Solutions to Slumber Theory

1. Eight (1 | 2 | 3 | 4; 12 | 3 | 4; 1 | 23 | 4; 1 | 2 | 34; 12 | 34; 1 | 234; 123 | 4; 1234)

2. 67 | 89 (12 is not slime since it is not prime, and the only possible slicing creates a sequence which includes 1, which is not prime. 345 is not slime, since each of the four possible slicings includes a non-prime: 3 | 4 | 5; 3 | 45; 34 | 5; 345)

3. 2; 2 | 2; 3 | 2

4. 5 x 5 = 2 | 5; 15 x 15 = 2 | 2 | 5

5. 3 x 3 x 3 = 2 | 7; 7 x 7 x 7 = 3 | 43

6. 2 and 3; 2 | 2 and 23; 31 and 3 | 2

7. 31, 3 | 2, and 3 | 3; 71, 7 | 2, and 73

8. There are an infinite number of primes

9. 23 or 2 | 3

10. 223, 2 | 23, or 2 | 2 | 3

11. 2, 3, 5, 7, 23, 37, 53, 73, 373. There are no others.
    Indeed, the only digits one can use are 2, 3, 5, and 7.
    2 can only occupy the first place, otherwise there would be a two-digit slice ending in 2, which would be even and therefore not prime. Similarly, 5 can only occupy the first place, otherwise there would be a two-digit slice ending in 5, which would be a multiple of 5, and not prime. A digit cannot be repeated in consecutive positions, since that would create a slice that would be a multiple of 11.
    If the first digit is 2, the next must be 3, since 27 is not prime. If the first two digits are 23, there can be no third digit, since 237 is a multiple of 3. Therefore, there are no other super-slimes starting with 2.
    A parallel argument shows that the super-slimes starting with 5 are only 5 and 53.
    Super-slimes starting with 3: there is none greater than 3, 37, and 373, since 3737 is a multiple of 37.
    Super-slimes starting with 7: there is none greater than 73, since 737 is a multiple of 11.