Replicator dynamics

1. The replicator equation for the proportion x_i of type i is ...
   (a) $\dot{x}_i = \phi - f_i(x)$
   (b) $\dot{x}_i = x_i\phi$
   (c) $\dot{x}_i = x_i(f_i(x) - \phi)$, where ϕ is the average fitness
   (d) $\dot{x}_i = f_i(x)$

2. A type's frequency increases under the replicator dynamics when ...
   (a) it is rare
   (b) the average fitness is zero
   (c) its fitness is below the population average
   (d) its fitness is above the population average

3. An evolutionarily stable strategy (ESS) is one that ...
   (a) every individual must play
   (b) maximises the total payoff of the population
   (c) cannot be invaded by a small group playing a different strategy
   (d) is always a pure strategy

4. A rest point (stable population) of the replicator dynamics satisfies ...
   (a) $f_i(x) = 0$ for all i
   (b) $\phi = 1$
   (c) $\dot{x}_i = 0$ for all i
   (d) $x_i = 1$ for some i

5. Every ESS is also ...
   (a) a zero sum outcome
   (b) a strictly dominant strategy
   (c) a symmetric Nash equilibrium
   (d) an unstable rest point

6. In the Hawk-Dove game with $V < C$, the dynamics approach ...
   (a) all Doves
   (b) no rest point
   (c) an interior mix of Hawks and Doves (the ESS)
   (d) all Hawks

7. The average population fitness ϕ is ...
   (a) always equal to 1
   (b) $\sum_i x_i f_i(x)$, the fitness-weighted average over types
   (c) the fitness of the fittest type
   (d) the number of types
8. Under the replicator dynamics, a rare but fit type grows ...
   (a) only if it is the only type
   (b) at the same rate as a common type
   (c) instantly to fixation
   (d) slowly, because growth is proportional to its current frequency x_i
9. In a pairwise interaction game with payoff matrix M, the fitness of type i is ...
   (a) $\sum_j M_{ij}$
   (b) the largest entry of M
   (c) $f_i(x) = \sum_j x_j M_{ij}$
   (d) M_{ii}
10. The post-entry population after a fraction ϵ of mutants y invade residents x is ...
    (a) $x + y$
    (b) ϵy
    (c) $x - y$
    (d) $x + \epsilon(y - x)$
11. In Rock-Paper-Scissors, the replicator dynamics ...
    (a) converge to the uniform mix
    (b) converge to all Rock
    (c) have no rest point
    (d) cycle around the interior equilibrium rather than converging to it
12. A two-strategy coordination game (such as which side of the road to drive on) is ...
    (a) without any stable population
    (b) has two stable populations, each pure, with an unstable interior population between them
    (c) a zero sum game
    (d) always convergent to a single mix
13. An ESS is a refinement of Nash equilibrium because ...

(a) every ESS is a symmetric Nash equilibrium, but not every Nash equilibrium is an ESS

(b) they are unrelated

(c) every Nash equilibrium is an ESS

(d) an ESS need not be a Nash equilibrium

14. The replicator dynamics keep the proportions x_i ...

(a) constant over time

(b) summing to 1 (they remain a valid distribution)

(c) summing to the number of types

(d) all equal

15. A stable population that the dynamics actually move towards is ...

(a) the point of maximum fitness

(b) any rest point, even a repelling one

(c) an asymptotically stable rest point (a small perturbation returns)

(d) always $x = 1/2$

16. For a strategy σ^* with $f(\sigma^*, \sigma^*) = f(\sigma, \sigma^*)$, the ESS condition additionally requires ...

(a) $f(\sigma^*, \sigma) > f(\sigma, \sigma)$

(b) $f(\sigma^*, \sigma^*) > f(\sigma, \sigma^*)$

(c) $f(\sigma^*, \sigma) < f(\sigma, \sigma)$

(d) nothing further

17. Taking $\epsilon \to 0$ in the ESS definition recovers ...

(a) the fixation probability

(b) a Condorcet cycle

(c) the replicator equation

(d) the symmetric Nash condition $f(\sigma^*, \sigma^*) \geq f(\sigma, \sigma^*)$

18. The replicator-mutator dynamics extend the replicator equation by adding ...

(a) pairwise proposals

(b) a fixed population size

(c) discounting of future payoffs

(d) mutation between types

19. The asymmetric replicator dynamics model ...

(a) two interacting populations with distinct roles and payoff matrices

(b) a finite population of fixed size

(c) a zero-sum game only

(d) a single population playing itself

20. In a pairwise interaction game with payoff matrix M, the fitness of playing σ against population state x is ...

(a) $\sigma + x$

(b) $\det(M)$

(c) the largest entry of M

(d) $\sigma M x$ (linear in the population state)