja nukleofilowa



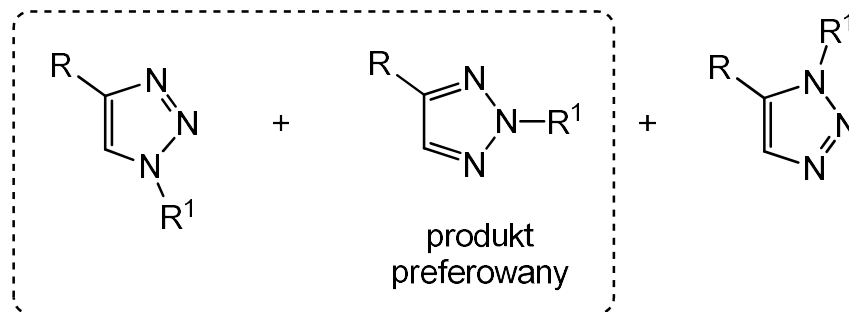
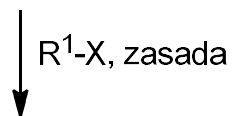
## 6.6. Azole - reaktywność anionów



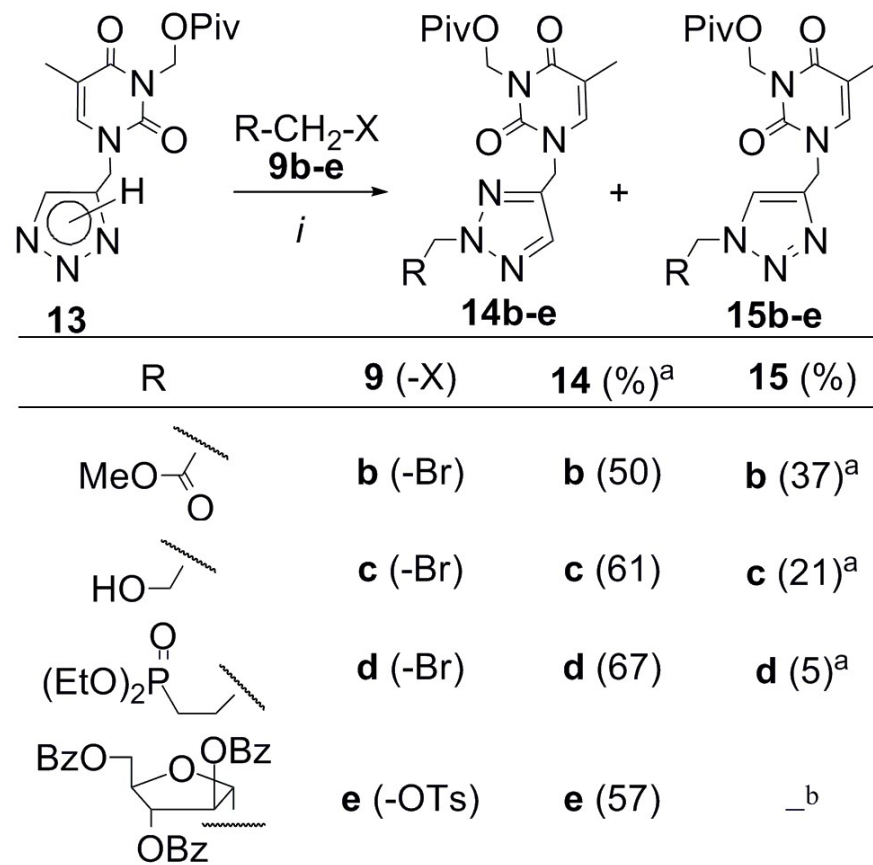
### 6.7. Azole – reaktywność NH-1,2,3-triazoli, reakcja N-alkilowania lub N-acylowania



R<sup>1</sup> = alkil, acyl  
 X = grupa odchodząca (halogen, OMs, OTs)



### 6.7.1. Azole - reaktywność *NH*-1,2,3-triazoli, reakcja *N*-alkilowania lub *N*-acylowania, przykłady

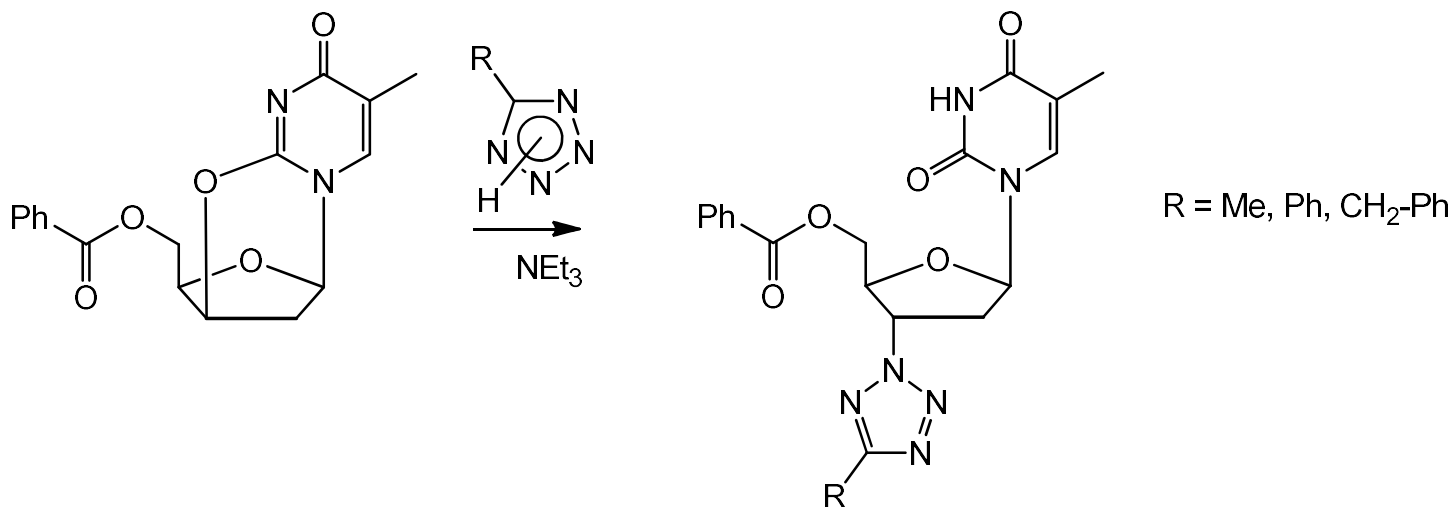
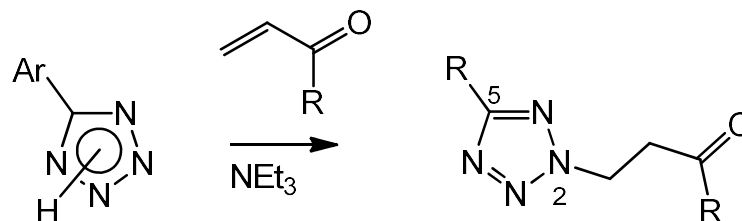
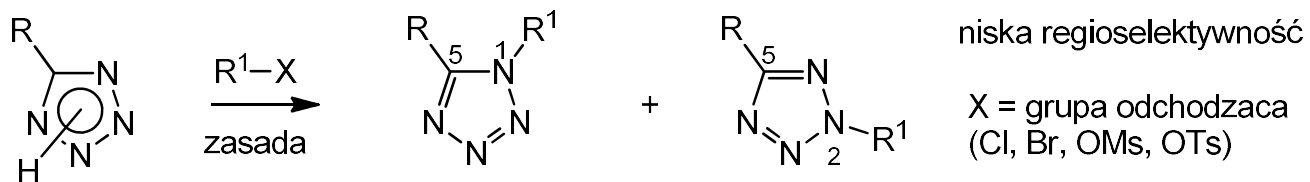


<sup>a</sup>Isolated yield. <sup>b</sup>Not isolated from a **14e/15e** mixture of 70/30, respectively, by <sup>1</sup>H NMR. The **14e/15e** combined yield was 69%.

**Scheme 3.** Reagents and conditions: (i) DBU, DMF, rt, 1d.

M. Koszytkowska-Stawinska, E. Mironiuk-Puchalska, T. Rowicki *Tetrahedron* **2012**, *68*, 214-225.

### 6.8. Azole - reaktywność tetrazoli, reakcja N-alkilowania 5-podstawionych tetrazoli



G. I. Koldobskii, R. B. Kharbush *Russ. J. Org. Chem.* **2003**, 39, 453-470